

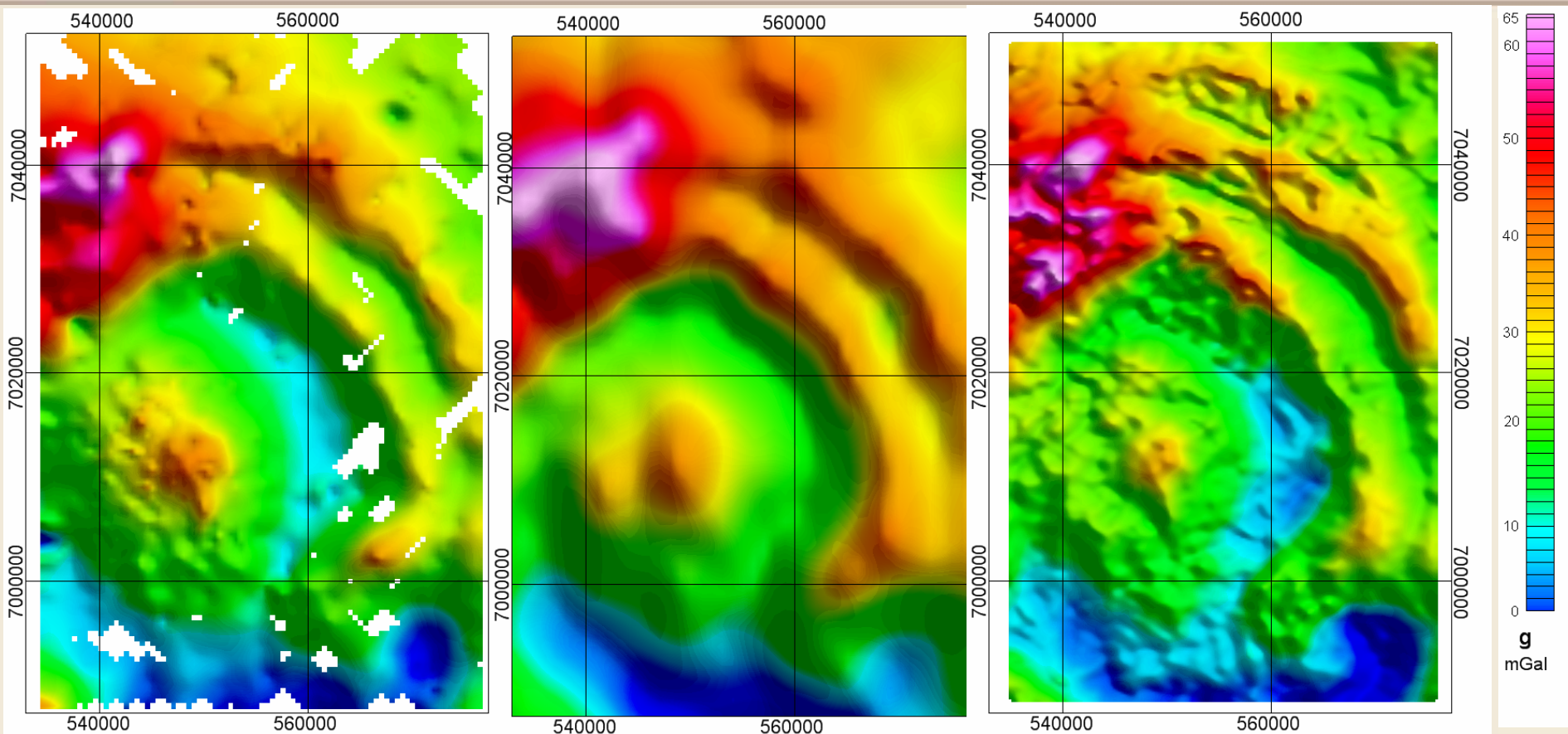


## FALCON AGG A Review

Greg Street



# High resolution gravity - Vredefort Dome



Ground gravimetry

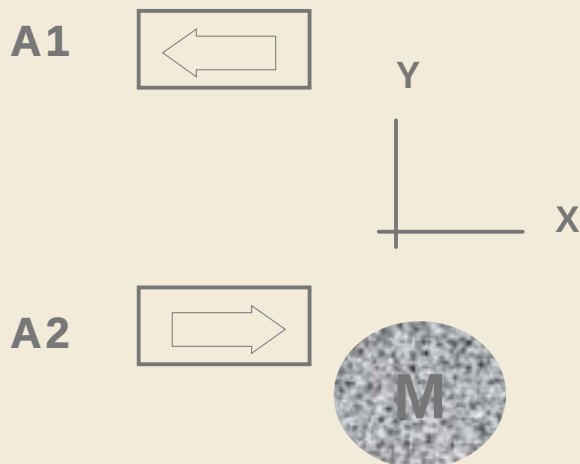
Airborne gravimeter

FALCON AGG



# Gradiometers cancel out motion

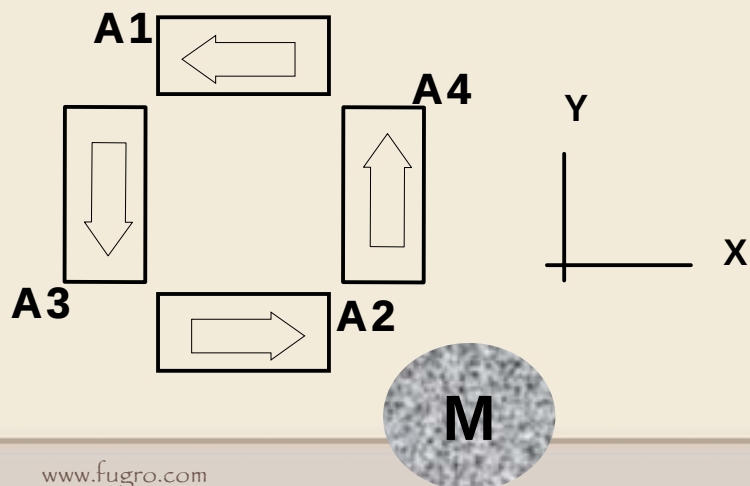
## Simplest $G_{xy}$ Gradiometer



- Differencing displaced accelerations measures the gradient. The aircraft motion cancels out if the accelerometers have the same sensitivity.

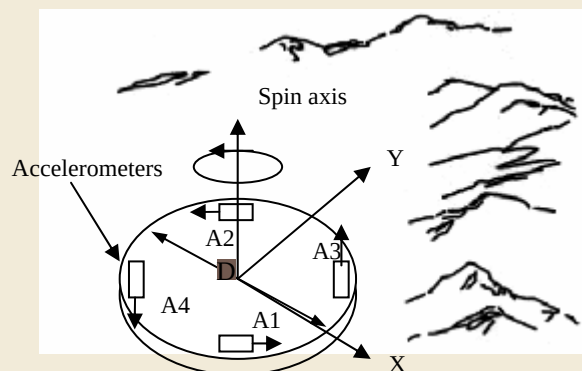
$$G_{xy} \sim A1 + A2$$

## $G_{xy}$ Gradiometer immune to rotational accelerations



- By using two simple gradiometers, we also cancel out rotational accelerations.
- We are still sensitive to accelerations caused by rotational velocities and these are dealt with by an inertial platform.

$$G_{xy} = (A1 + A2) - (A3 + A4)$$



$$(A1+A2)-(A3+A4) = D(G_{xx}-G_{yy})\sin(2\Omega t) + 2DG_{xy}\cos(2\Omega t)$$

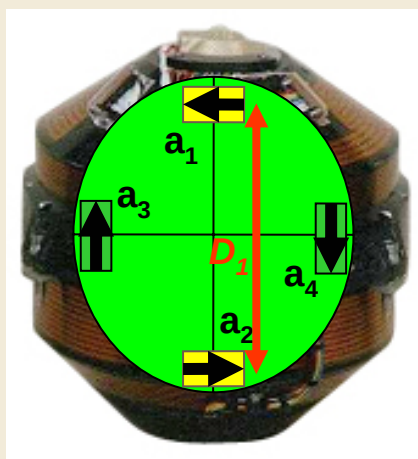
The Lockheed Martin gravity gradiometer instrument (GGI) is based on the principle of accelerometers with tangential sensing axes mounted on a slowly rotating wheel.





- Lockheed Martin design, based on a rotating complement of 4 accelerometers
- Design improvements led to a larger, 2-complement system of lower noise.

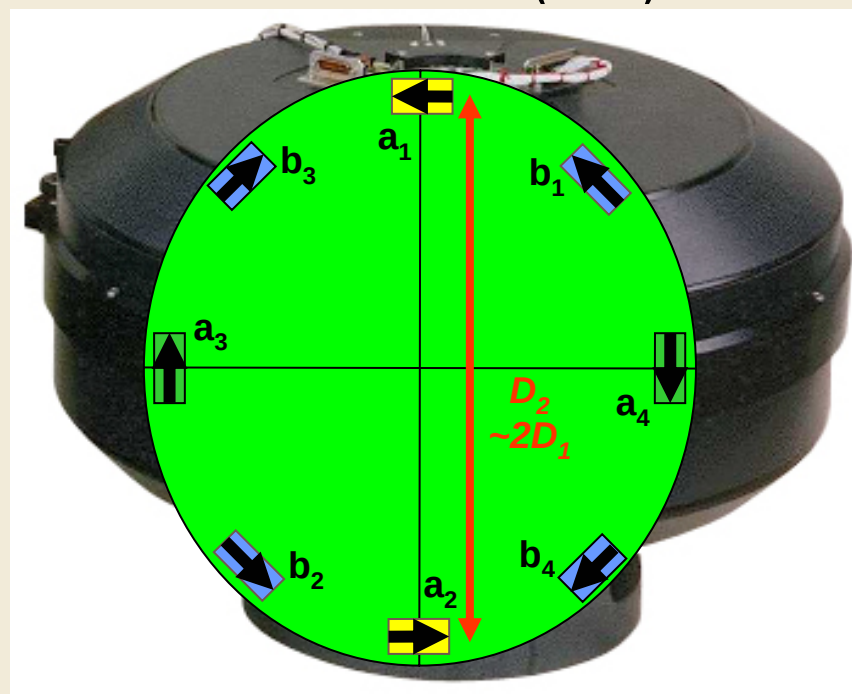
Tensor GGI (1986)



Typical noise power  
15 E<sup>2</sup>/Rad/Sec



Falcon GGI (1999)



Improvement to  
< 2 E<sup>2</sup>/Rad/Sec



# Lockheed Martin family of gradiometers - evolution in design

## All Others



← X →

## FALCON (exclusive)



← 2X →

### Not designed for airborne geophysics

- 1X baseline between accelerometers
- One complement of accelerometers
- Near-vertically oriented accelerometers

### Designed for airborne geophysics

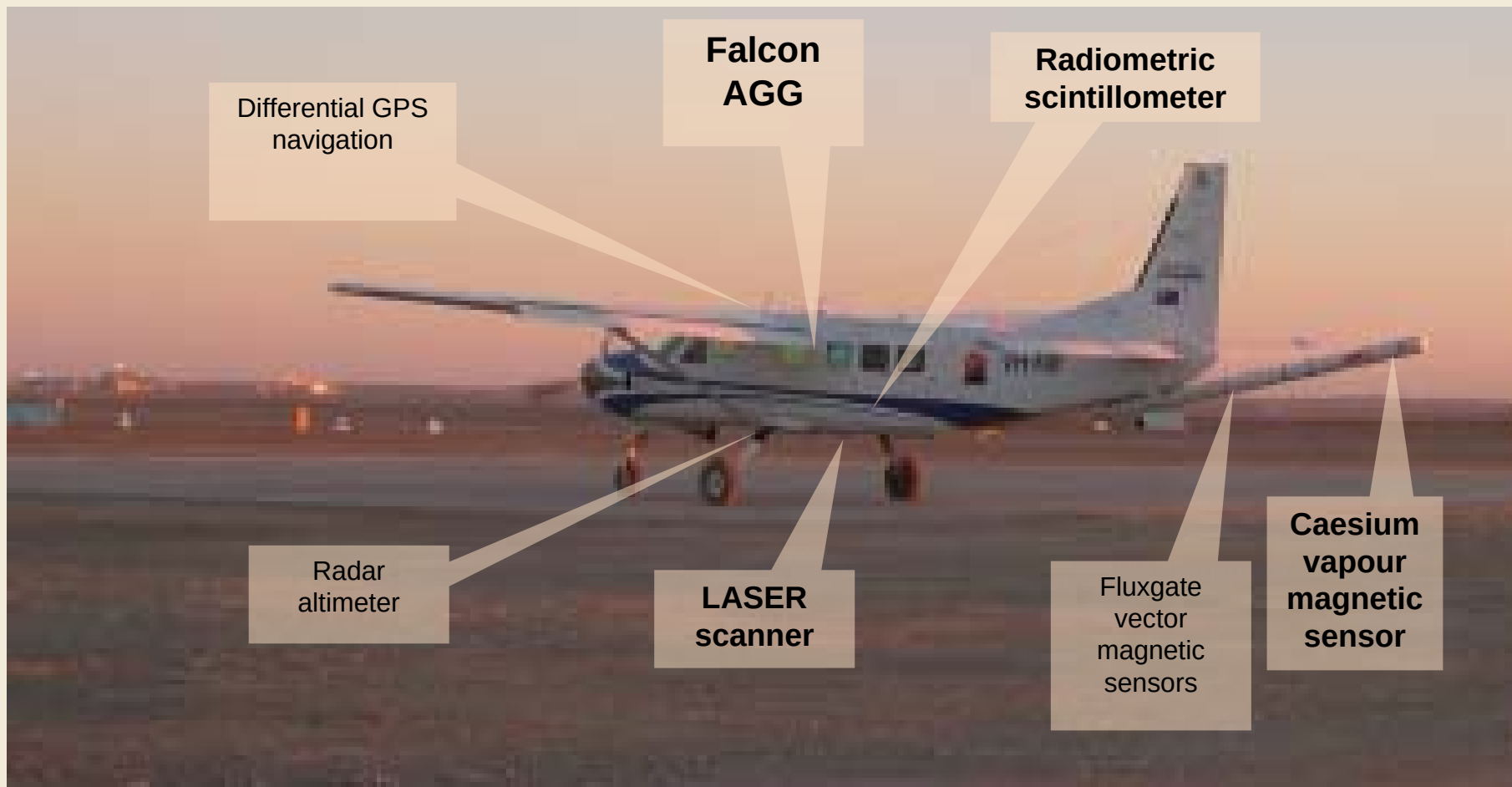
- 2X baseline between accelerometers
- Two complements of accelerometers
- Horizontally oriented accelerometers

