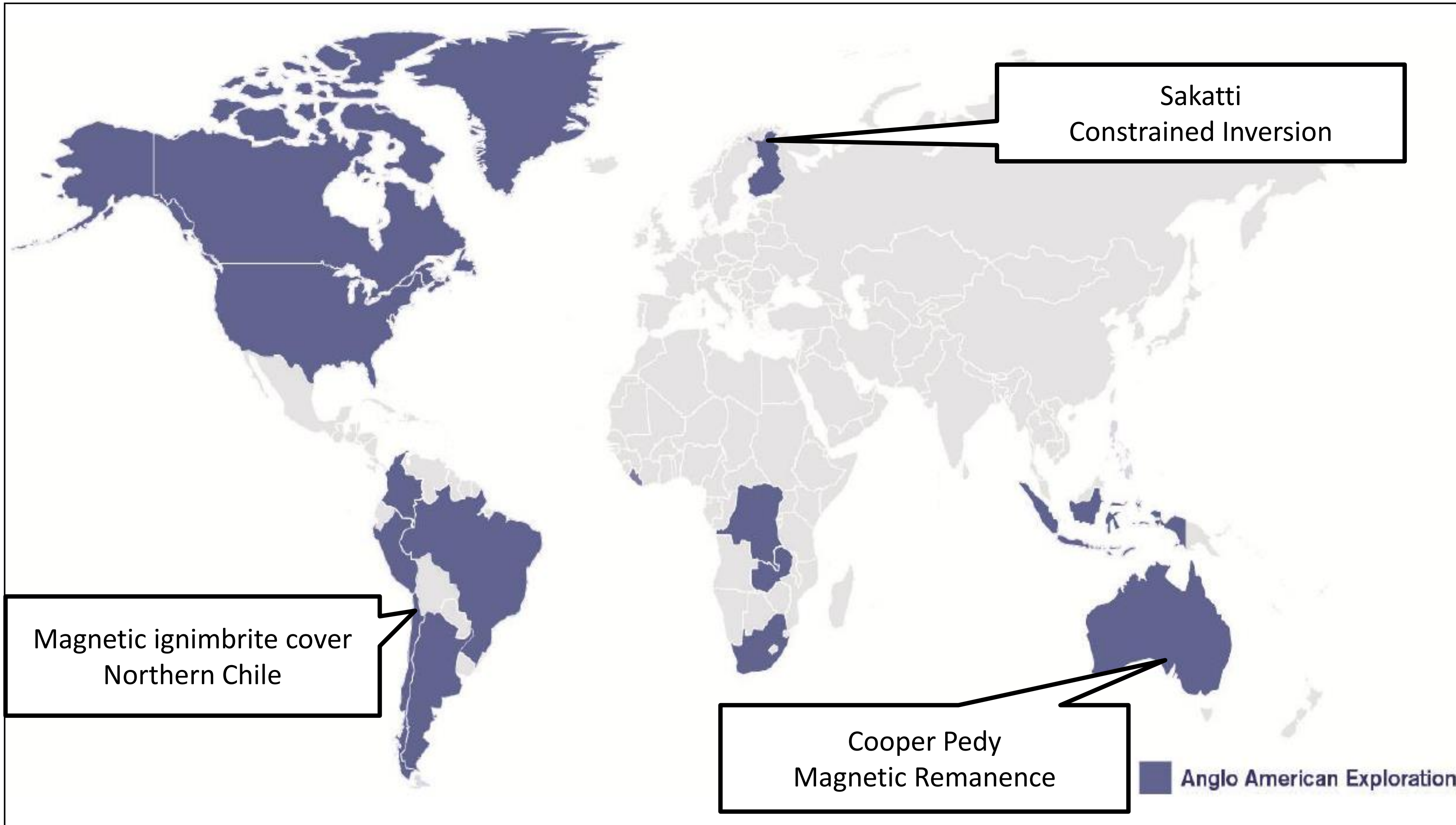
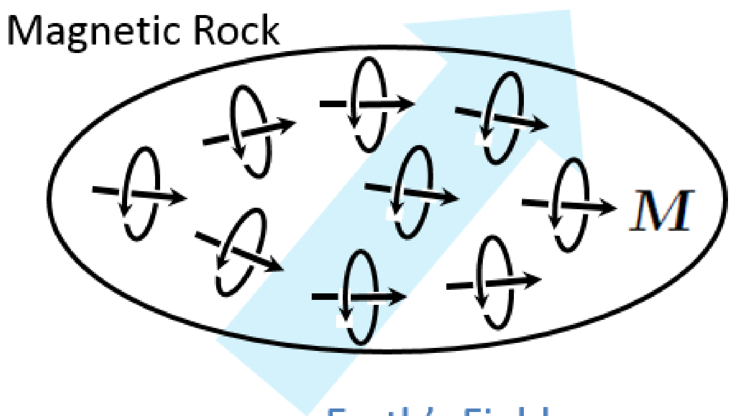
Magnetics – From the Arctic to the Andes

Mike Webb & Rob Ellis



Magnetic Susceptibility Inversion & Magnetisation Inversion

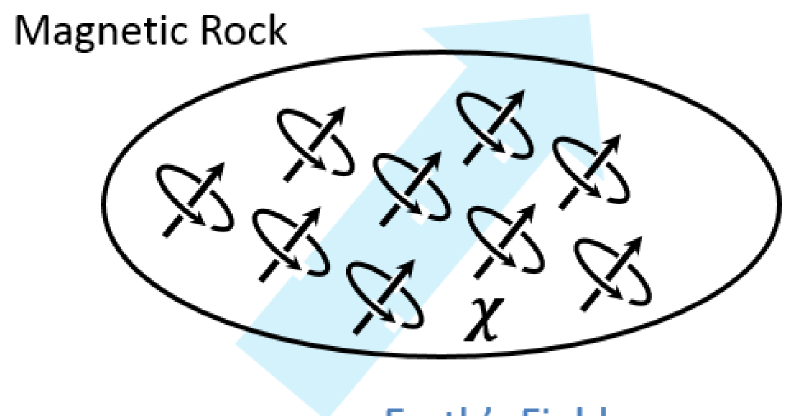
Magnetization Vector



$$B(r) = \nabla \int_V M(r') \cdot \nabla' \frac{1}{|r - r'|} dr'^3$$

- Measuring B at a series of locations gives the inverse problem for M.
- M is the "natural" parameter for magnetic field inversion.
- This is a crucial observation

Susceptibility



- Susceptibility modeling assumes ALL rock magnetization aligns with the Earth's field.
- Recent studies indicate that this is a very poor assumption at all exploration scales.

Sakatti Project - Finland

Reporting of Sakatti Exploration Results

EXPLORATION RESULTS

The Sakatti exploration target is being reported under clause 17 of the 2012 Edition of the JORC Code and is based on exploration results within Anglo American's 100% tenure which are supported by diamond drilling and assays, geochemical analyses, geophysics, geotechnical studies and geological modelling undertaken over the last two years. However there has been insufficient exploration to date to define a Mineral Resource and it is uncertain whether further exploration works will result in the definition of a Mineral Resource.

CP DECLARATION

The information in this document that relates to Exploration Results is based on information compiled by Dr. Stuart McCracken who is a Member of the AusIMM. Stuart McCracken is the Head of Exploration Business and Strategic Planning, a full time employee of Anglo American plc, and has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2012 Edition of the 'Australian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'. Stuart McCracken consents to the matters based on this information in the form and context in which it appears.