### Advantages of FALCON design

- Lower noise
- Higher spatial resolution
- Measured error map



# The FALCON Airborne Geophysics System



# 4 FALCON systems are in operation

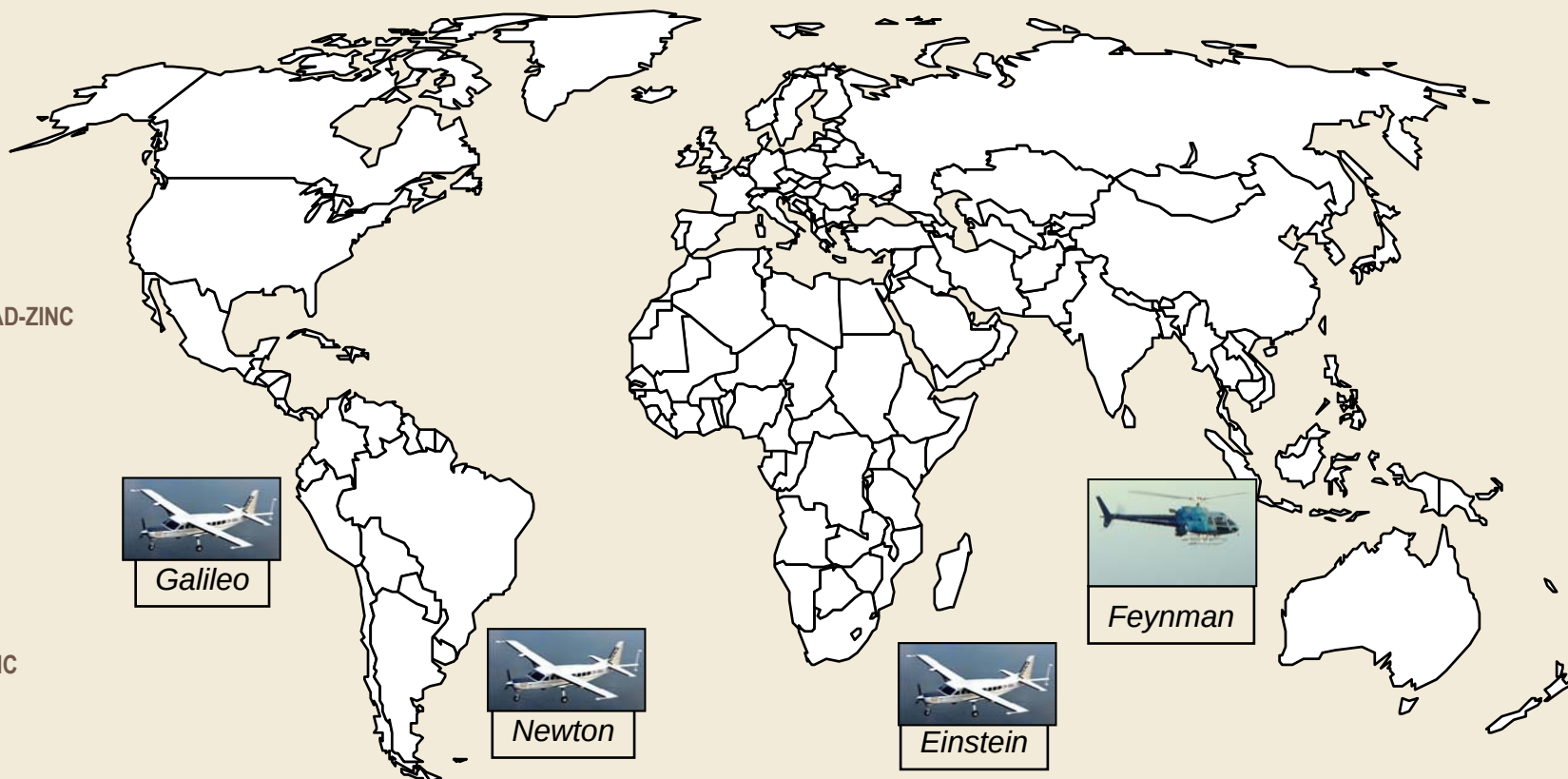






# Nearly 10 Years Of Proven Exploration Success

- DIAMONDS
- IRON ORE
- COPPER
- SILVER- LEAD-ZINC
- OIL&GAS
- URANIUM
- ALUMINIUM
- NICKEL
- COPPER-ZINC
- COAL
- GOLD
- PLATINUM GROUP



**Total of 17 countries, 5 continents, > 1,500,000 km over 250 surveys**

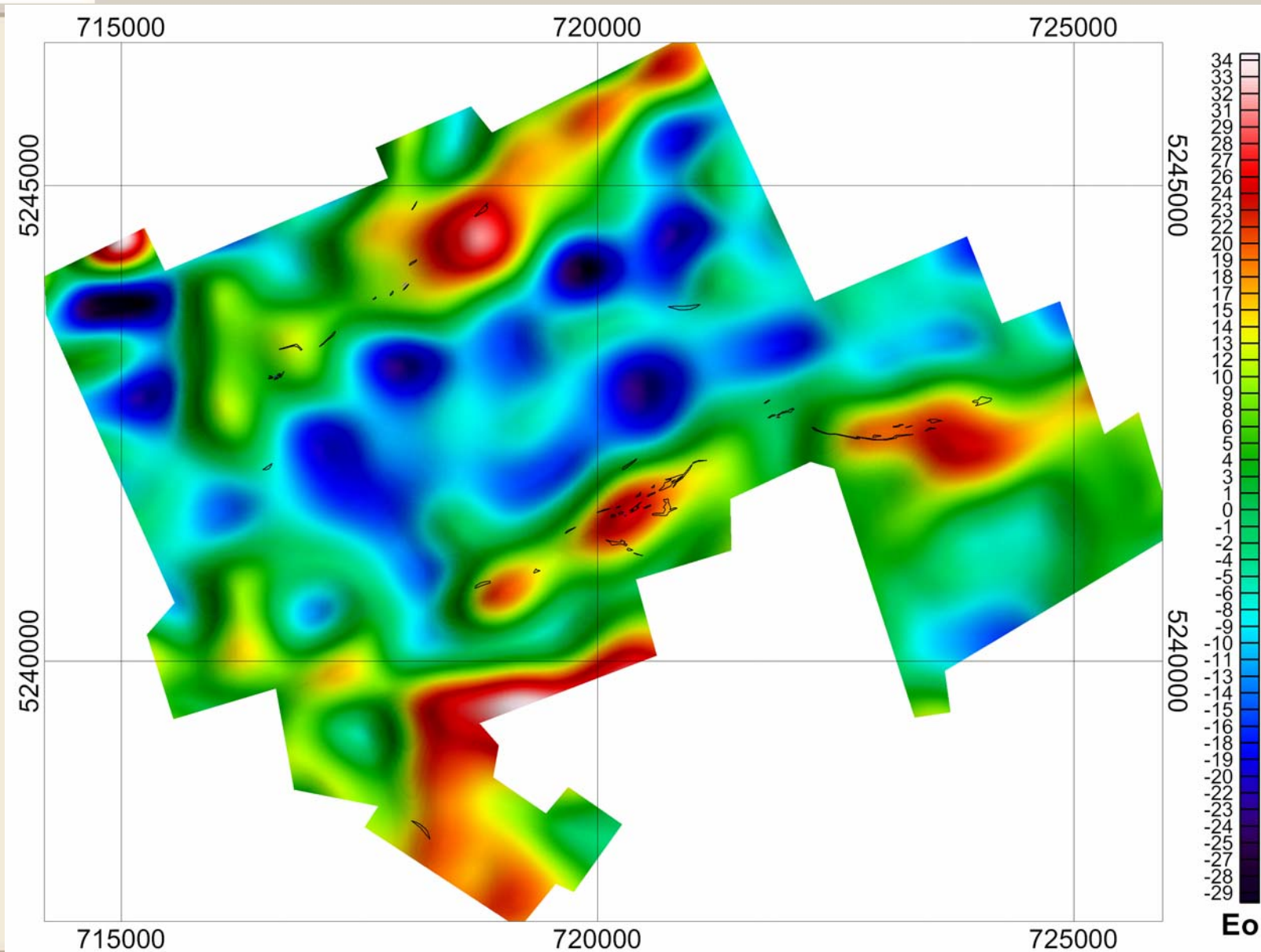
**Oil & gas: 22 surveys and ~ 150,000 km**



- Minimum line length 10 km
- Lead in / Lead out 600 m
- Line separation (target dependent) 50 to 5000 m
- Tie line spacing 3 ~ 5 times
- Nominal survey altitude 80 + m
- Typical speed (Cessna 208B Grand Caravan) 110 knots
- Average weekly production 3000 line km
- Minimal turbulence limitations
- Approved countries under US export licence



# VMS - Heath Steele, Bathurst





# Diamond discoveries - alluvial and kimberlite

## Kimberlitic material intersected at Athena

**Document date:** Wed 29 Aug 2001 **Released time:** Wed 29 Aug 2001  
**Document No:** 200976 **Document part:** A  
**Market Flag:** Y  
**Classification:** Progress Report

THUNDELARRA EXPLORATION LIMITED

2001

HOMEX - Perth

+++++

The Directors of Thundelarra Exploration Ltd ("THX") announce that BHP Billiton has intersected kimberlitic material recently discovered "Athena" gravity anomaly. The anomaly is located in the Mt Barnett-Aries project area in the Kimberley's of Western Australia, which is a joint venture between BHP Billiton and THX.

The first inclined (60 deg N), HQ diamond drill hole intersected the Athena anomaly intersected 53 metres of kimberlitic breccia and macrocrystic kimberlitic material. The hole also targeted a discrete, non-magnetic, gravity anomaly located 100 metres north of the Athena anomaly.

## Diamonds from Gravels

### Feeder Channel



### Eastern Gravels



BHP BILLITON QUARTERLY REPORT ON EXPLORATION AND DEVELOPMENT ACTIVITIES. BHP BILLITON PLC RELEASE April 2001 - June 2001

Two additional kimberlite pipes were discovered during the spring drilling programs bringing the number of known kimberlites to three. One of the pipes (Impala) returned significant quantities of microdiamonds as shown in the table below:

| Pipe   | Interval (m)  |
|--------|---------------|
| Impala | 35.7 - 103.1  |
| Impala | 103.1 - 170.9 |
| Impala | 170.9 - 241.0 |

The Impala pipe was



## ASX Release

### ABNER RANGE - DIAMOND DISCOVERY

#### New Diamondiferous Kimberlite Find

Gravity Diamonds Limited is pleased to announce that it has discovered a new diamond-bearing kimberlite in the Abner Range district, near McArthur River in the Northern Territory. The discovery is subject to the Gravity Diamonds Limited / Rio Tinto Exploration Agreement and is located some 42 kilometres southwest of Xstrata's McArthur River mine.

The kimberlite was found by drilling one of a number of priority targets which had been identified from the FALCON® gravity aerial survey which was flown as part of Gravity's 2004 field programme. Several similar, untested gravity features in the vicinity of the discovery are considered priority drill targets for the upcoming field season. RC drill chips from two of the four holes targeted on the FALCON® gravity low returned geological and geochemical results typical of a weathered kimberlitic source. One of the holes contained diamonds. Recovery and analysis of kimberlitic indicator minerals from the drill holes is in progress with results to date as follows:

- Hole ARC 03 recovered one macrodiamond and two microdiamonds. The hole intersected rare rounded sandstone clasts and more dominant clay material from a hole terminated prematurely at 28 metres due to high water flows. An extremely strong kimberlitic indicator mineral response from 16-28 metres (EOH) included the recovery of these diamonds from a 24kg sample of -2.0mm to +0.3mm processed material. The three diamonds are reported as being unresorbed, colourless octahedra with flat faces and sharp edges, which are indicative of gem quality stones. Observation reports of samples from 0-16 metres are pending.