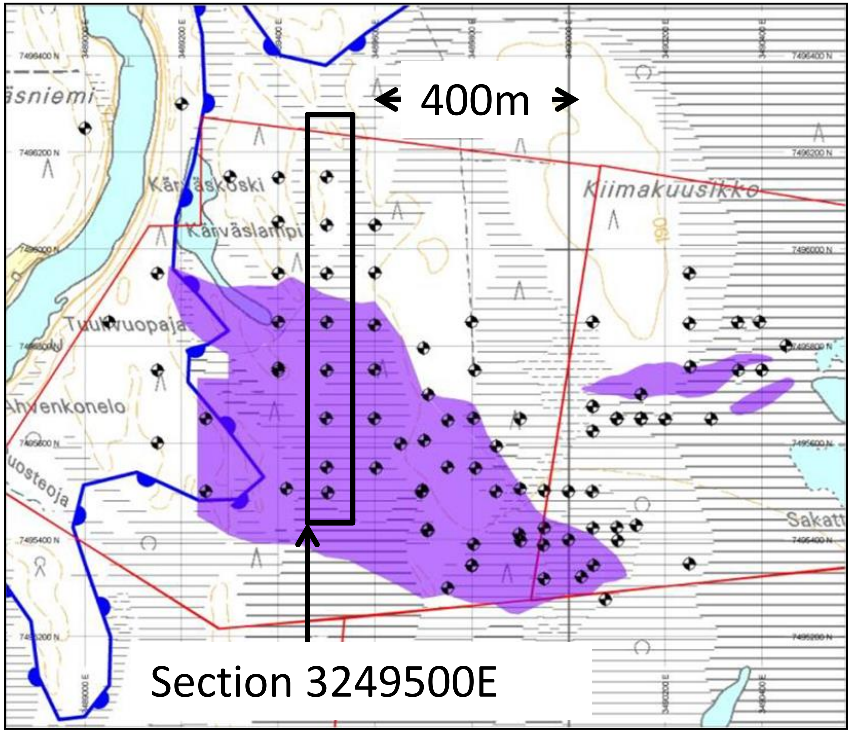
Squid EM survey

Sakatti – Key Facts

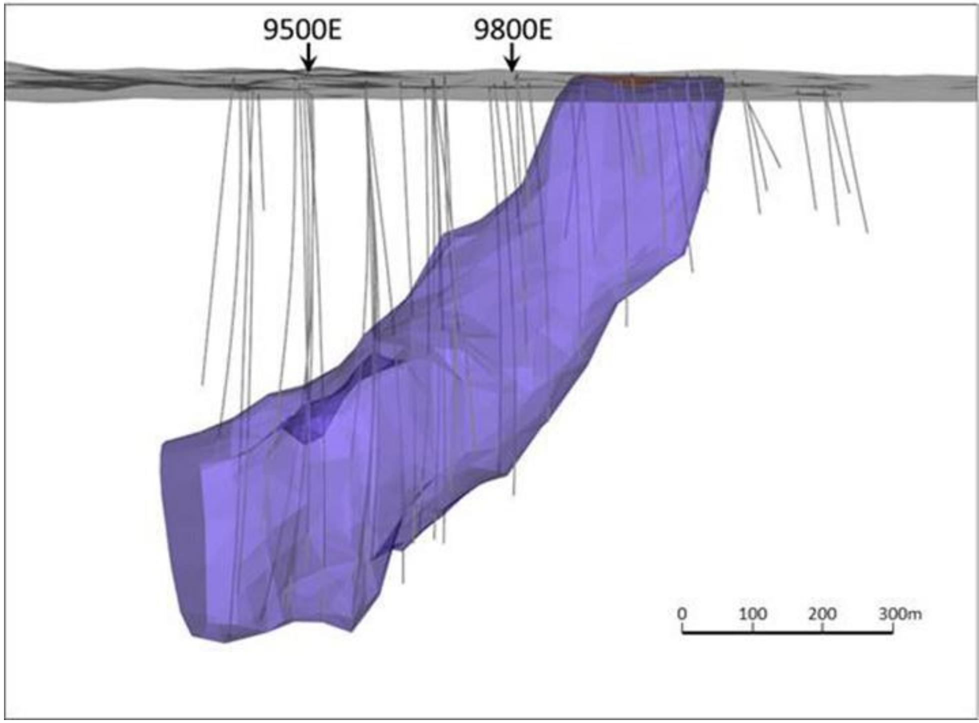
- Sakatti is a magmatic Cu-Ni-PGE deposit hosted predominantly by a serpentinised ultramafic olivine cumulate rock
- Discovered in 2009 using conventional exploration methods - Till Geochemistry – coherent Cu,Ni, PGE anomaly, Geophysics (airborne, ground and downhole systems)
- Massive, semi massive, vein and disseminated style sulphide mineralisation
- Main deposit is blind – can be seen using Anglo Low Temperature SQUID EM technology – The shallow NE & SW mineralised systems can be seen by VTEM
- 1.5 km x 0.7 km projected surface expression mineralised zone, plunges to the NW
- Open to the west, north, south and at depth

Sakatti – Drilling Results

Plan View of mineralised body



0.2% Cu shell of main mineralised body



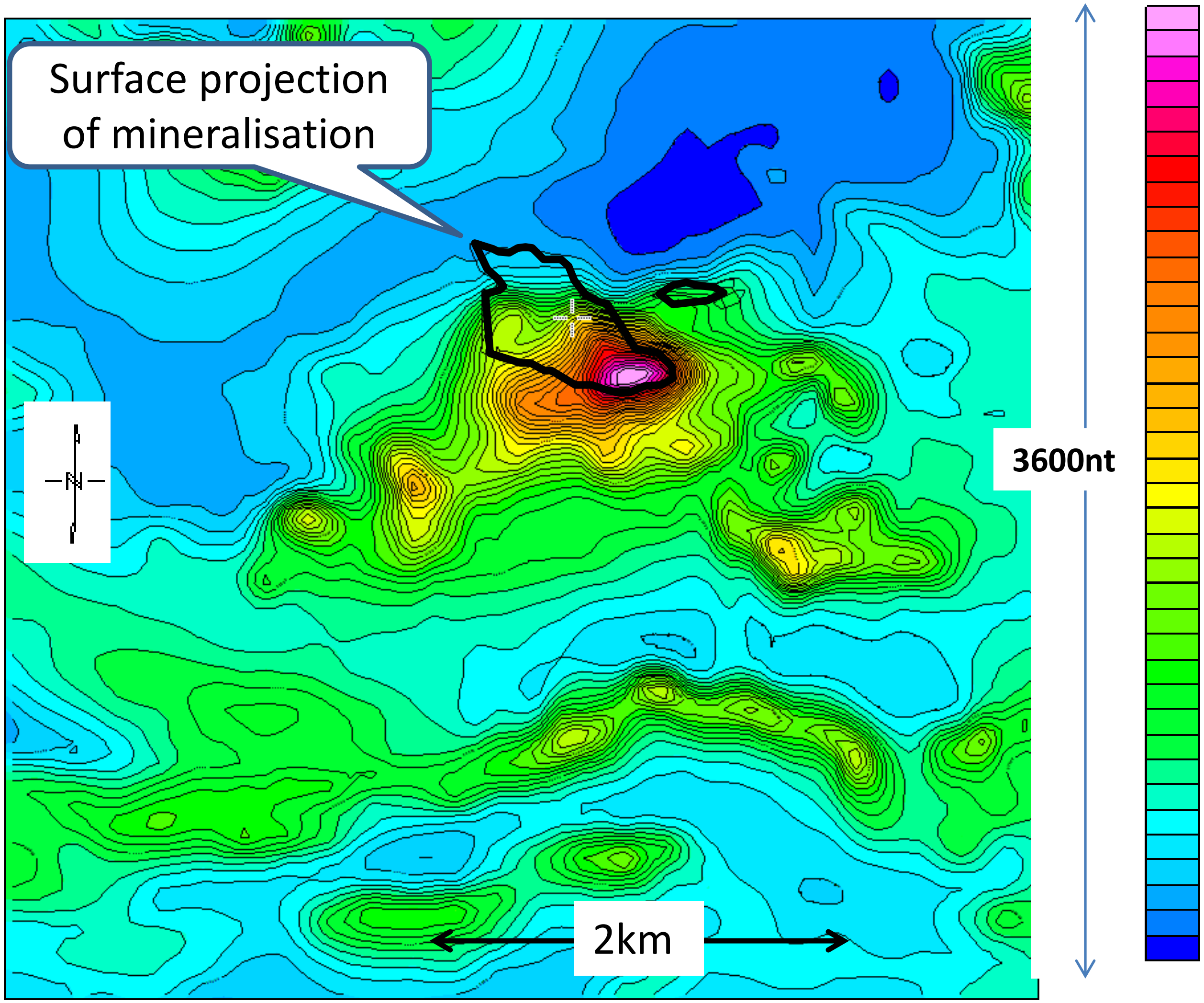
Drill results on section 3249500E

10MOS8038: 3489502E 7495651N Dip: -75º AZ: 172º EOH: 745.90m
from 560.00m: 121.95m @ 1.37% Cu, 0.22% Ni, 0.24g/t Pt, 0.16g/t Pd, 0.23g/t Au

11MOS8044: 3489500E 7495750N Dip: -76º AZ: 173º EOH: 849.70m
from 573.50m: 225.70m @ 1.11 % Cu, 0.94 % Ni, 0.37 g/t Pt, 0.42 g/t Pd,0.09 g/t Au

11MOS8046: 3489500E 7495849N Dip: -75º AZ: 170º EOH: 895.90m
from 699.00m: 57.00m @ 1.57% Cu, 1.48% Ni, 0.43g/t Pt, 0.44g/t Pd, 0.07g/t Au