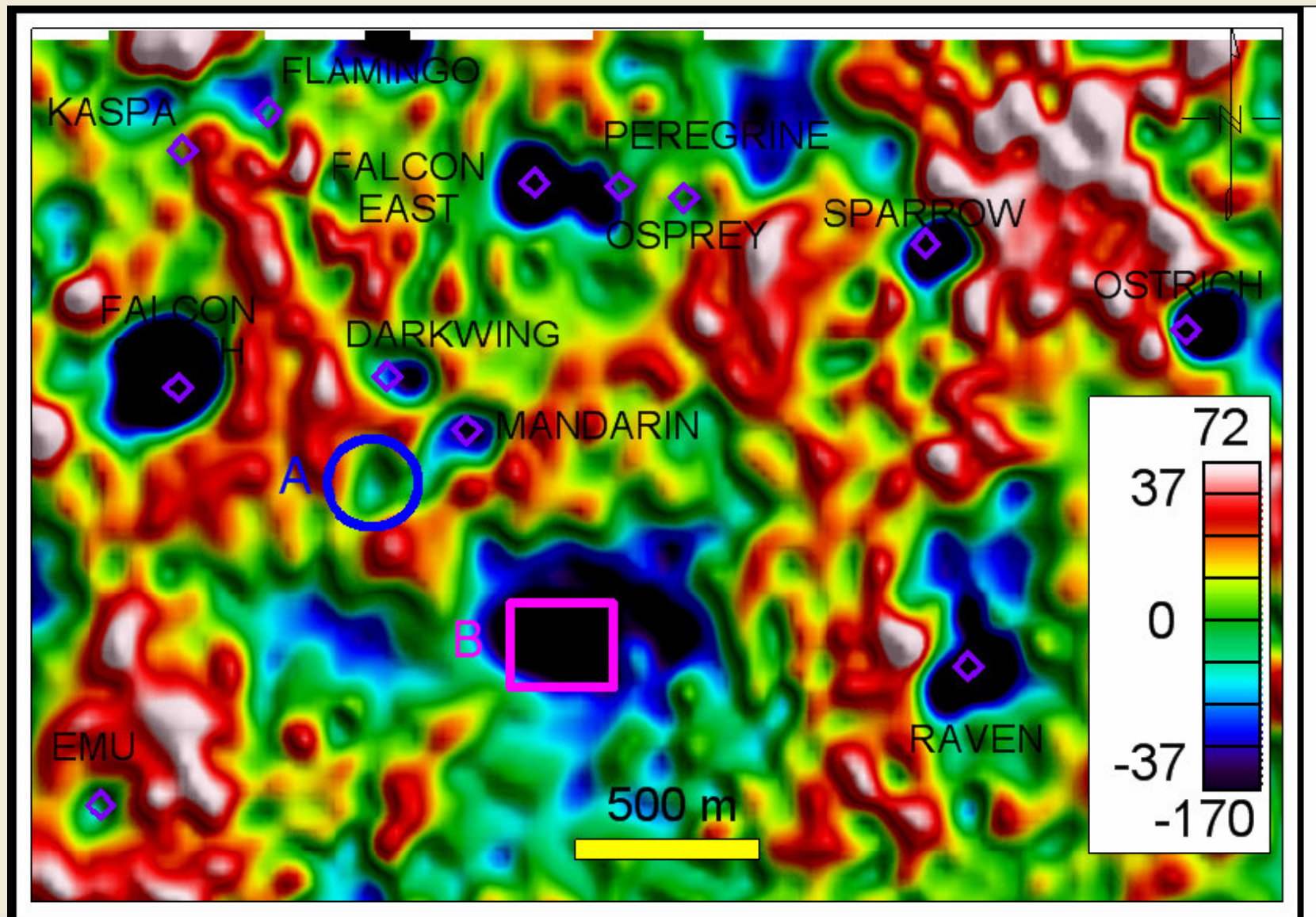
- Hole ARC 01, located approximately 50 metres from ARC 03, returned a 20.00 carat (4.00 g) of rough and faceted diamonds.

17 January 2005

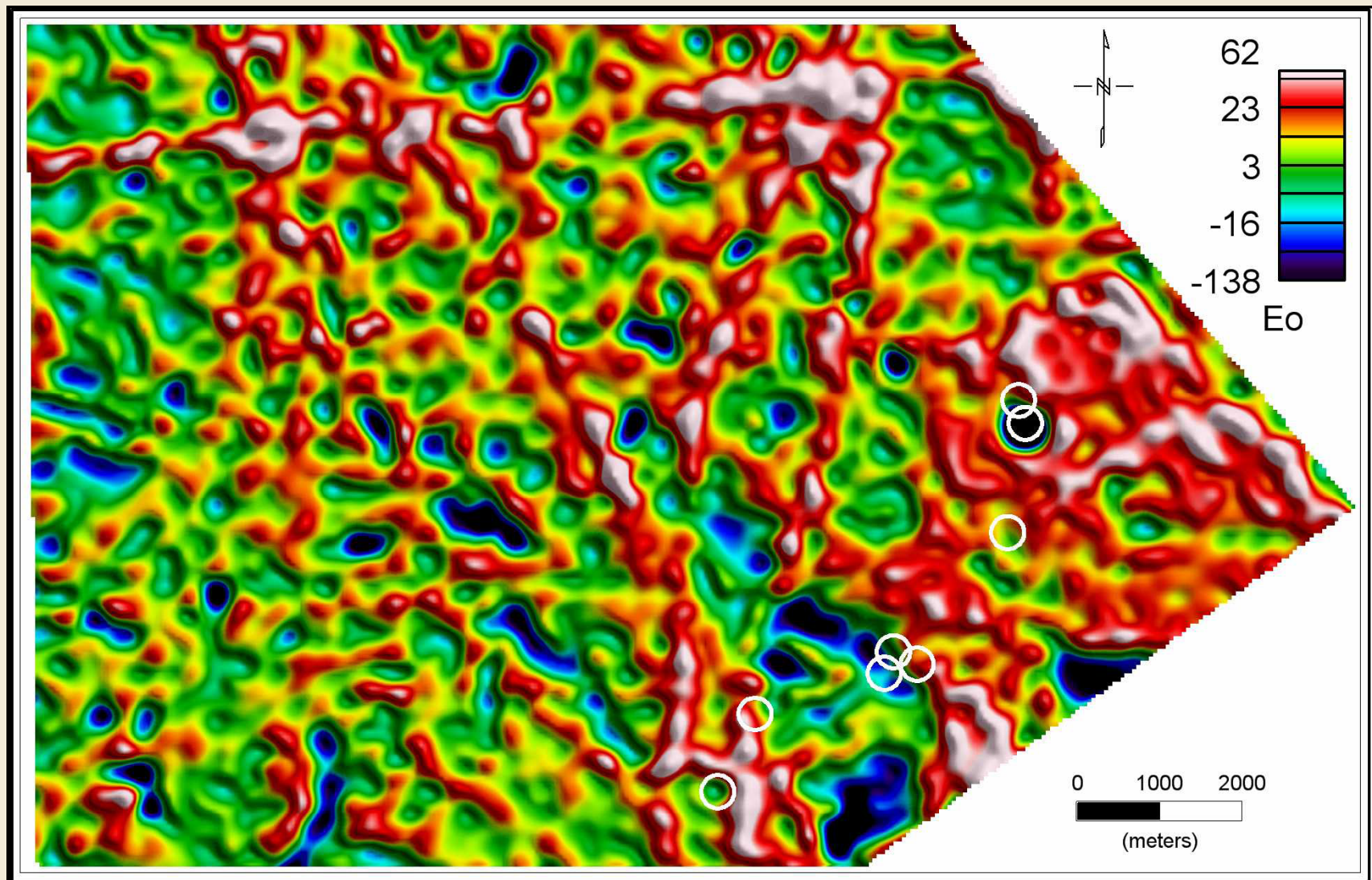
### Alluvial Projects





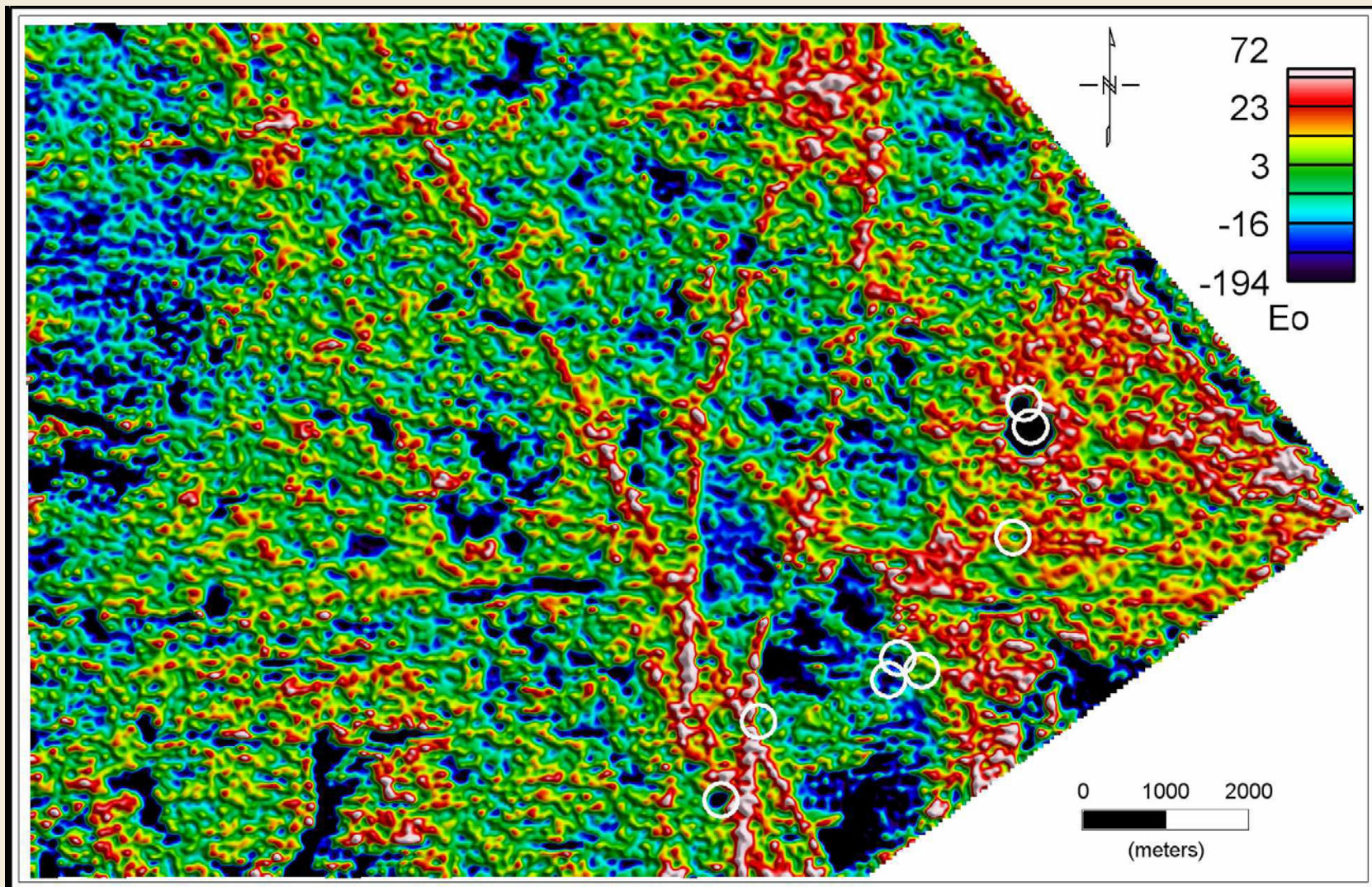






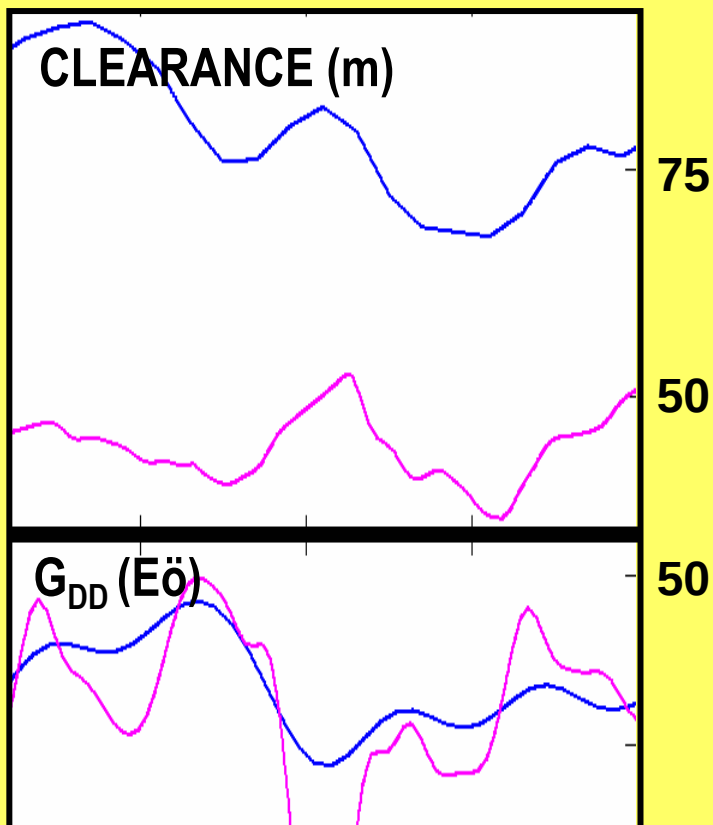
EW 100/1000 80m alt





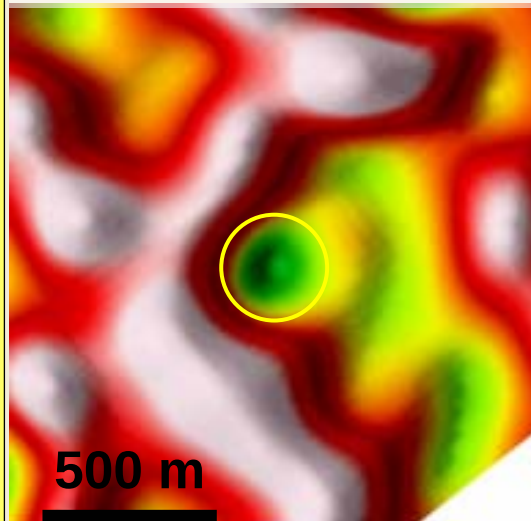
EW 50m x 500m at 50m alt and 30m/s

Fixed wing — Helicopter —

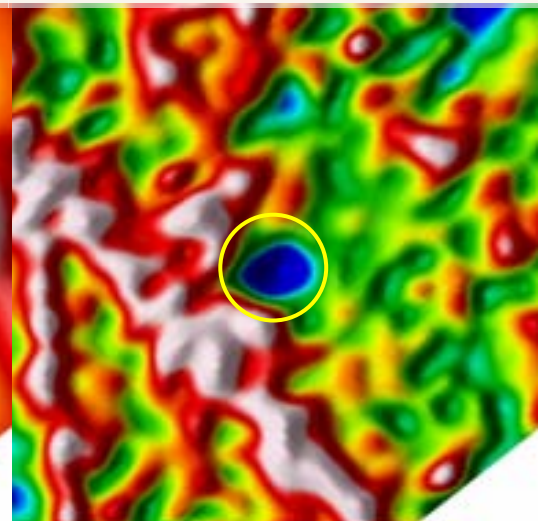


This amplitude increase is primarily due to the significant improvement in data resolution.