Sakatti – Total Magnetic Intensity



Magnetic Field Parameters

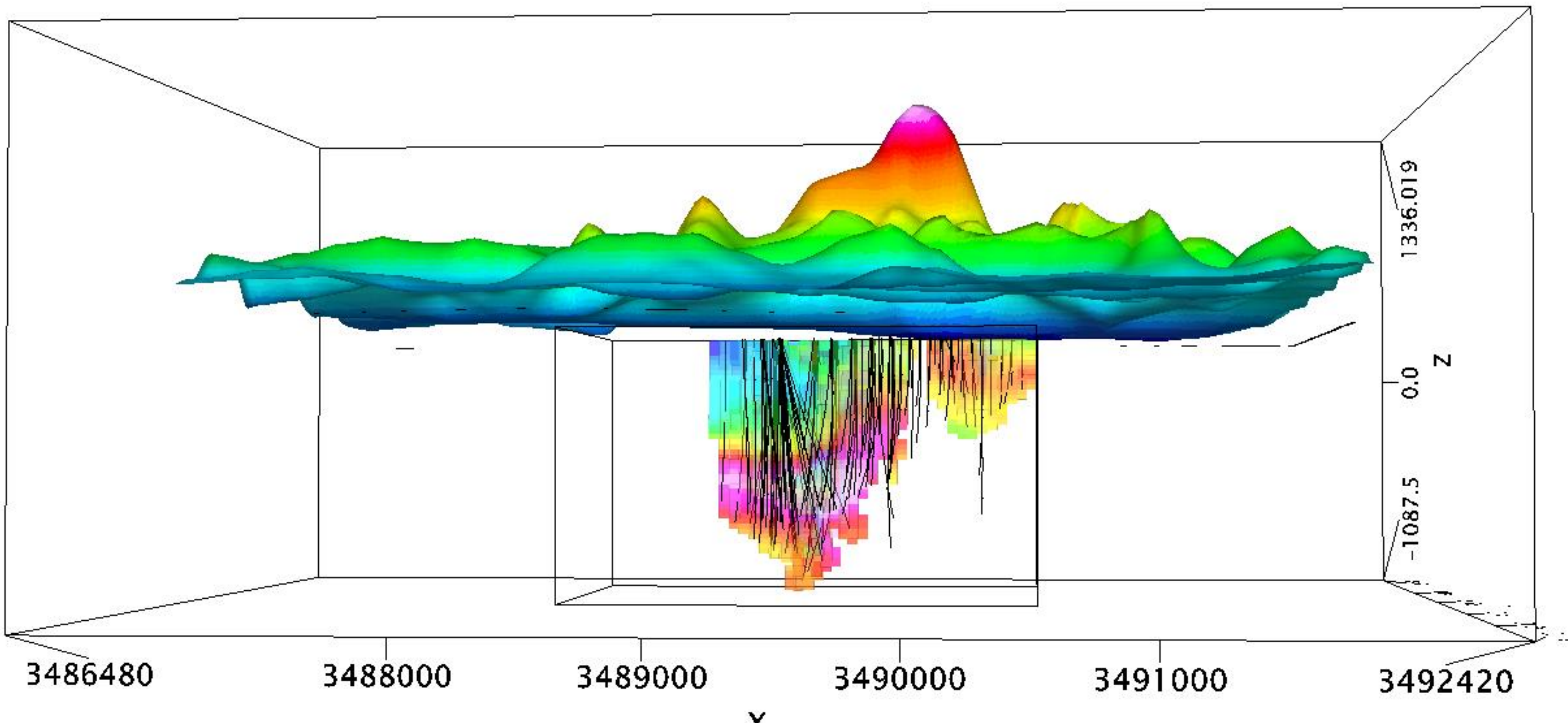
Field Strength (nT): 53490
Inclination (degrees): 77.4
Declination (degrees): 11.5

Magnetic Survey Parameters

Line spacing 100m
Sensor height 70m

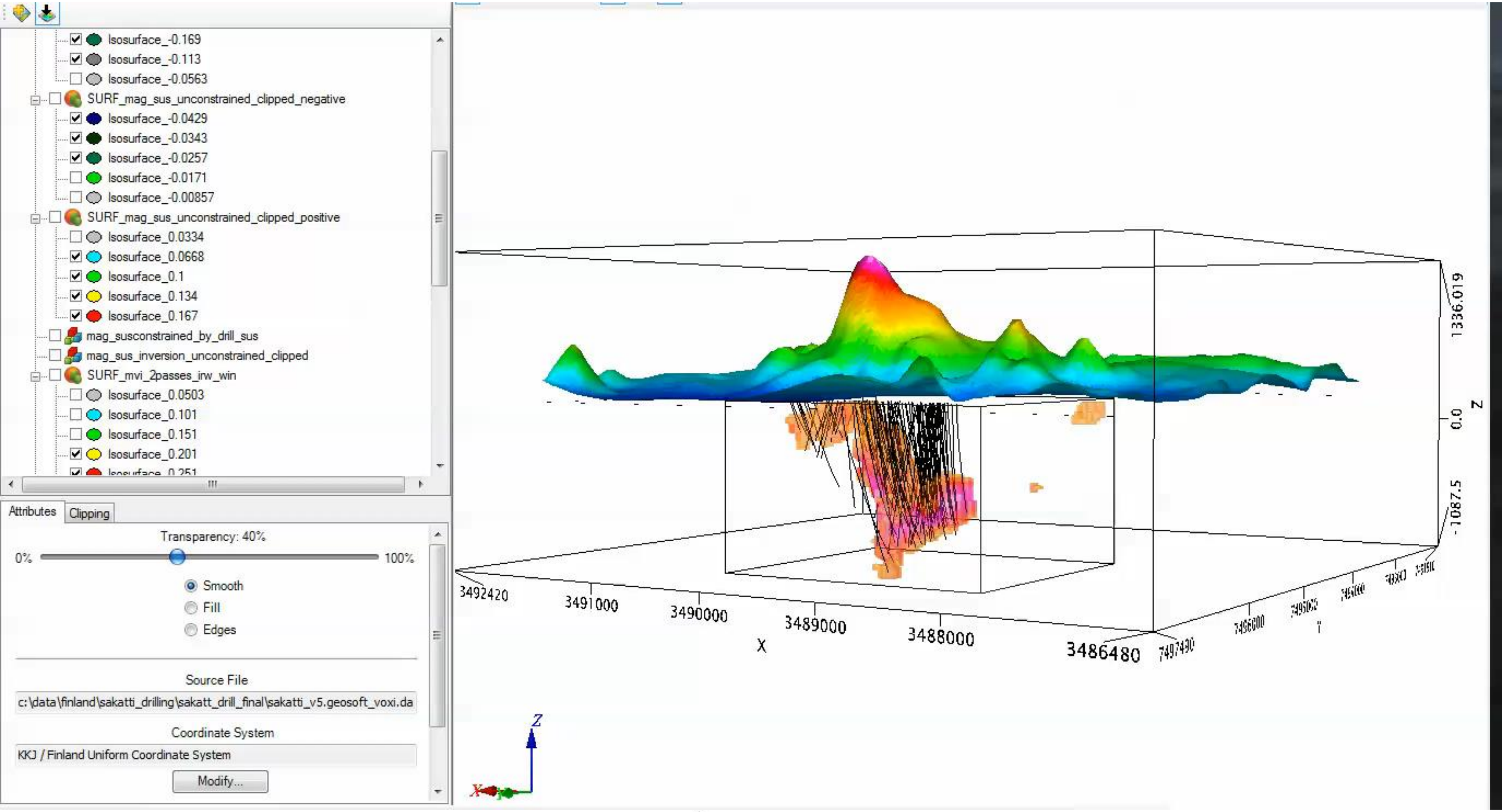
Total Magnetic Intensity 100nt contours

TMI image with drill holes and a sectional view of magnetic susceptibility shown

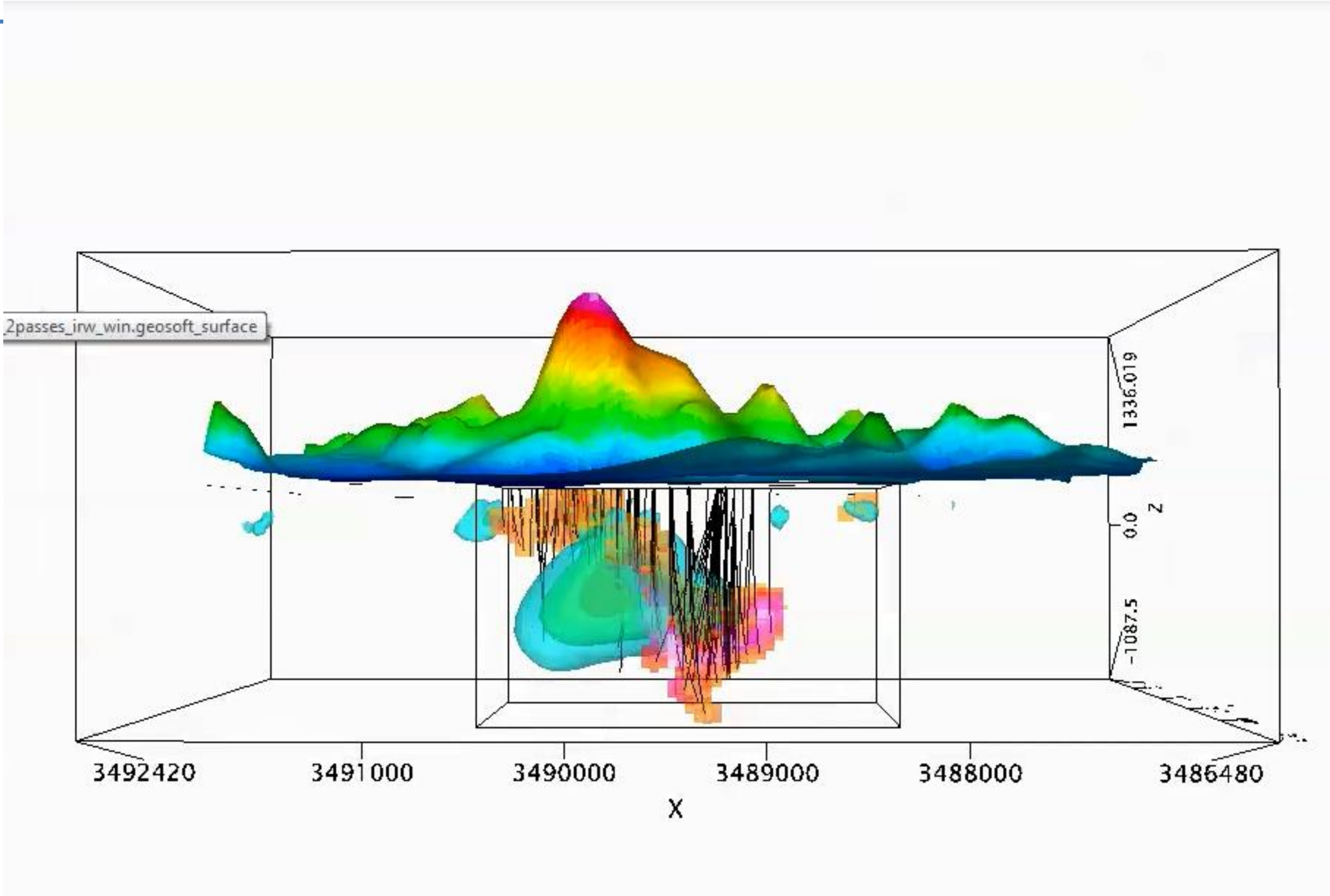


Sakatti – Magnetics

Short video of unconstrained magnetic susceptibility inversion

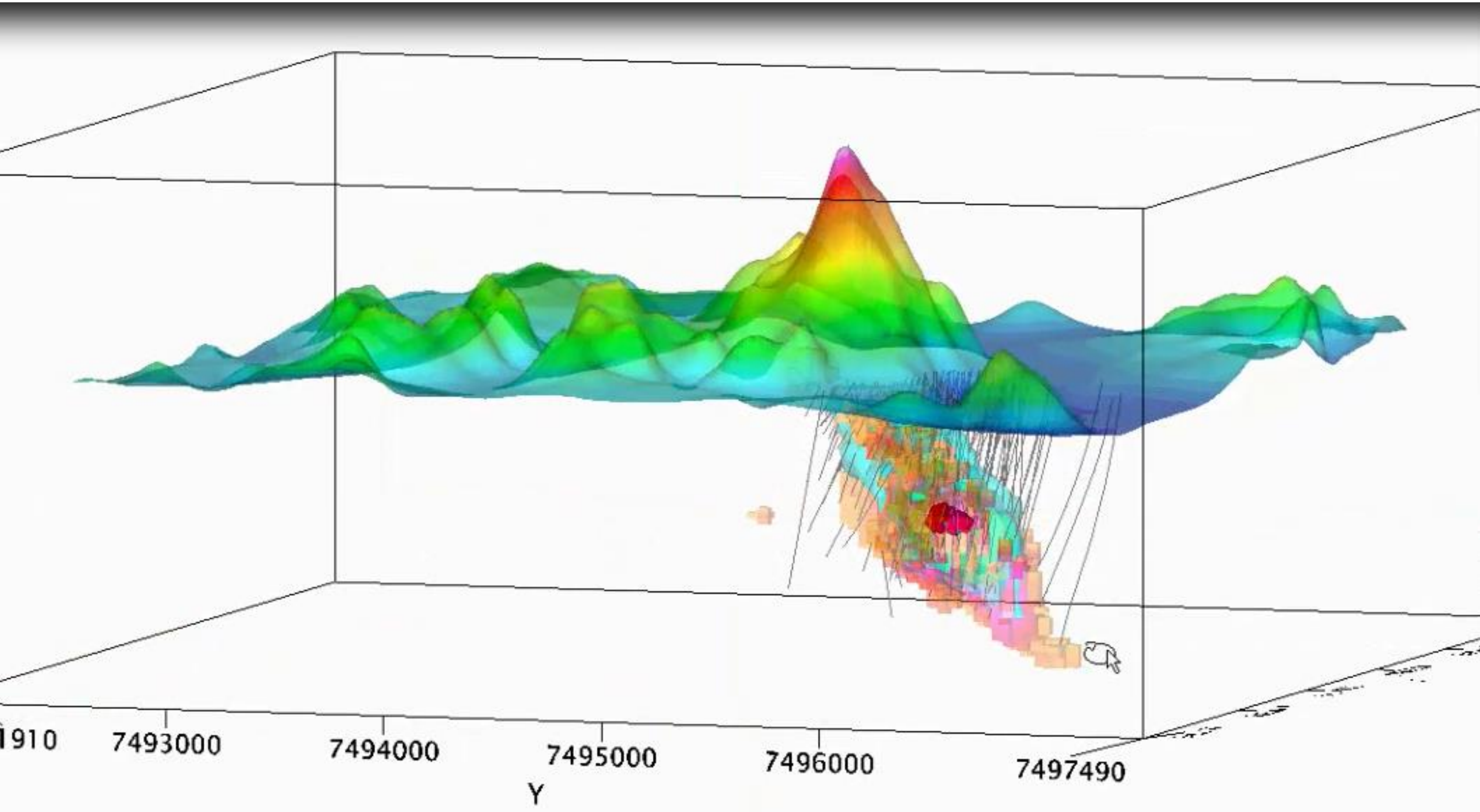


Sakatti – Magnetics



Sakatti – Magnetics

Short video of magnetic vector inversion constrained by drill hole susceptibility measurements