**Fixed wing G<sub>DD</sub>**

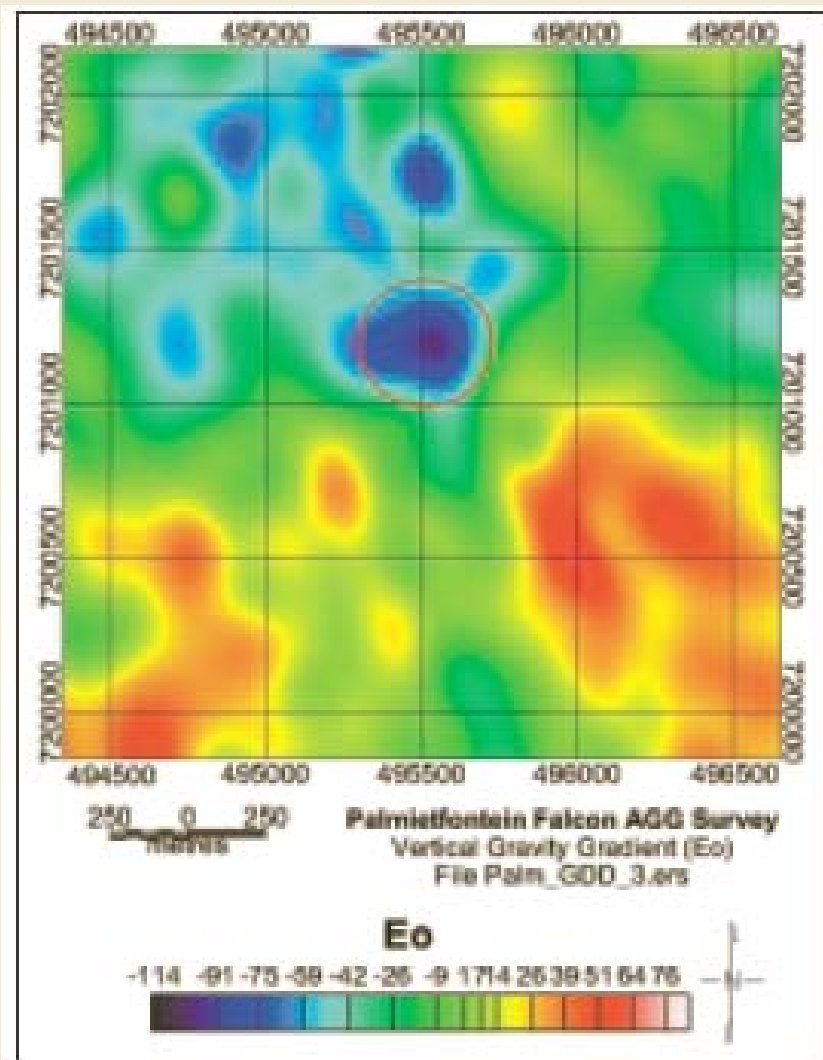
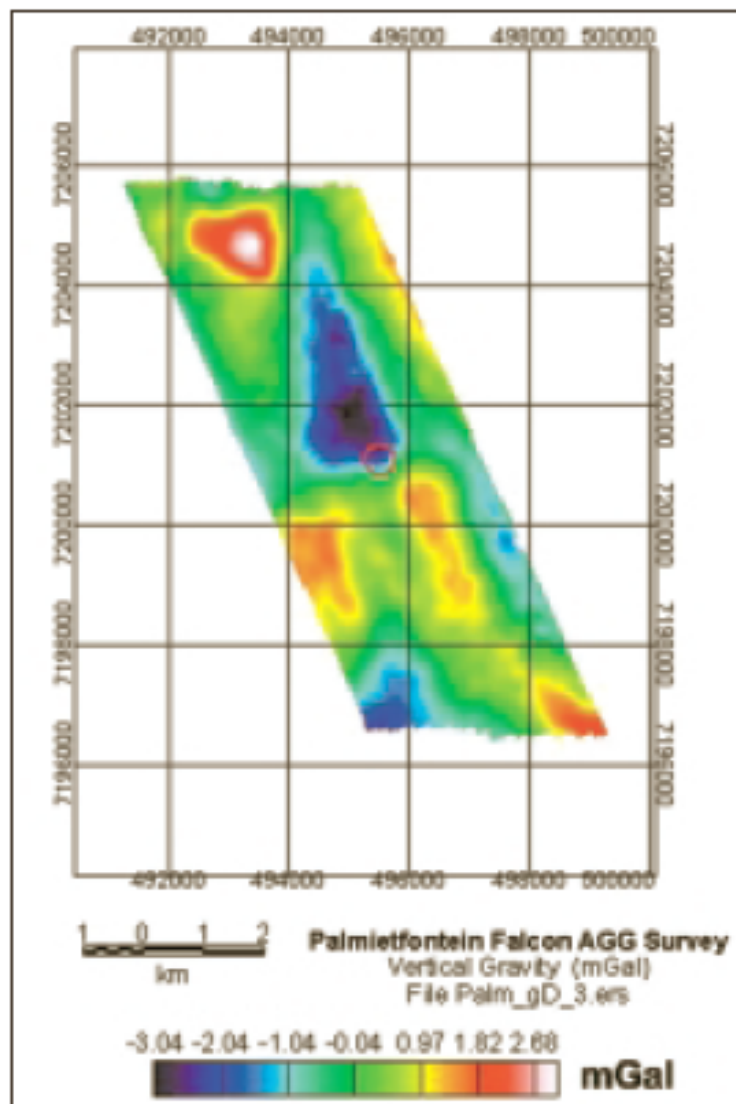


**Helicopter G<sub>DD</sub>**

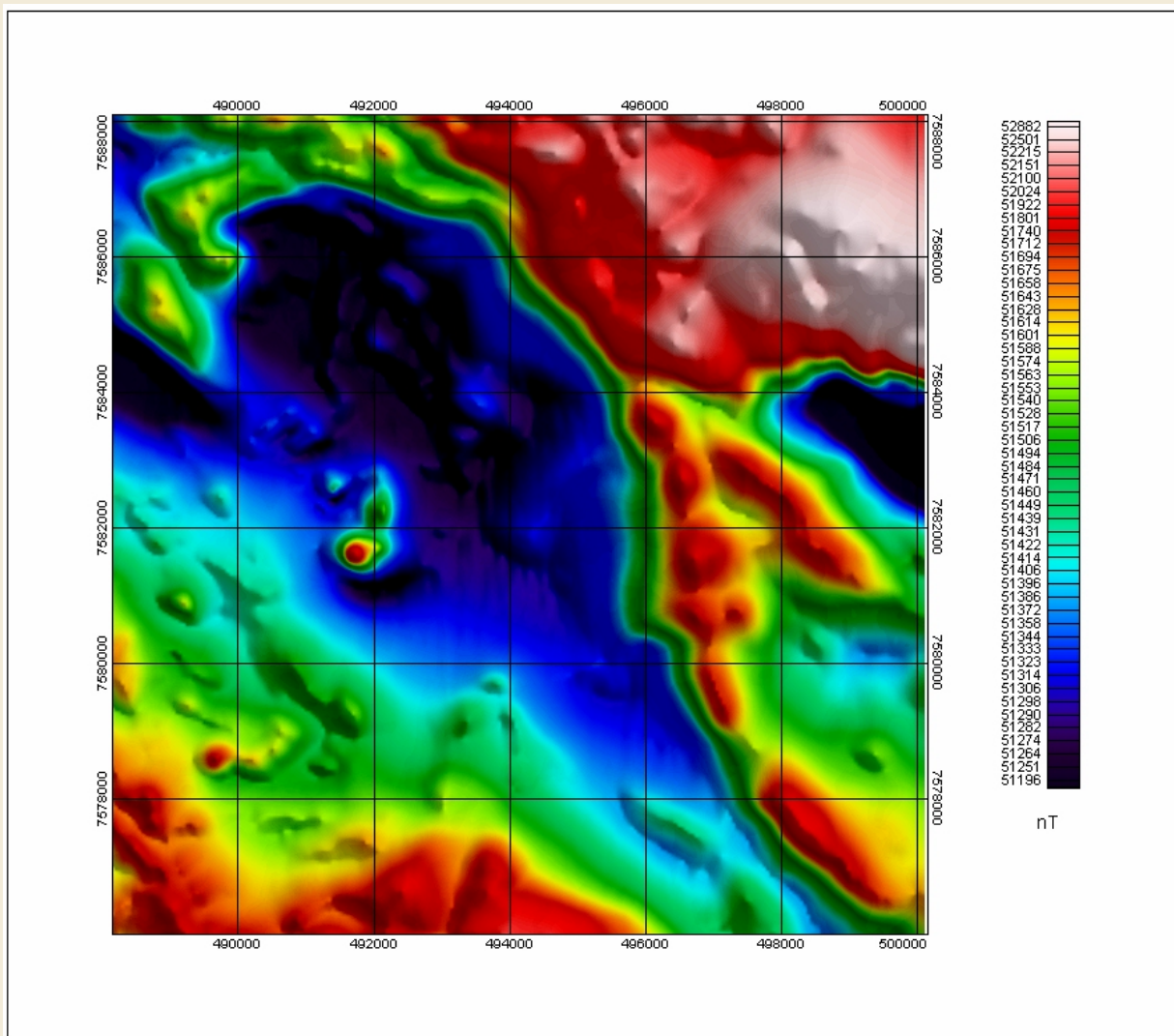


This kimberlite would not have been selected as a target in the original data whereas in the helicopter data it shows as a stand-out anomaly with amplitude 100 Eötvös.









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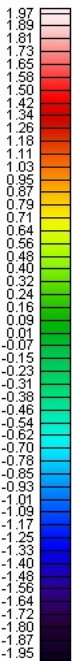
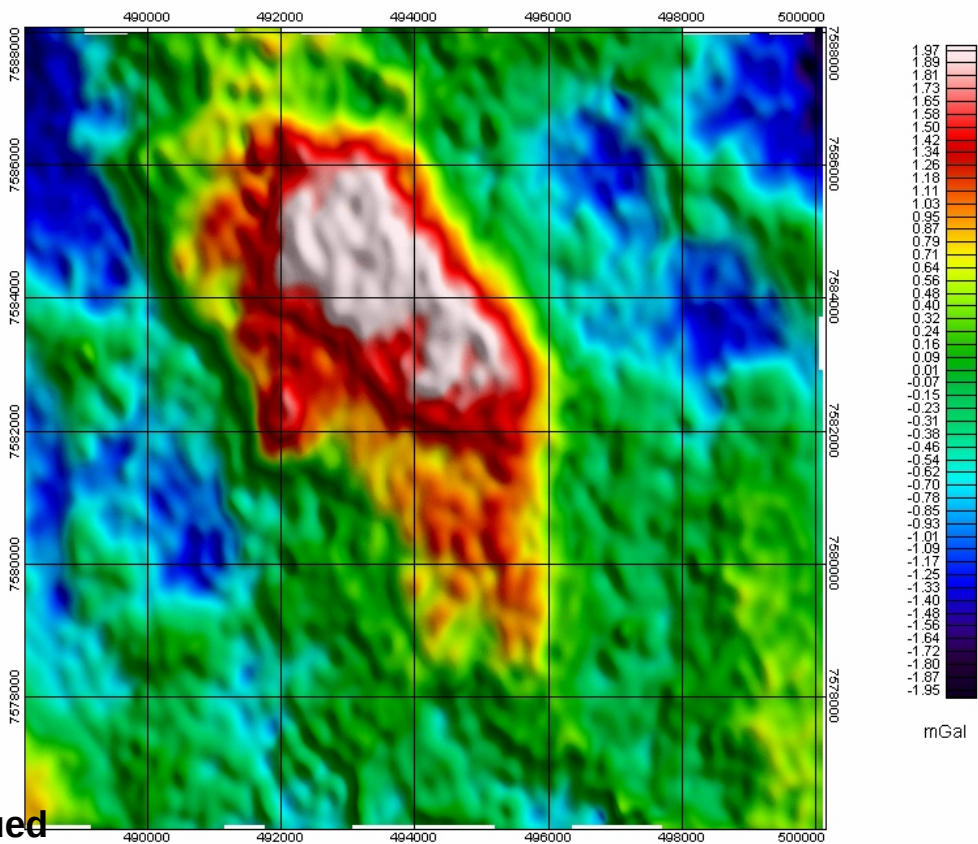
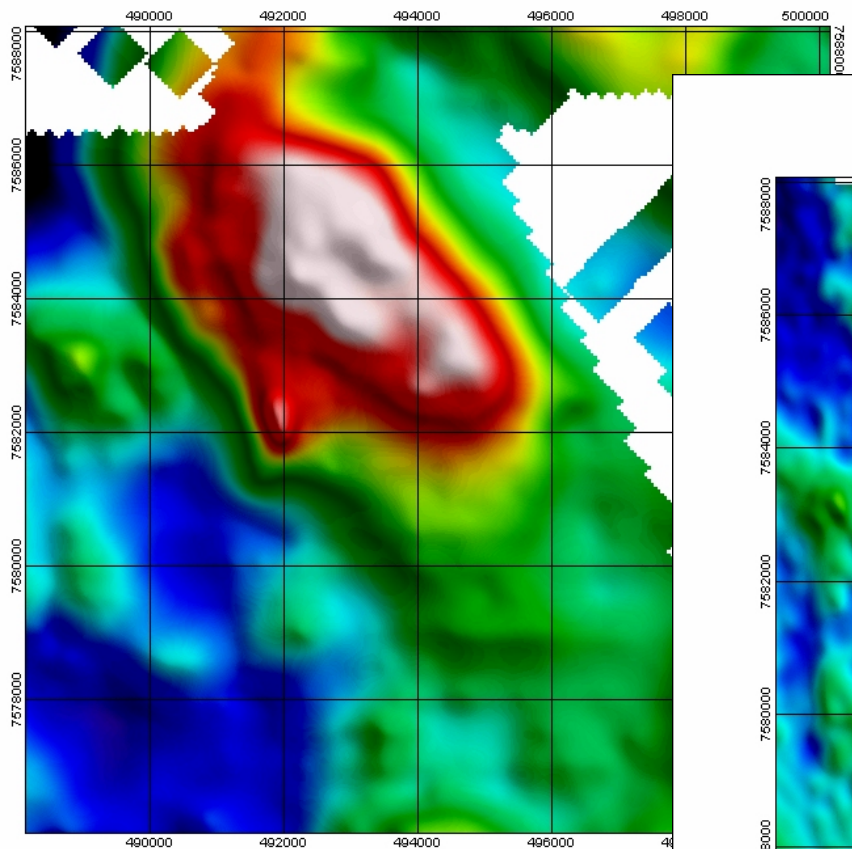
| Survey          | A    | B    | C   | D   | E   | F    |
|-----------------|------|------|-----|-----|-----|------|
| Clearance (m)   | 120  | 120  | 170 | 220 | 320 | 120  |
| Bearing         | NS   | EW   | NS  | NS  | NS  | NS   |
| Line spacing(m) | 100  | 100  | 200 | 200 | 200 | 100  |
| No. of lines    | 120  | 120  | 60  | 60  | 60  | 120  |
| Line (km)       | 1750 | 1750 | 870 | 870 | 870 | 1750 |

Survey parameters for the 6 AGG surveys over Cannington (from Christensen et al. 2001).

Found that a body such as Cannington was detectable from a flying height of 120m below 130m of regolith

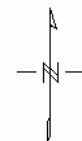
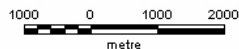


# Gravity at Cannington



mGal

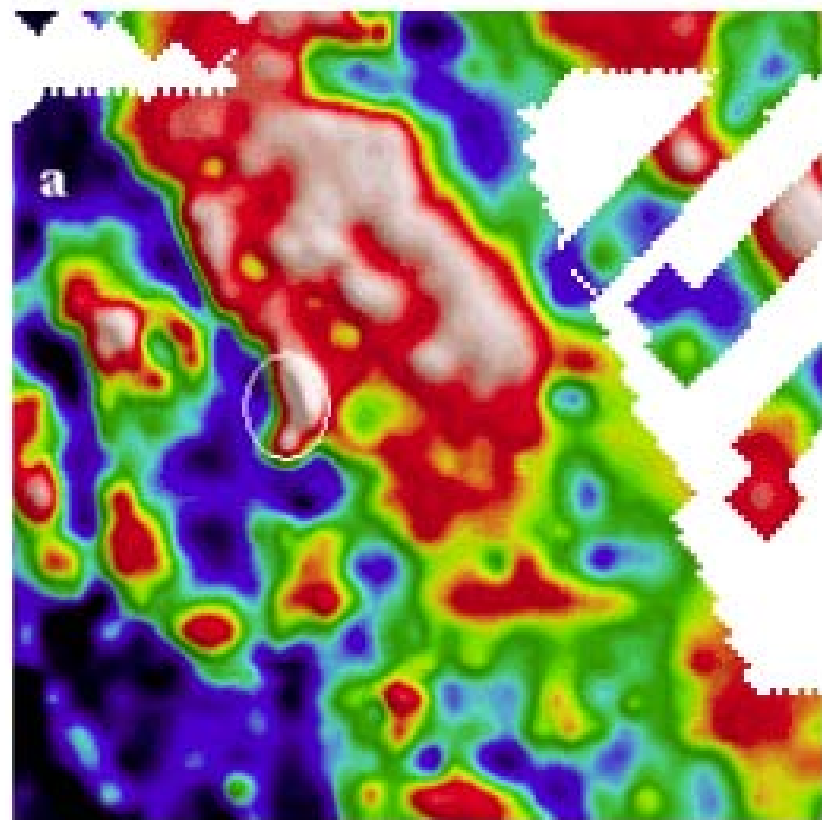
Falcon gD



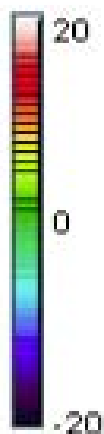
Ground gravity measurements upward continued



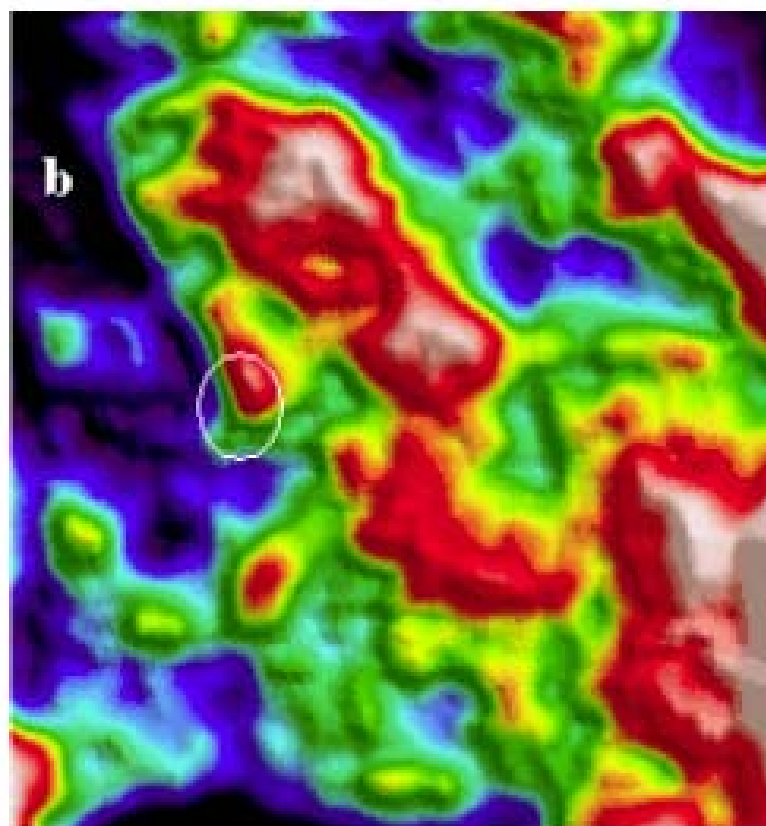
# Gravity vertical gradient at Cannington