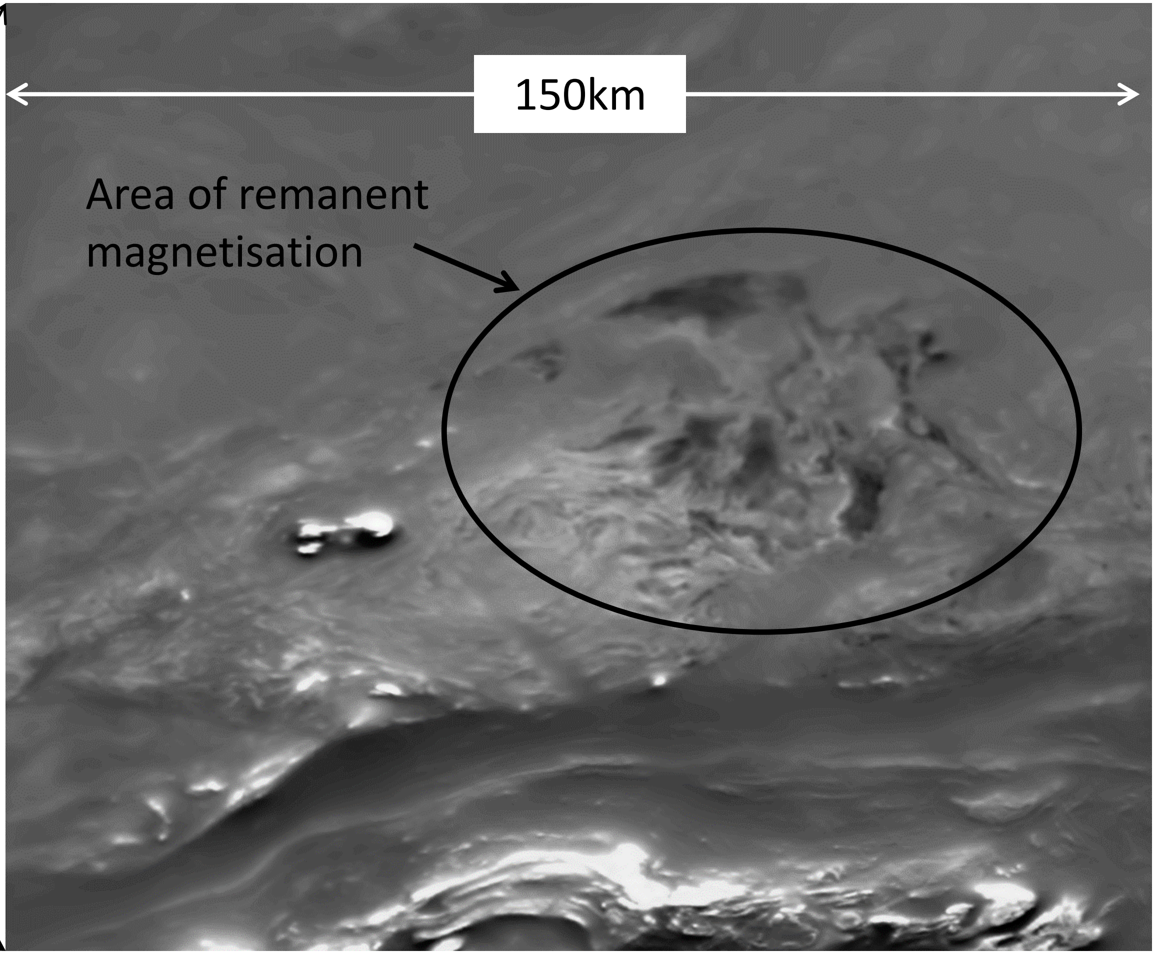


Cooper Pedy – South Australia

Inversion of strong remanent magnetism

Magnetic field properties

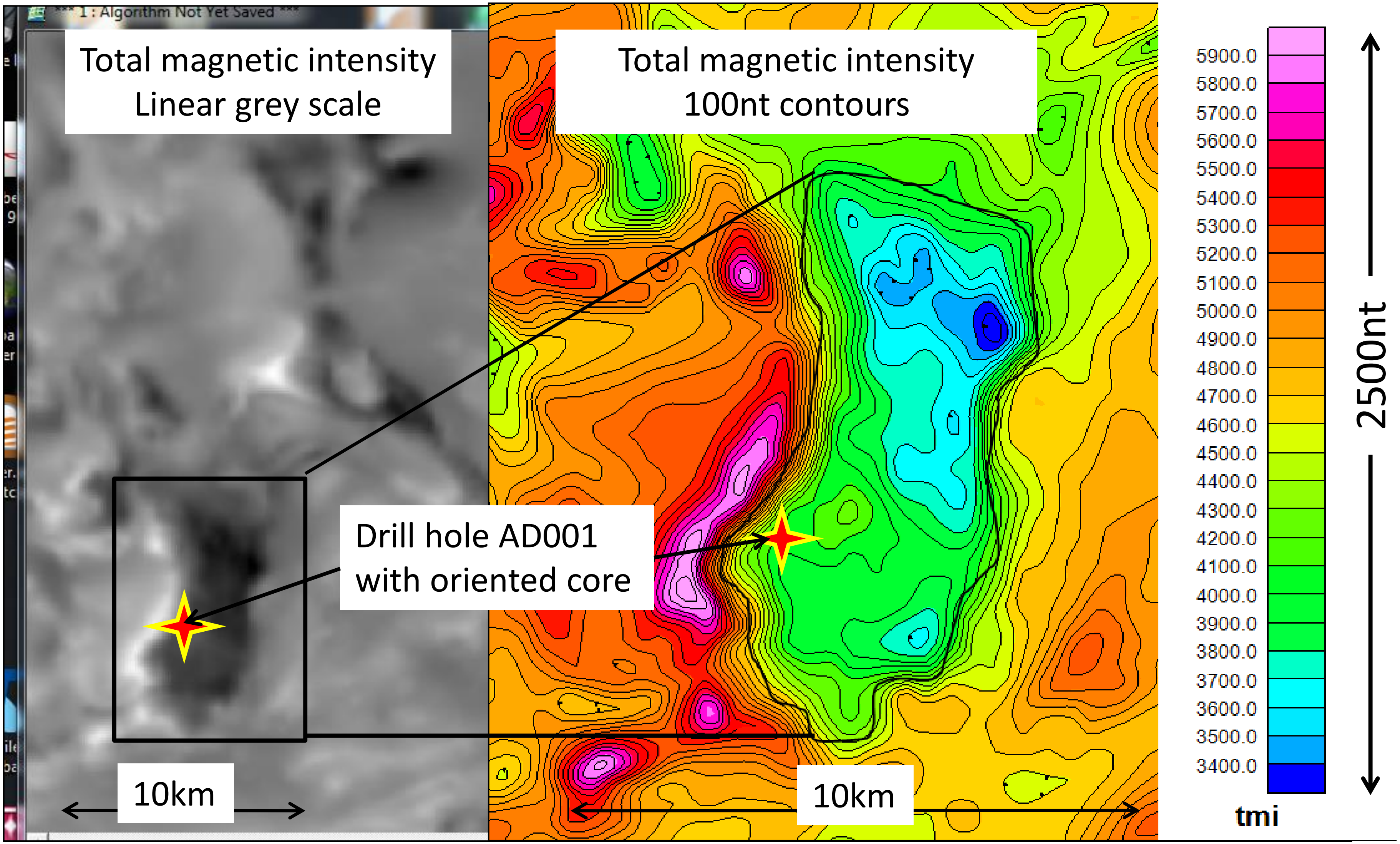
Intensity = 56400nt
Inclination = -61deg
Declination = 5.5deg



Total magnetic Intensity – linear stretch

Cooper Pedy – South Australia

Magnetic intensity is more than 1000nt lower than background



Cooper Pedy – South Australia

Drillhole AD 001 Intersected Gneiss – mineralogy is :

AD01 – 289.7m: Quartz-plagioclase-biotite-sillimanite-hematite (-muscovite)
AD01 – 308.5m: Quartz-plagioclase-K-feldspar (-titan hematite-ferrian ilmenite-muscovite).
AD01 – 340.4m: Biotite-sillimanite-K-feldspar-plagioclase- hematite.
AD01 – 341.0m: Quartz-plagioclase-cordierite-sillimanite-hematite-tourmaline

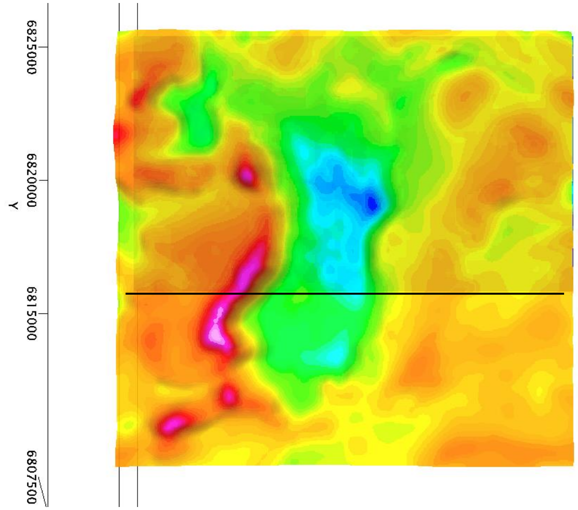
Drillhole AD 001 magnetic properties: *data from CSIRO report by D Clarke*

Sample	Susceptibility (10^{-6}SI)	NRM (declination, Inclination; Intensity)	Koenigisberger Ratio - Q
AD01/1	21	(188°,-63°; 0.19)	0.2
AD01/2	270	(151°,+62°; 6340)	648
AD01/3	9	(254°,+30°; 234)	727
AD01/4	570	(299°,+46°; 13,400)	655

Mean remanent direction for samples with significant remanence is: dec=234, inc=+46

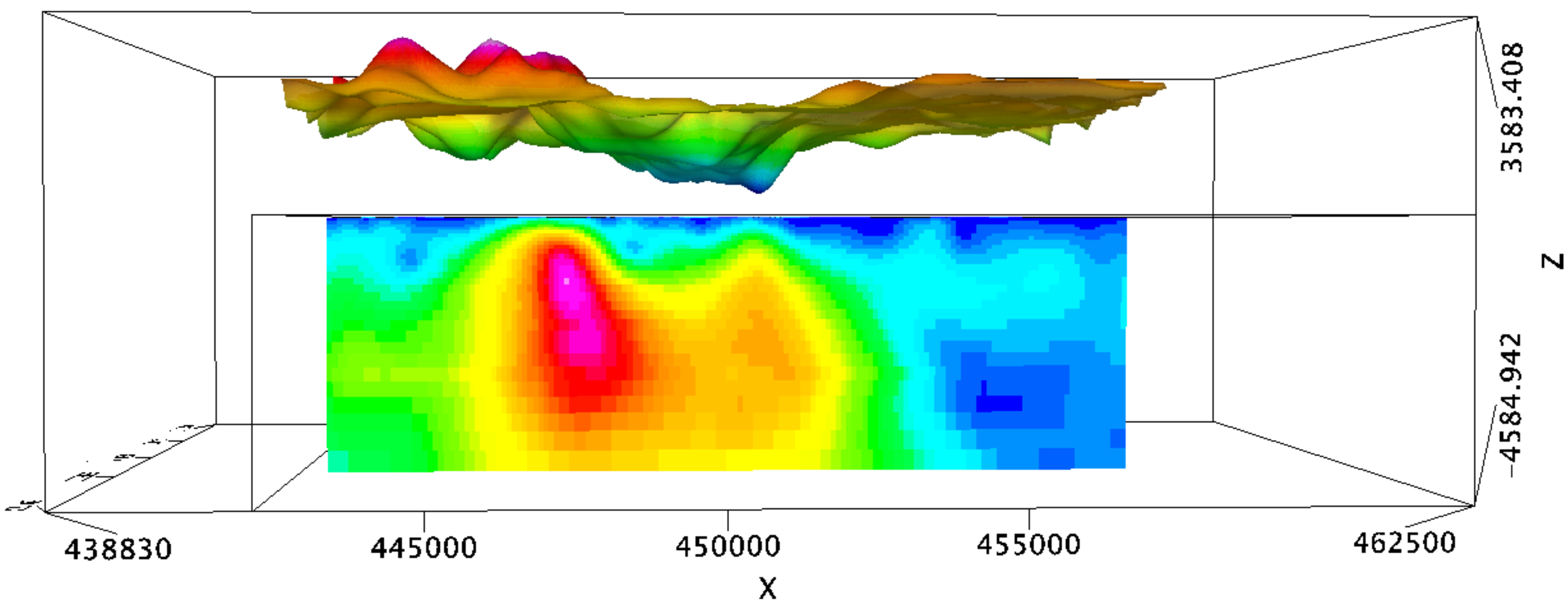
Cooper Pedy – South Australia

Magnetic vector inversion using Geosoft Voxi



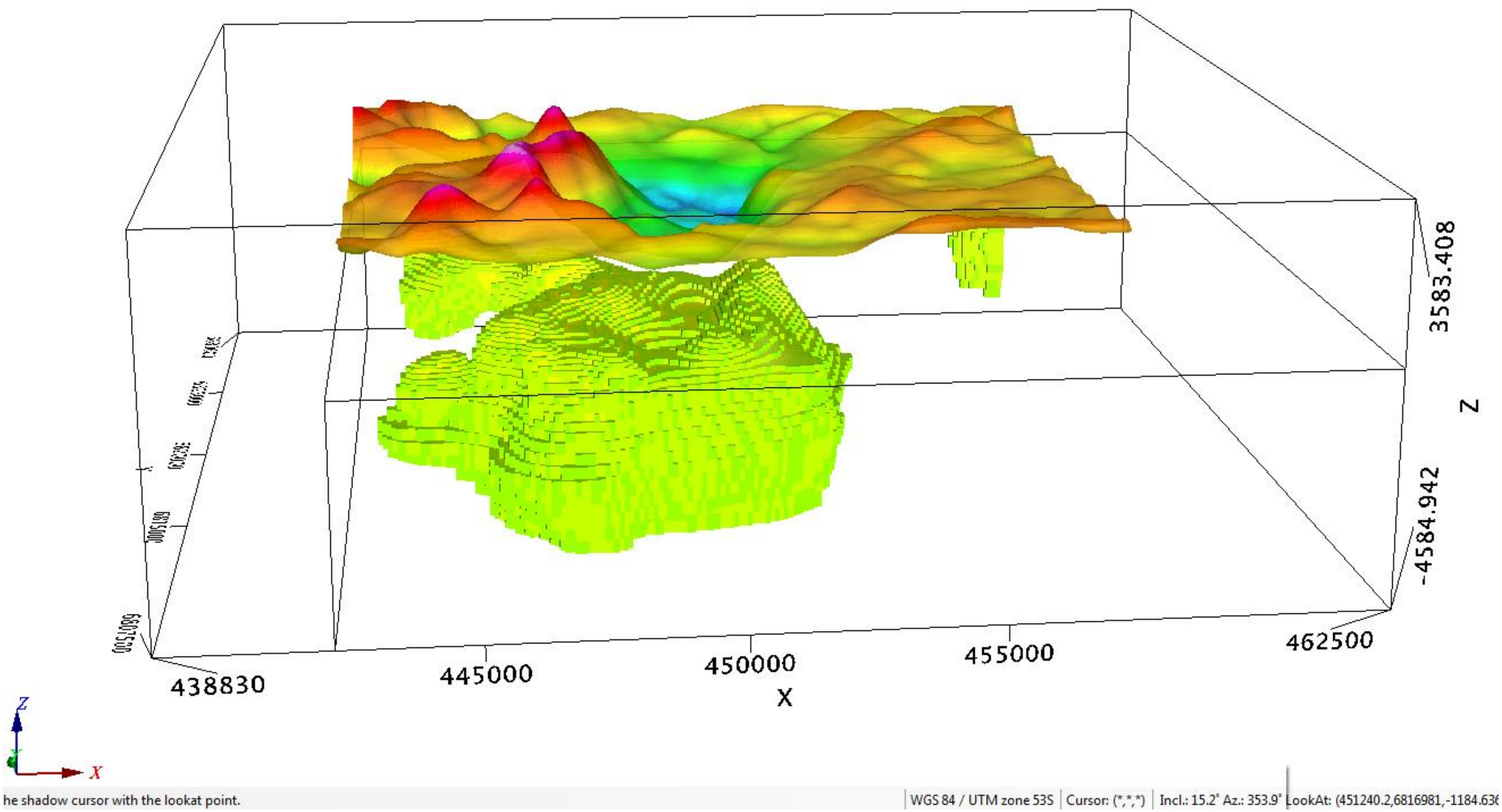
Plan with section location marked

Section view



Cooper Pedy – South Australia

0.02 magnetisation isosurface from the magnetic vector inversion.

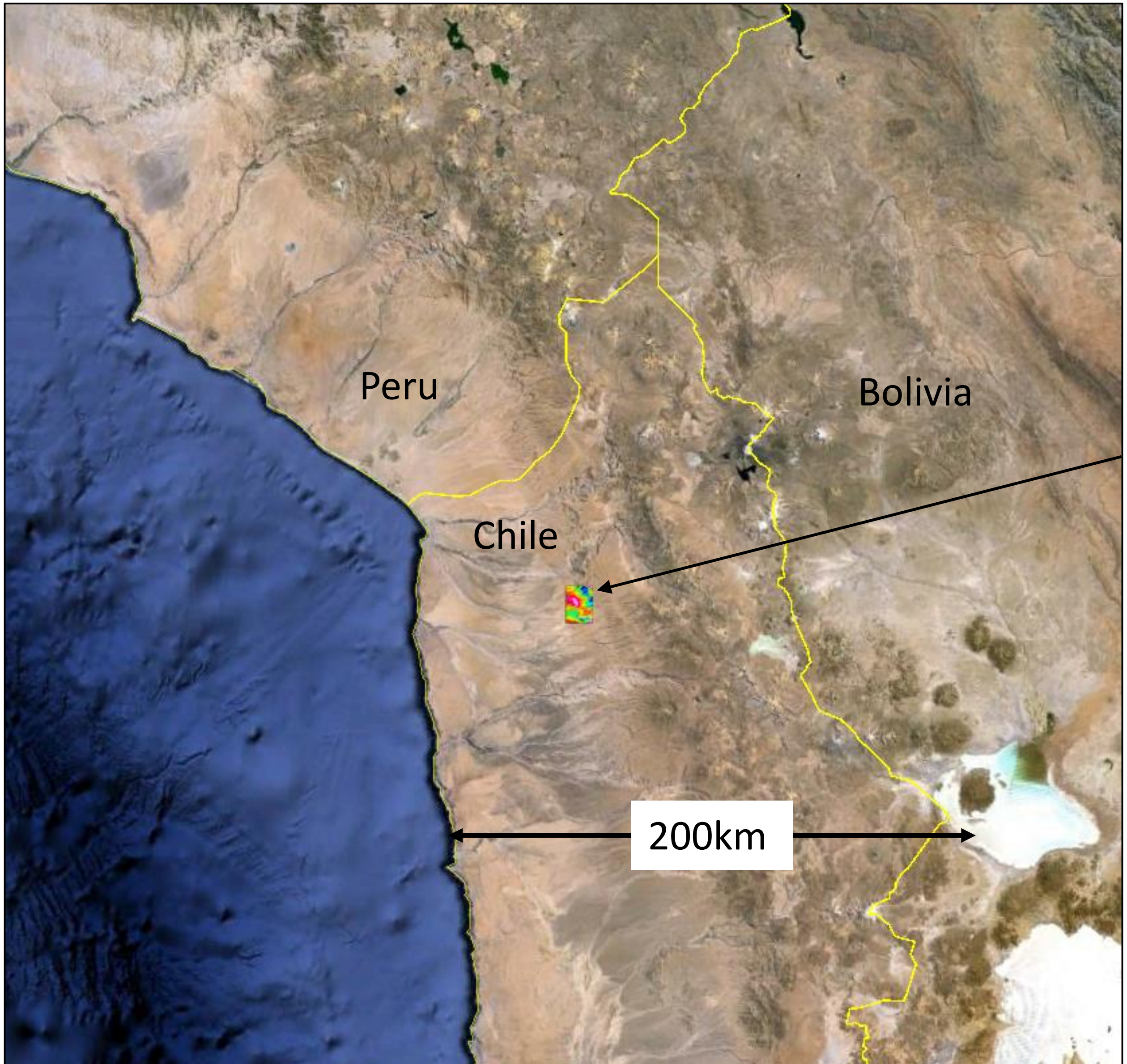


Chile - Santuario

This case study will show:

- An attempt at modelling the effects of magnetic topography (in this case the magnetic topography is thought to be a magnetic ignimbrite layer).
- Modelling of deeper magnetic sources at low magnetic latitudes using susceptibility and magnetic vector inversions.