Eotvos



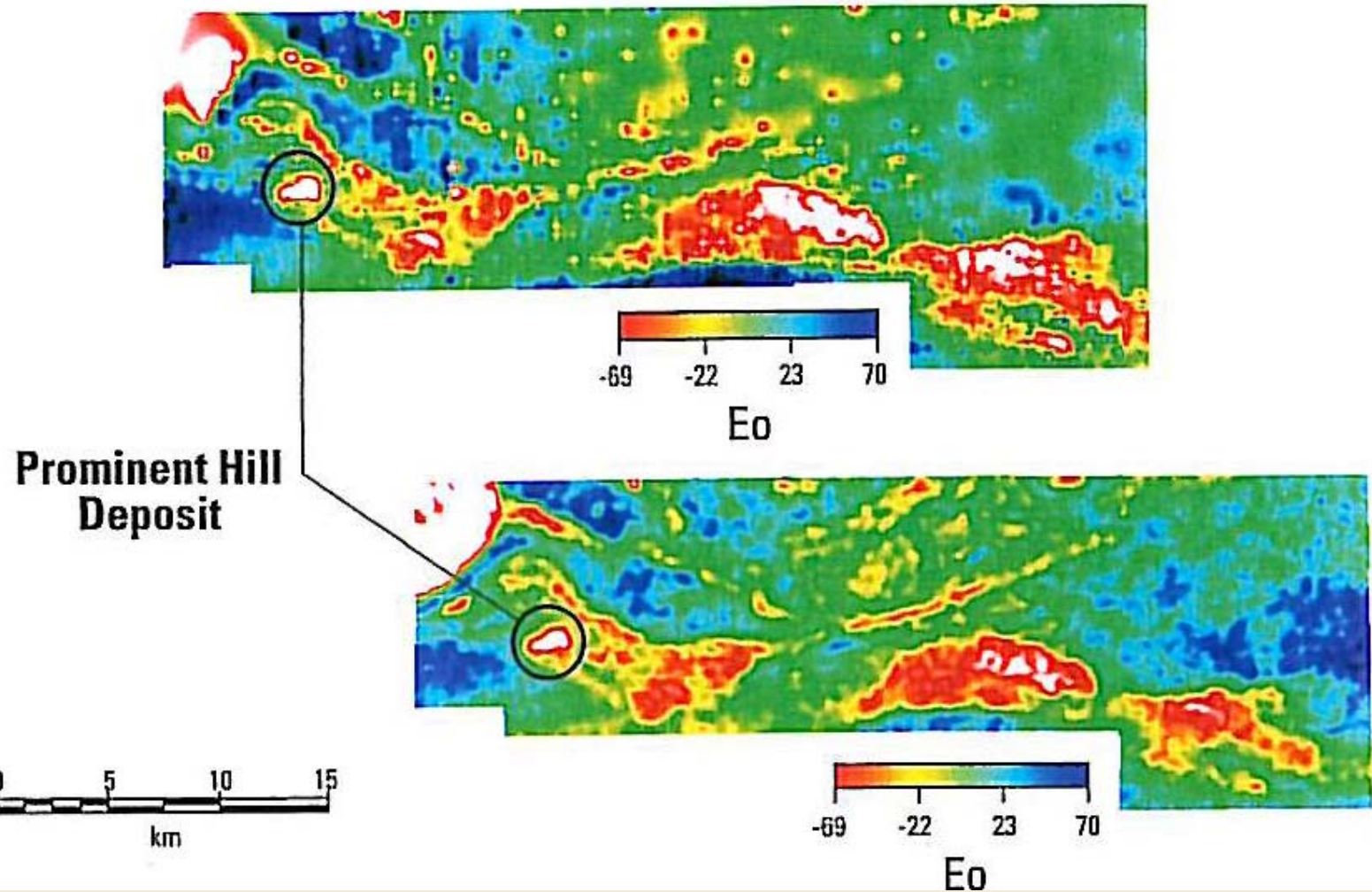
2 km

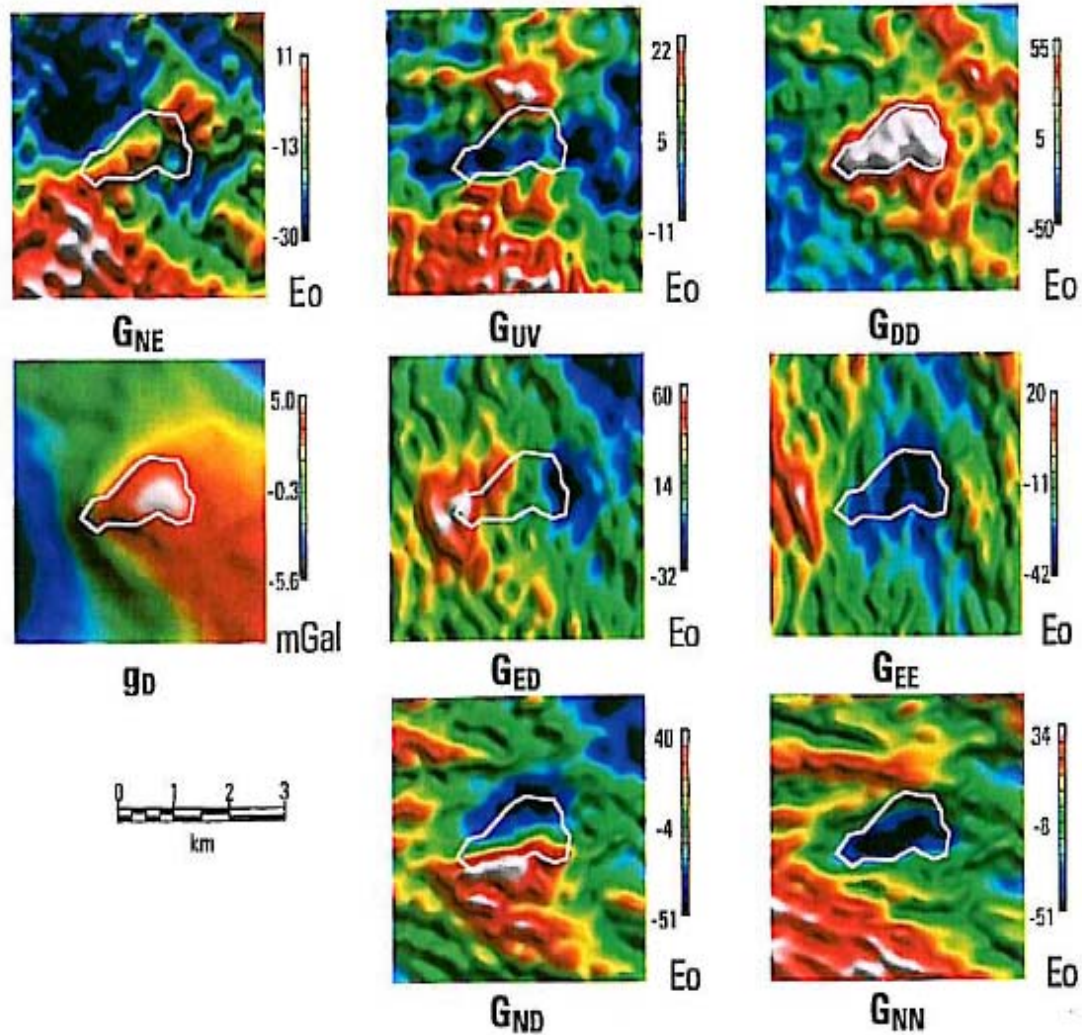


Ground gravity measurements upward continued

Falcon vertical gradient data

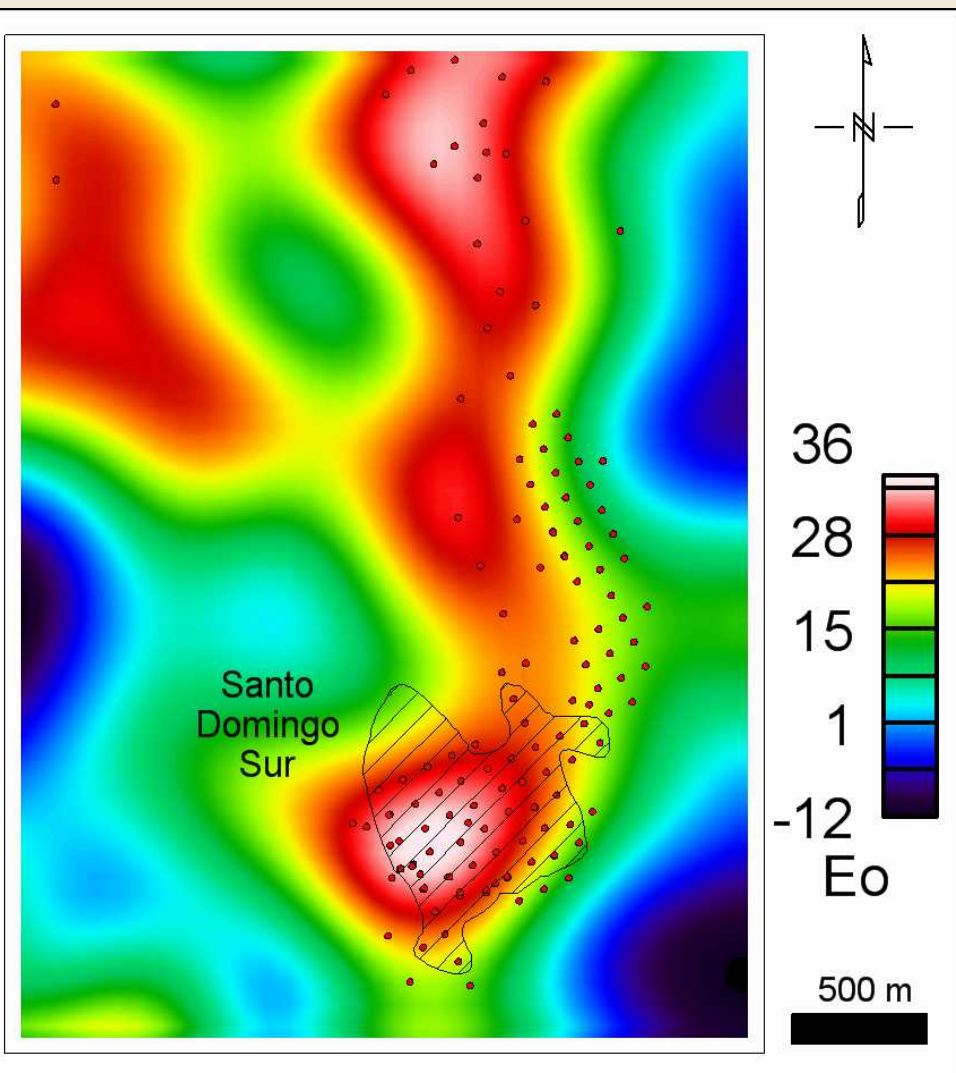
# Prominent Hill Vertical gradient of gravity











First hole into a  
FALCON target  
intersected IOCG  
mineralization  
averaging 2.5% copper  
and 0.33 g/t gold over  
a 60m interval.

The Indicated Resource  
at Santo Domingo Sur is  
171.5 Mt grading 0.57%  
Cu and 0.08 g/t Au

# Discovery! Copper deposits Candelaria belt, Chile

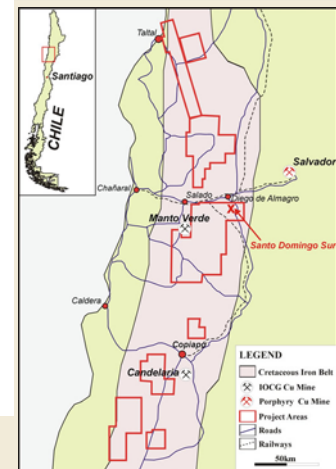
**Far West Mining (28 Apr 2009):**

**Indicated Resource - Santo Domingo Sur, Iris and Iris Norte deposits:**

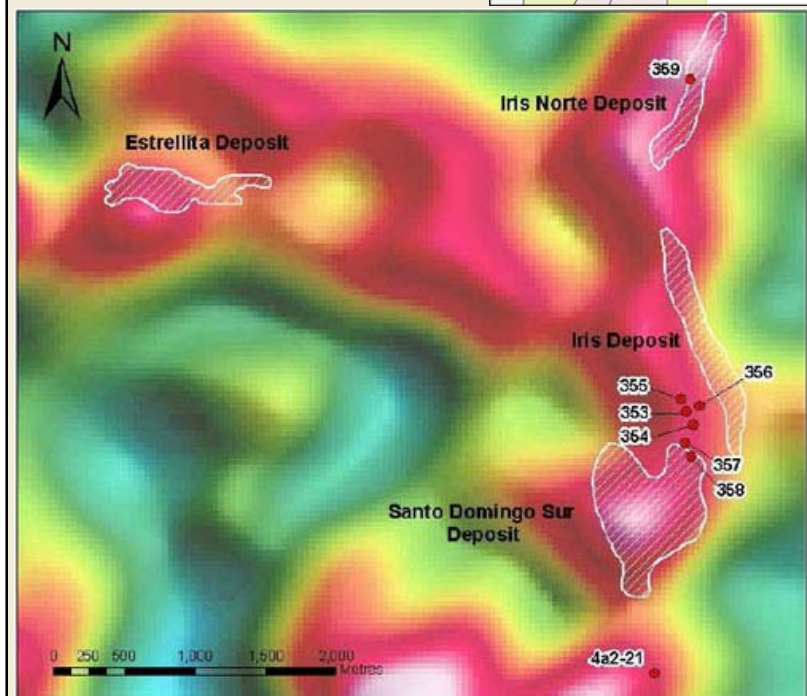
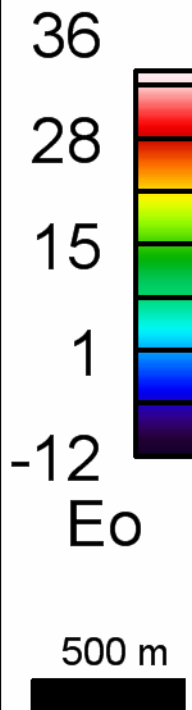
- 383 Mt of 0.57% Cu.

**Indicated Resource - Estrellita deposit:**

- 31.7 Mt of 0.53% Cu.



Santo Domingo Sur







# Discovery! Copper at Mumbwa, Zambia

- Copper discovery in Zambia (Feb 2007).

## Significant results:

655.4m @ 0.46% Cu, including:

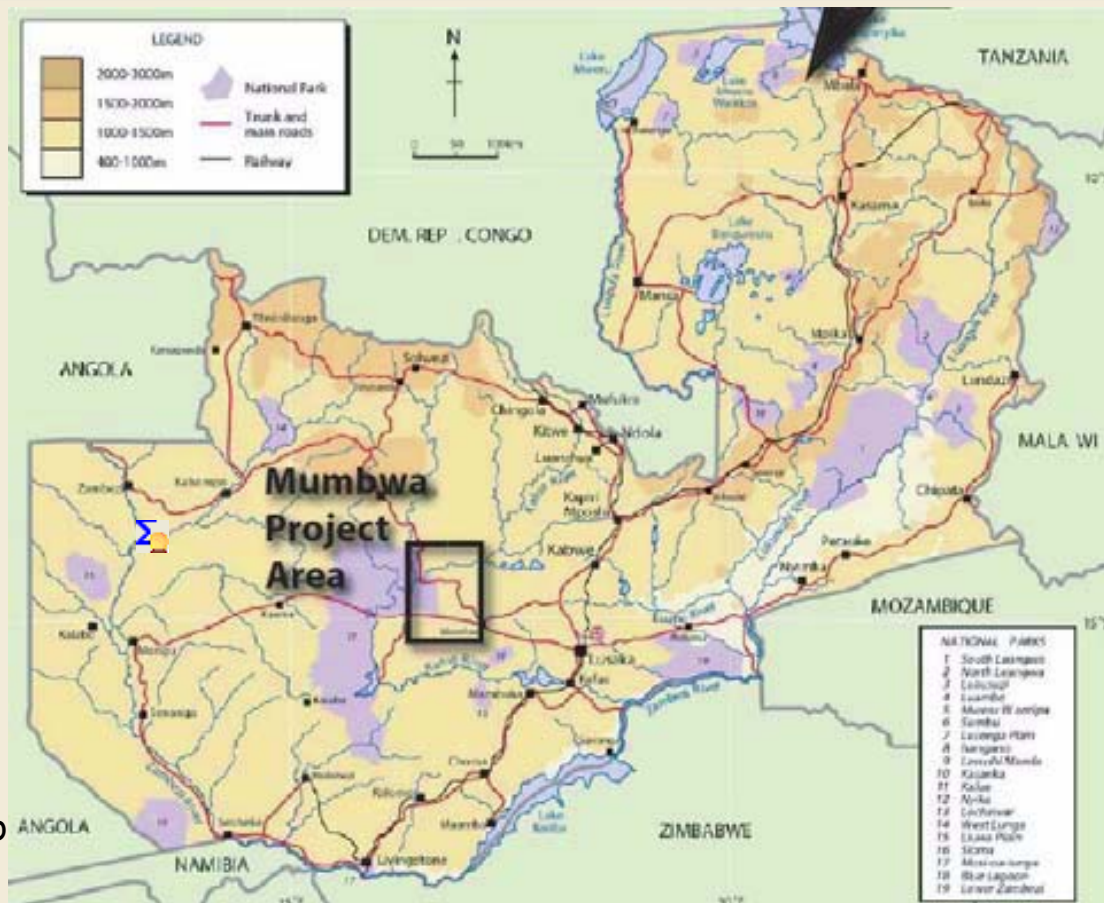
- 317m @ 0.79% Cu
- 18m @ 0.20g/t Au
- 42m @ 2.01% Cu,
- including 4m @ 5.56% Cu

401m @ 0.98% Cu, including:

- 270 metres @ 1.37 % Cu;
- 12 metres @ 1.17 % Cu;
- 20 metres @ 1.01 % Cu;
- 228 metres @ 1.47 % Cu.
- 4 metres @ 19.50 % Cu;
- 1 metre @ 11.05 % Cu.

12 March 2009

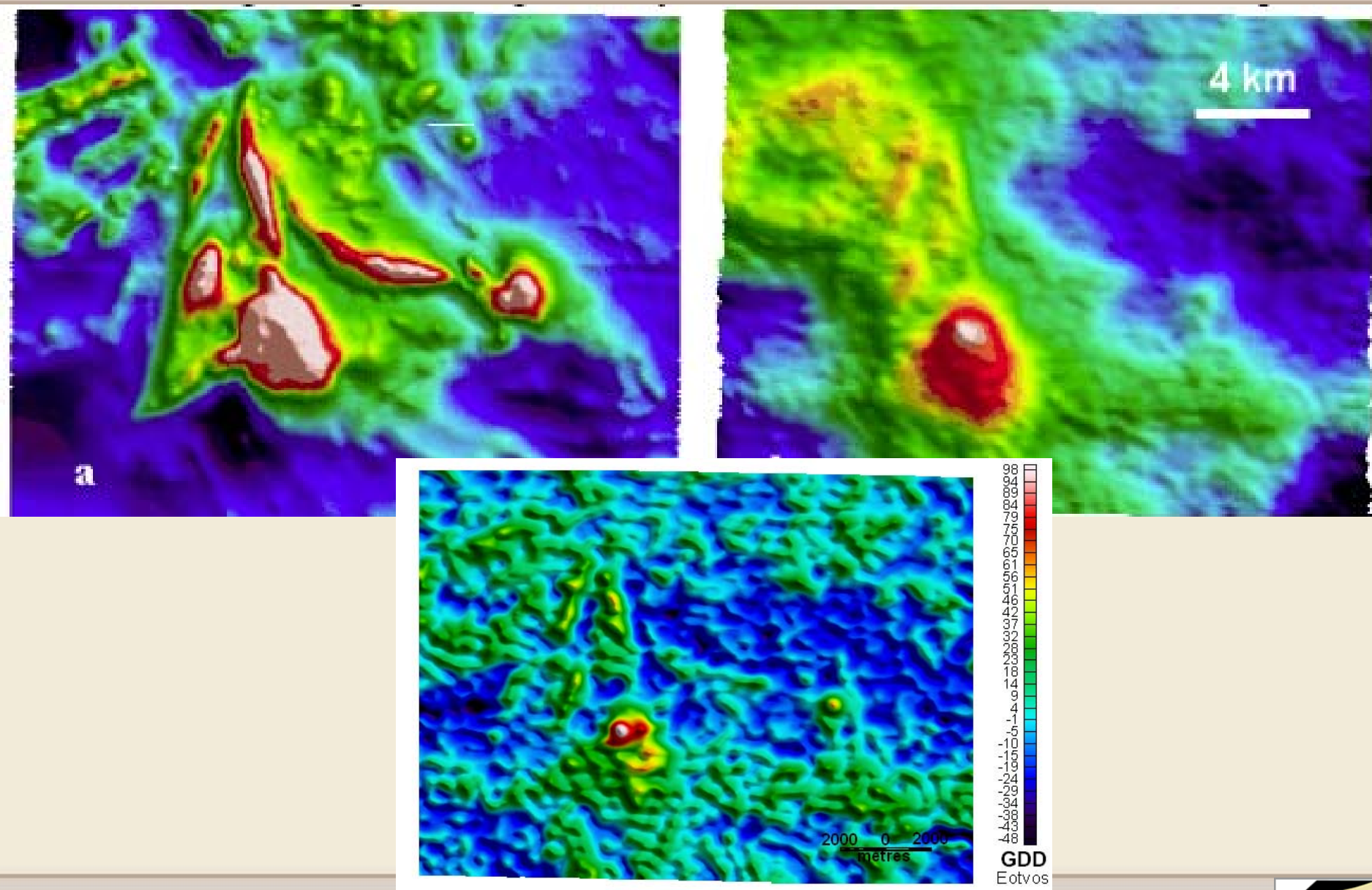
- Blackthorn Resources announce that BHP Billiton have formally elected to fully fund the next drilling phase on the Mumbwa IOCG Project in Zambia.



The project area exhibits a number of typical IOCG characteristics including structurally controlled hematite-rich breccia complex containing pyrite and chalcopyrite, with evidence of multiple brecciation.