Chile - Santuario



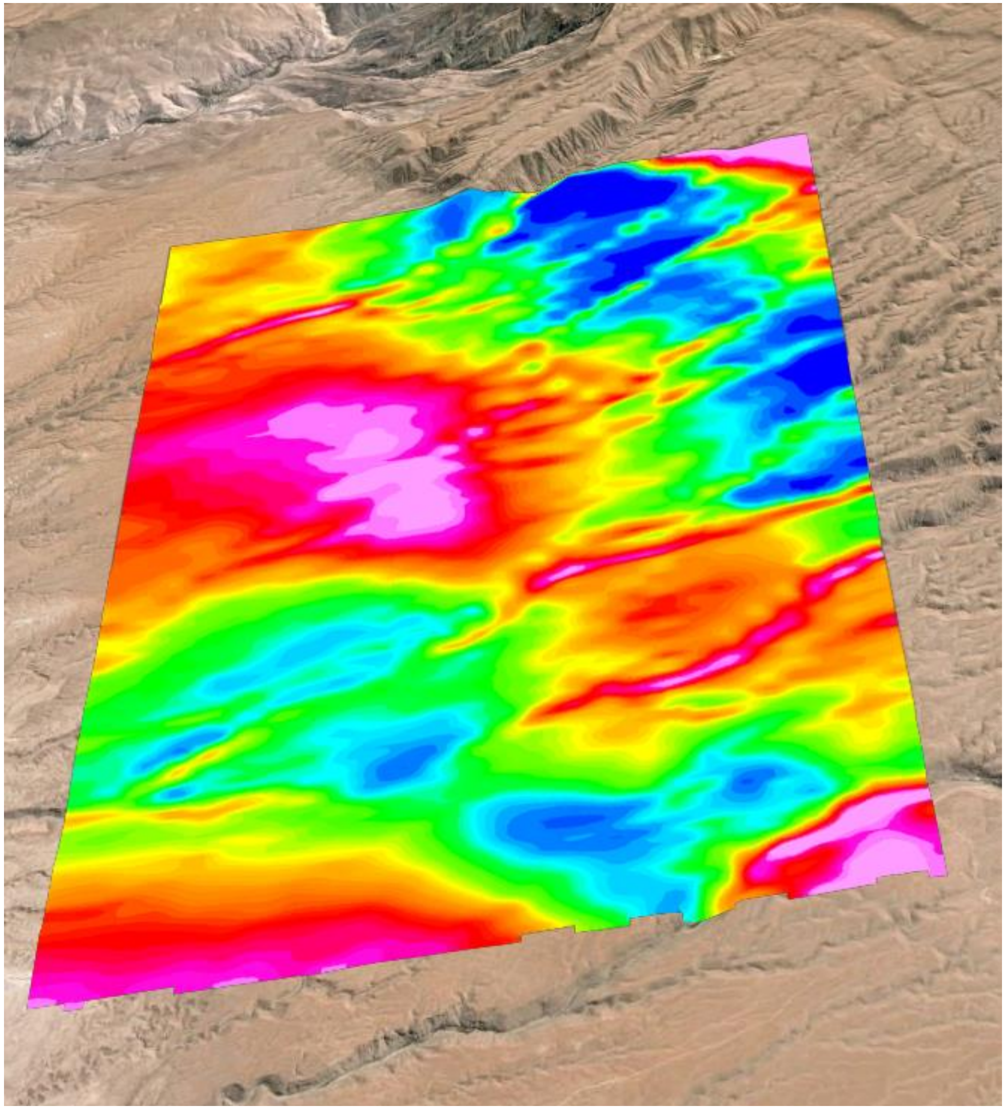
Magnetic Field Parameter
Magnetic inclination = -13.2
Declination = -5.2
Magnetic Intensity = 23000nt

Santuario Helimag Survey
400m line spacing
60m terrain clearance drape
North –south flight direction

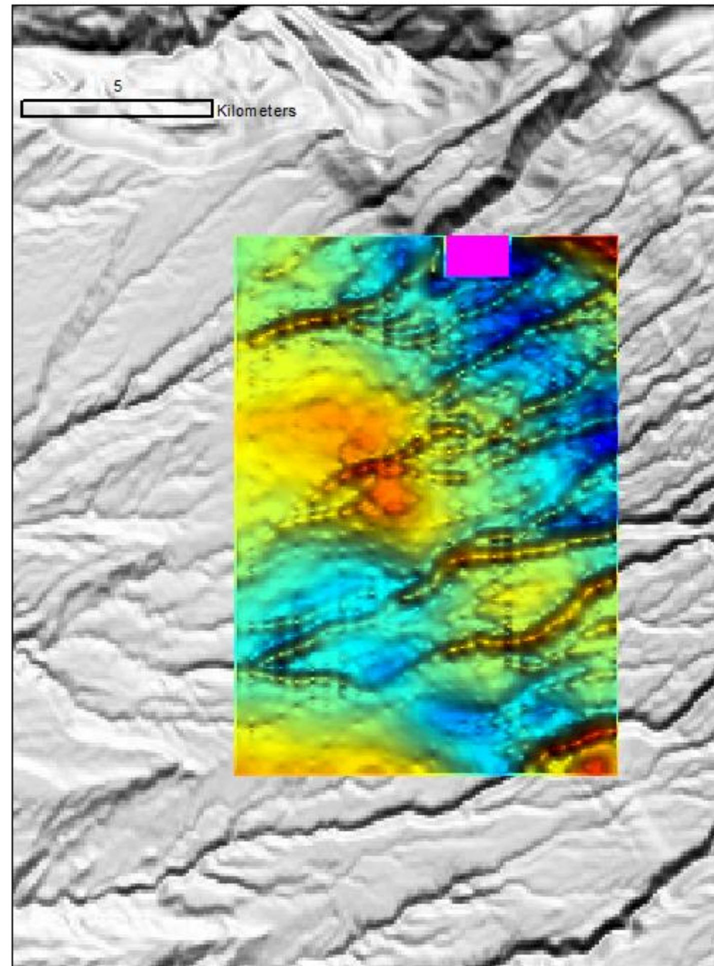
Geology
Magnetic ignimbrite cover over prospective basement.

Chile - Santuario

Total Magnetic Intensity Image draped on topography

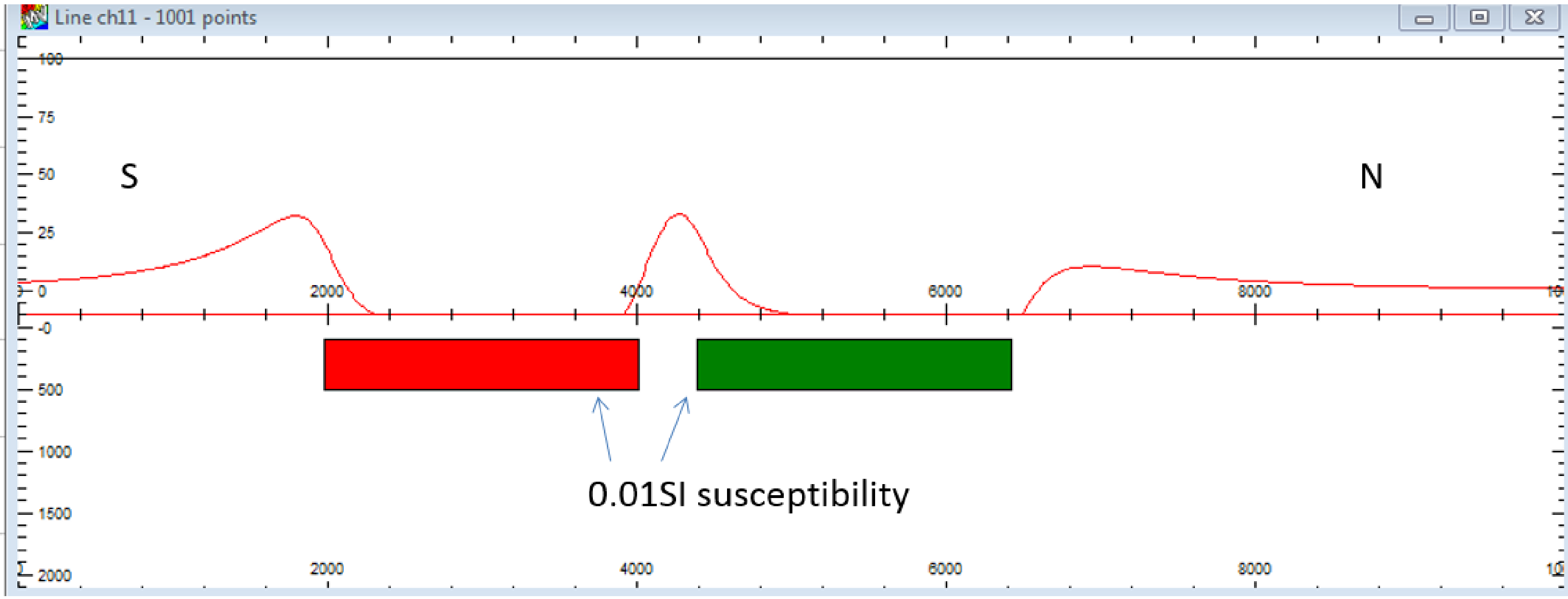


Note the association of linear magnetic highs with gullies (quebradas)