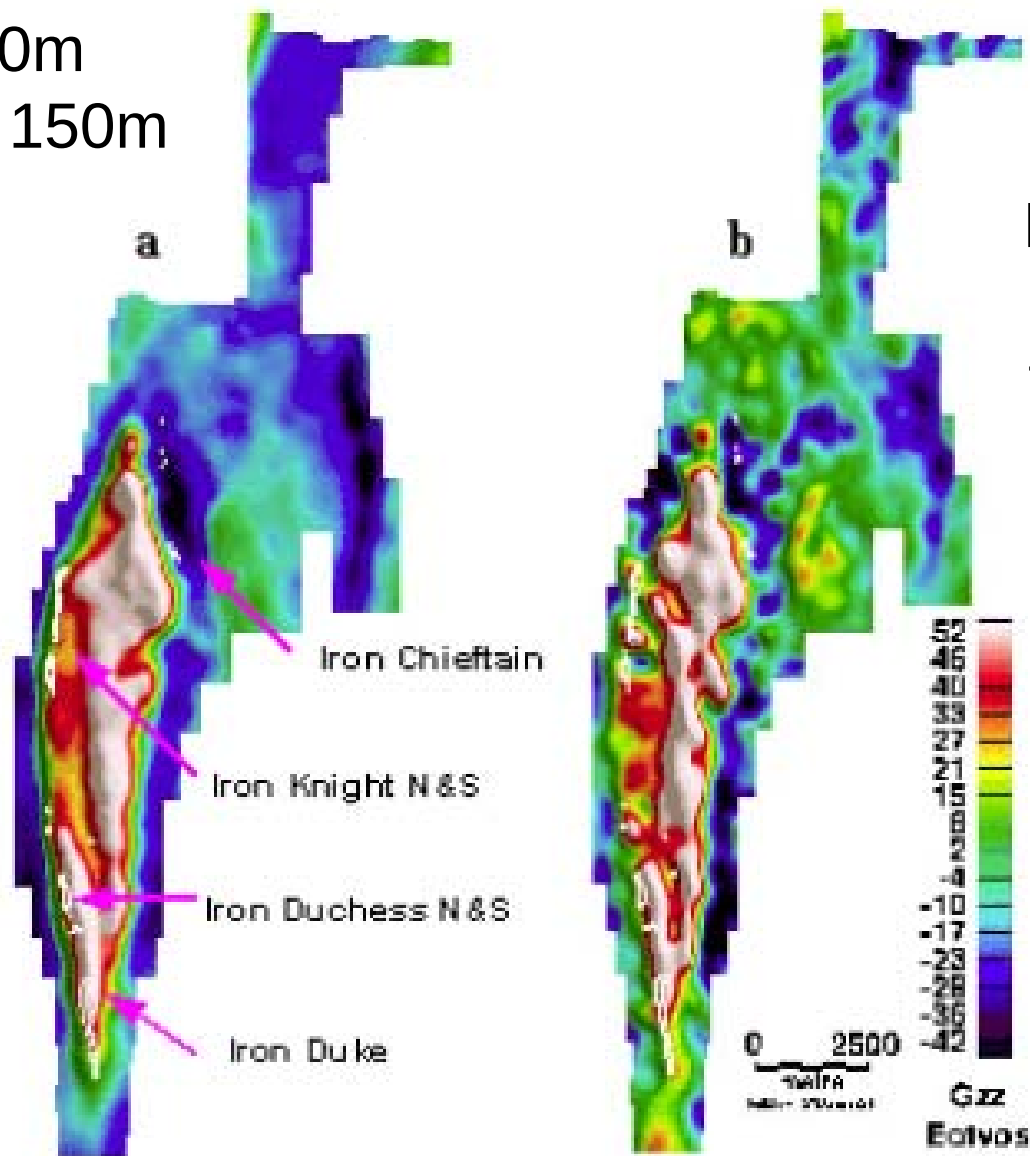
From: [www.blackthornresources.com.au](http://www.blackthornresources.com.au)

# King George Gravity Anomaly



Ground 50m  
stations and 150m  
lines

Falcon high relief  
and high  
turbulence 200m  
lines

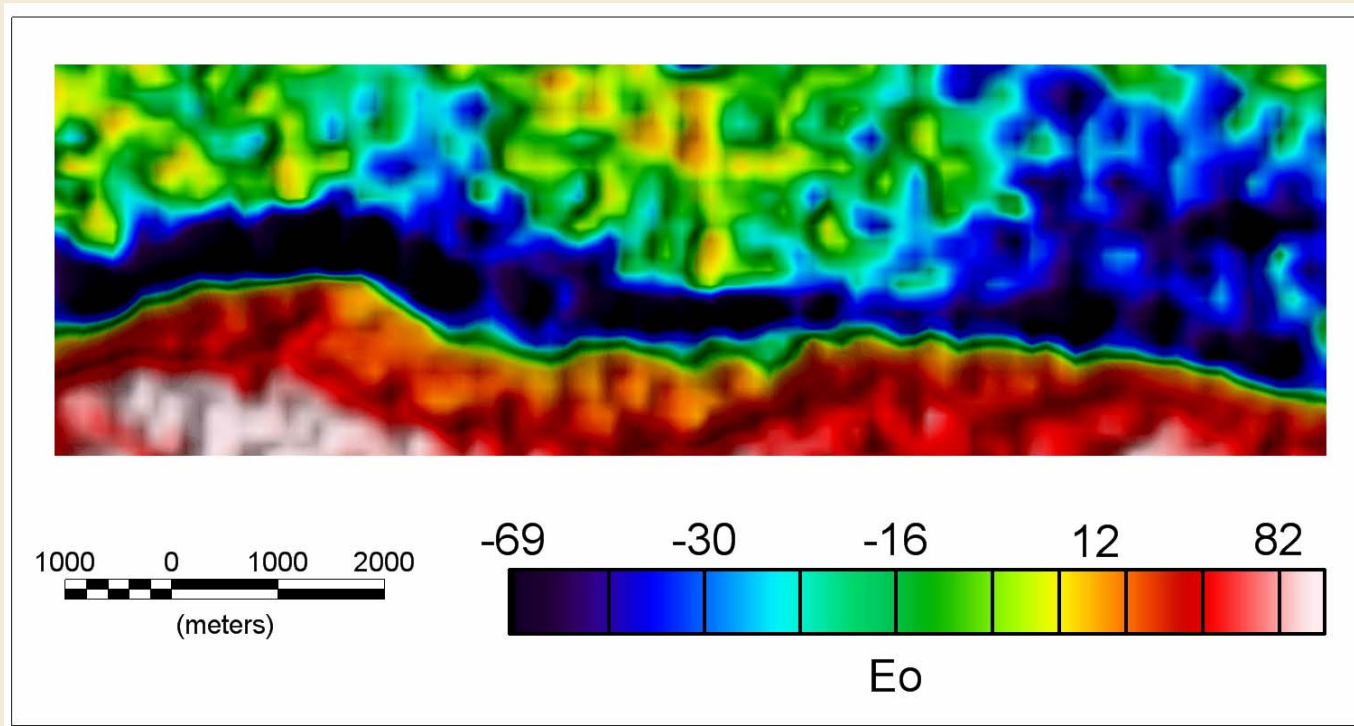




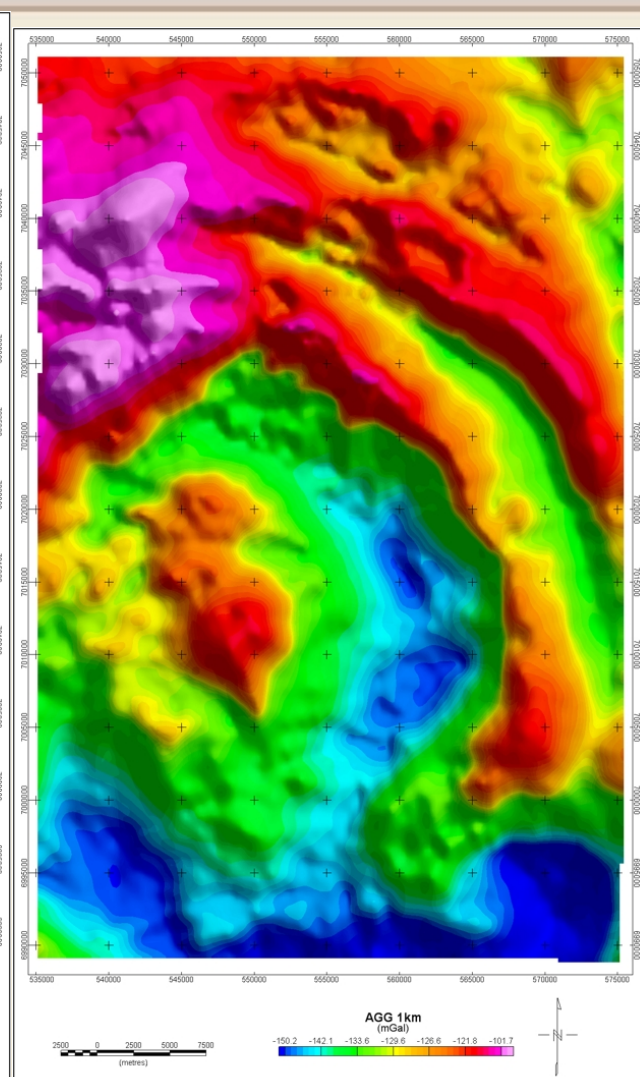
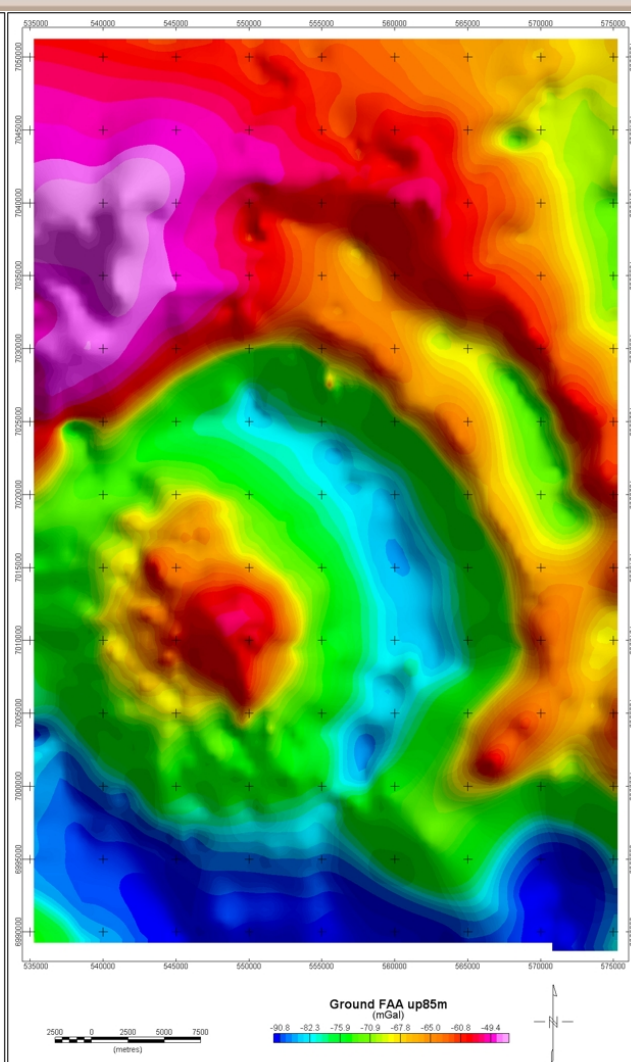
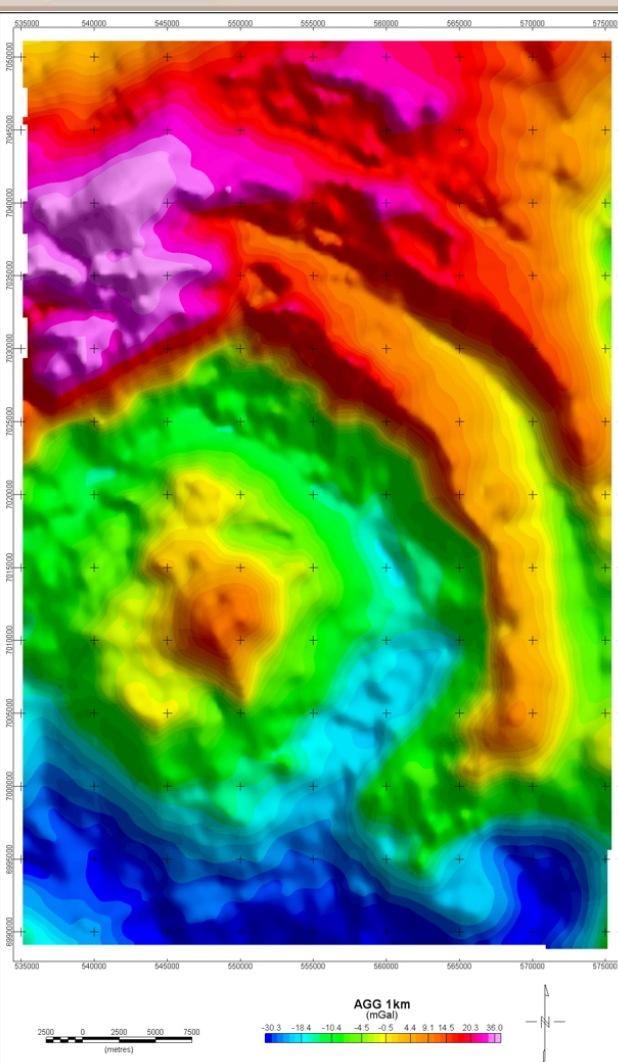


# Mapping coal beds – Latrobe Valley, Australia

- The Latrobe valley in south-east Australia is a significant local source of coal from shallow, sub-horizontal beds.
- FALCON AGG has proven useful in mapping the edge of these beds and variations in their dip and thickness.



# Free Air Anomaly- Ground vs AGG 1 km

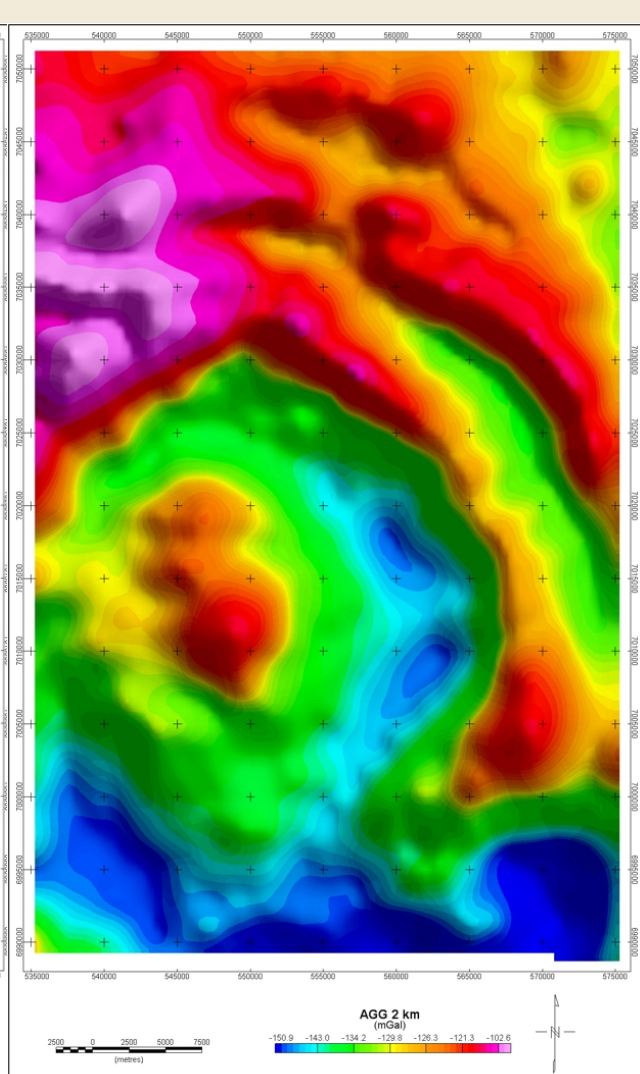
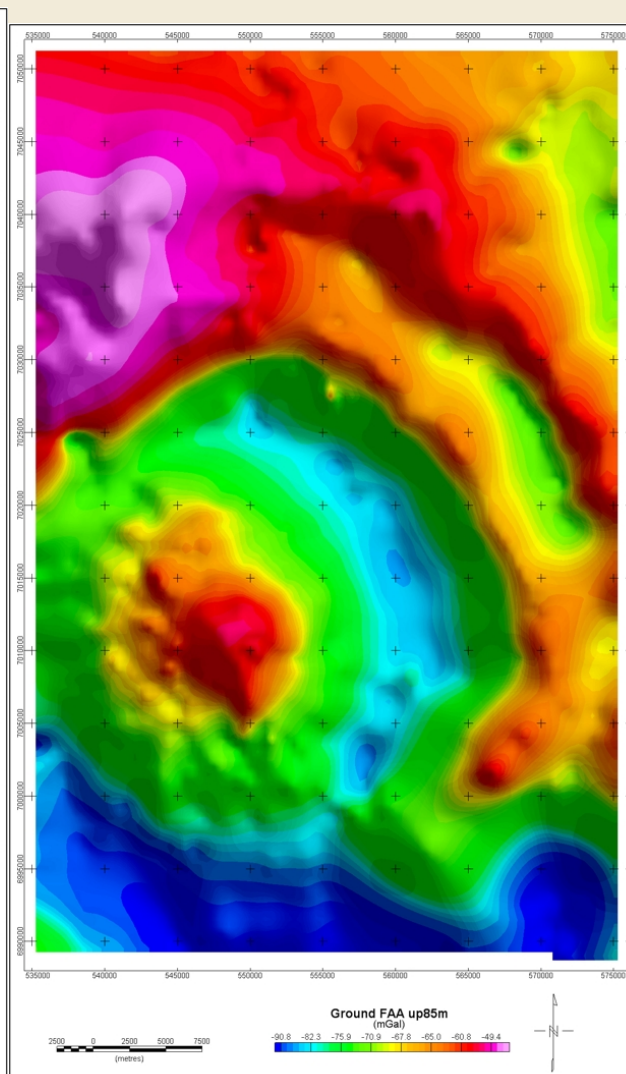
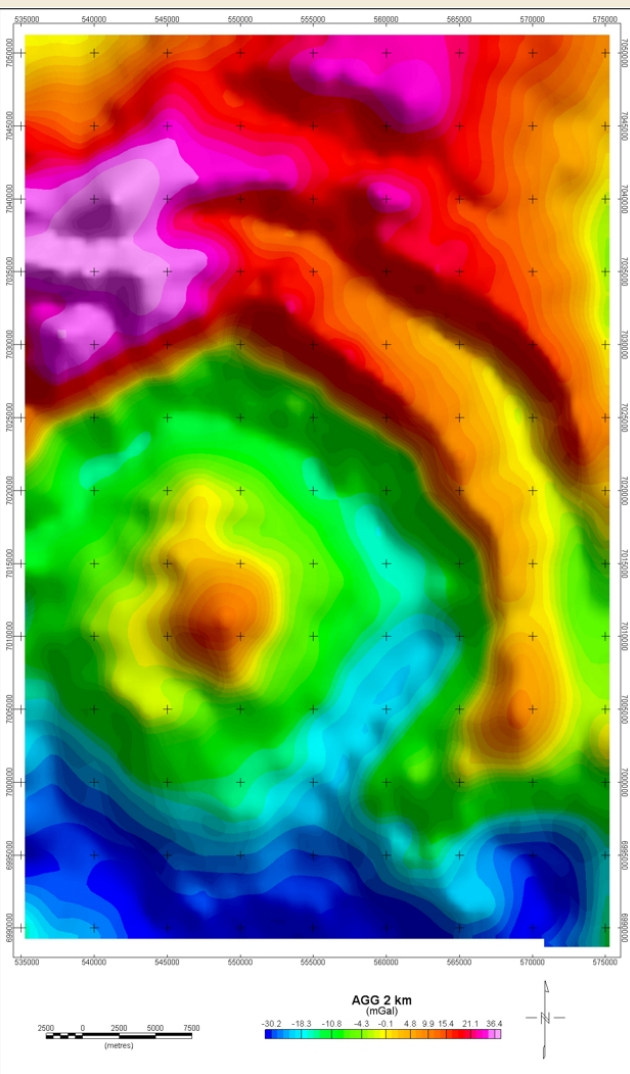


**AGG 1 km uncorrected**

**Ground upward continued 85m**

**AGG 1 km corrected**



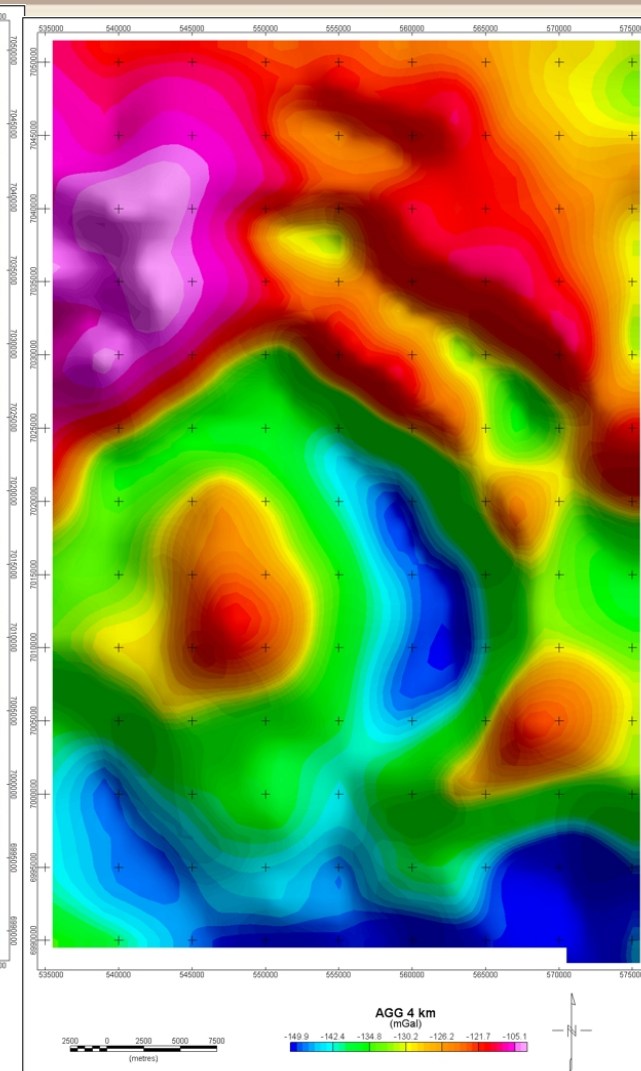
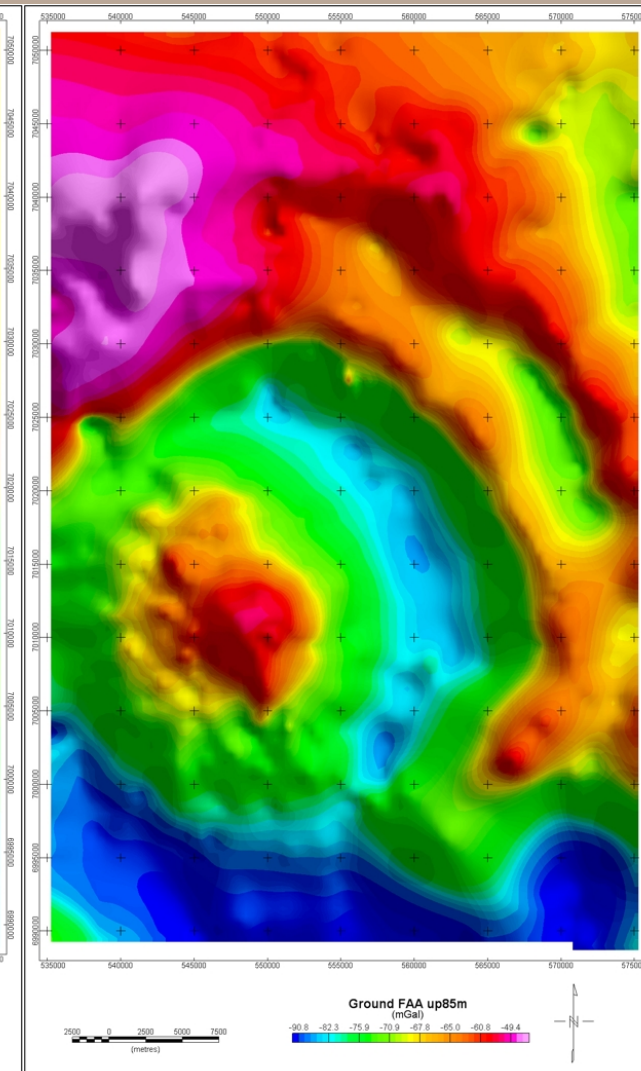
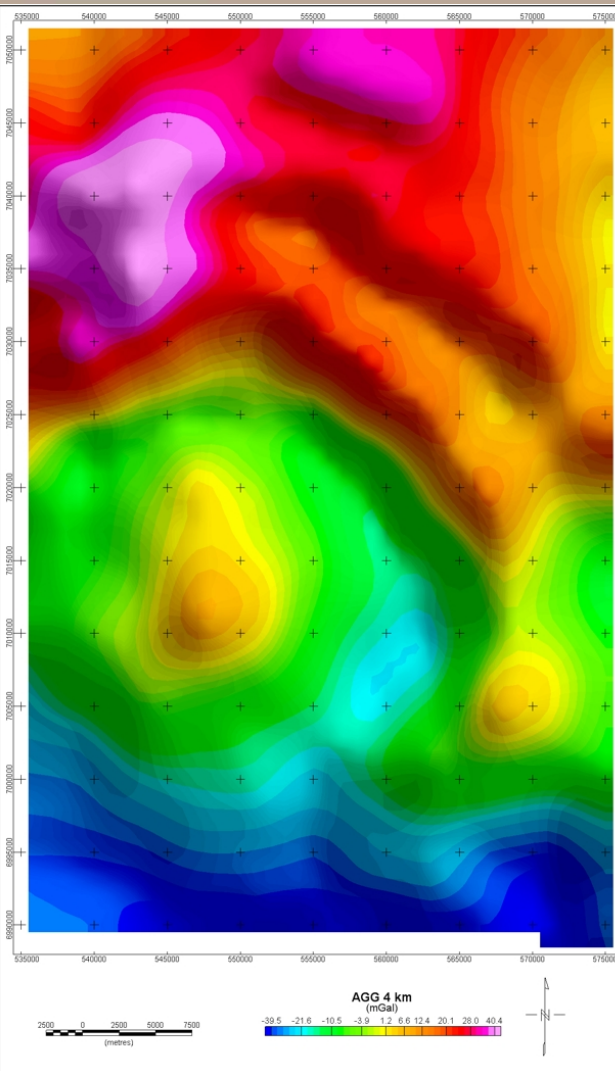


**AGG 2 km uncorrected**

**Ground upward continued 85m**

**AGG 2 km corrected**





**AGG 4 km uncorrected**

**Ground upward continued 85m**

**AGG 4 km corrected**



- AGG - low cost compared to ground crews.
- AGG surveys have assisted significantly in discovery of a range of targets including diamonds, IOCG, iron and coal. It is now in widespread use for petroleum exploration particularly in areas where access is difficult and geology complex.
- Further developments of airborne gravity systems are underway but any decrease in instrument noise levels will be most likely offset by the noise from terrain corrections. Dransfield (2007) already suspects that terrain correction noise may be more significant than instrument noise in some surveys.
- Further investment in systems also has to be justified by the market place. The release of FALCON AGG for mineral exploration in April 2010 will offer the mineral exploration industry fast repeatable gravity over large areas at low costs.

- FALCON AGG delivers a dramatic improvement in resolution for airborne gravity.
- This has already proved very valuable for many exploration programs
- And, in the future, we will see new applications for airborne gravity that exploit the FALCON AGG resolution.