Chile - Santuario

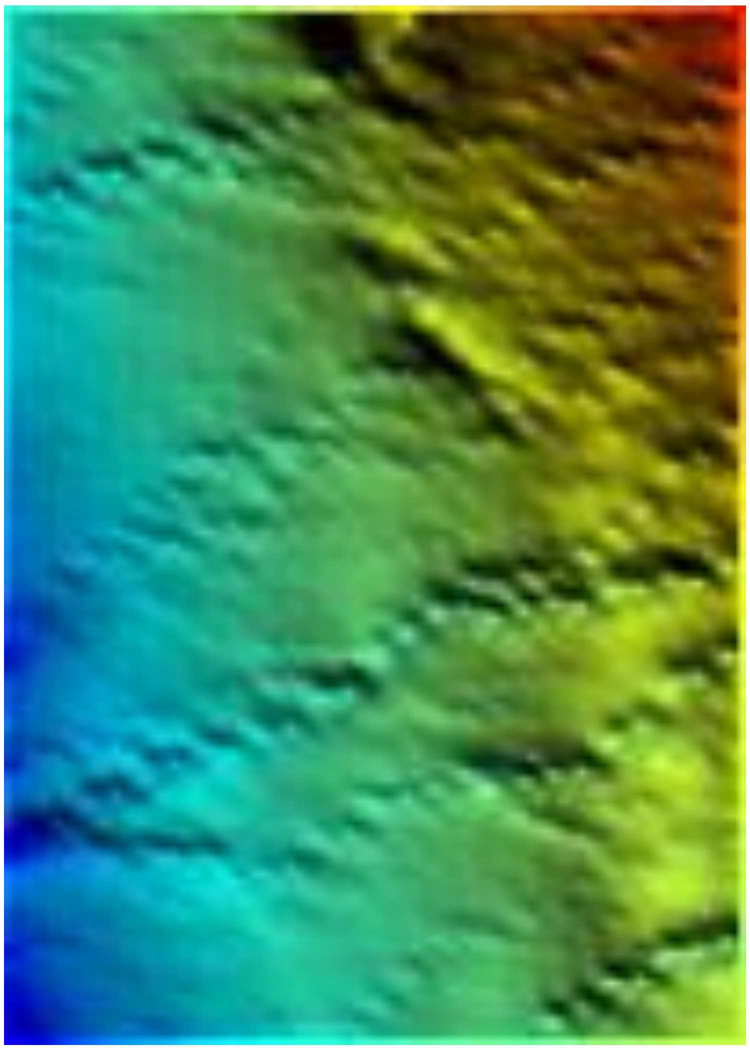
Forward Magnetic Modelling at this magnetic latitude shows gaps in the magnetic units are associated with magnetic highs



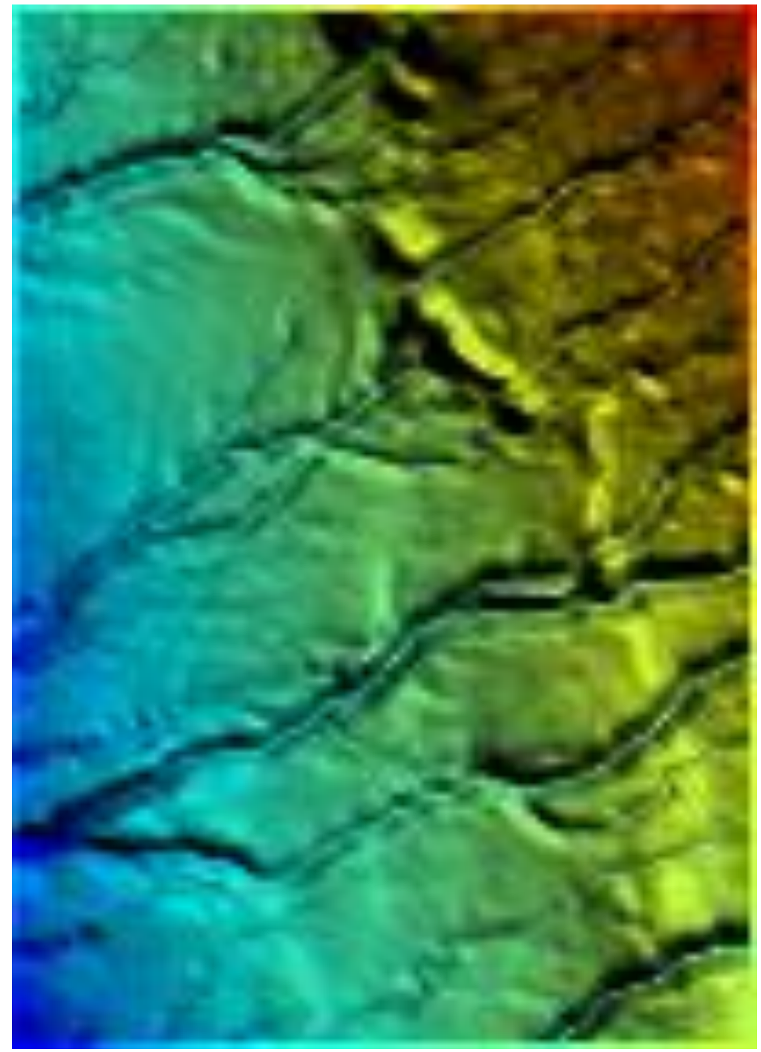
Chile - Santuario

Digital Elevation models - SRTM is superior

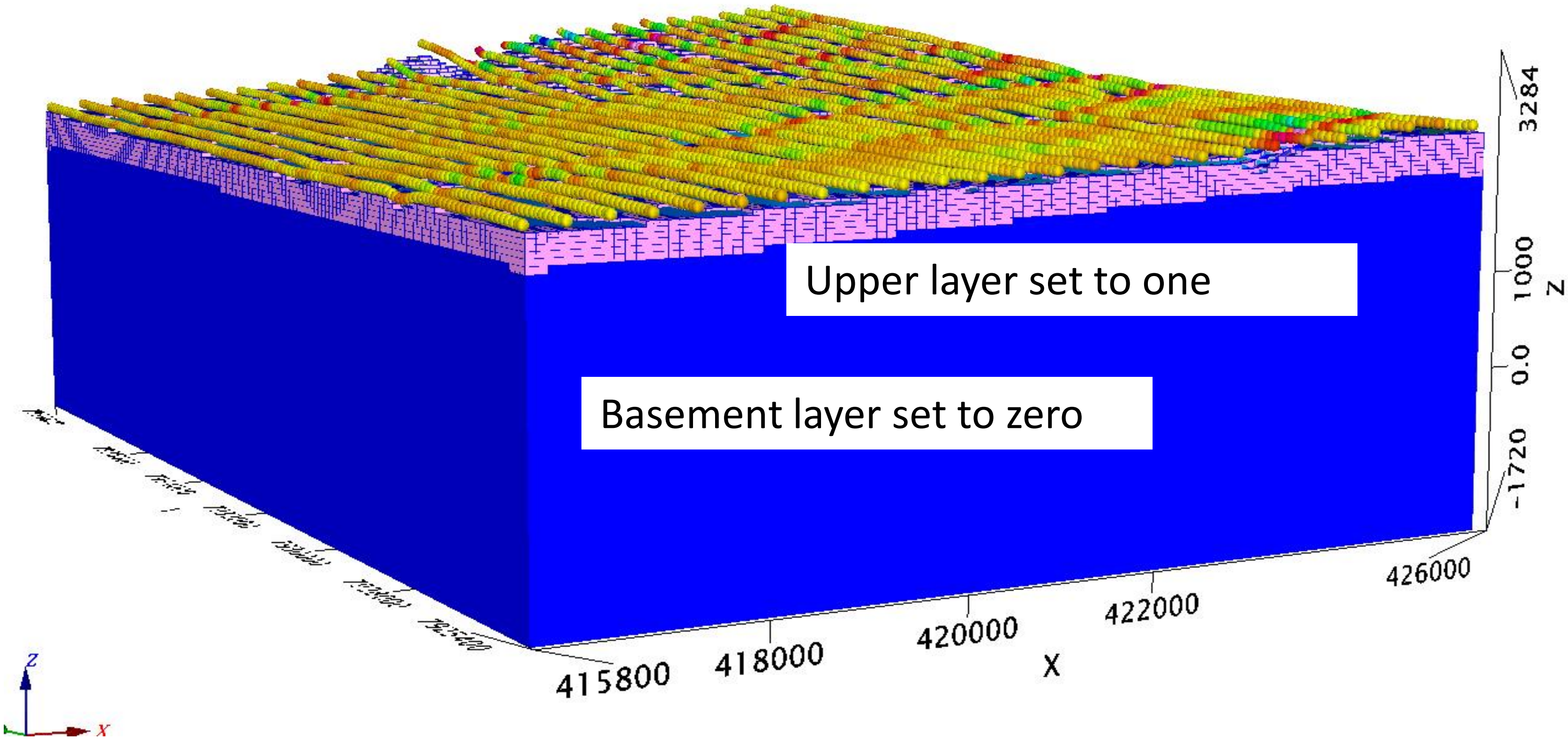
Helicopter survey



SRTM data



Forward magnetic susceptibility model setup for a surface magnetic layer using a dissected terrain as defined by SRTM. The Voxi modelling program uses Cartesian cut cells in preference to prismatic cells to honour the surface/air interface more precisely.



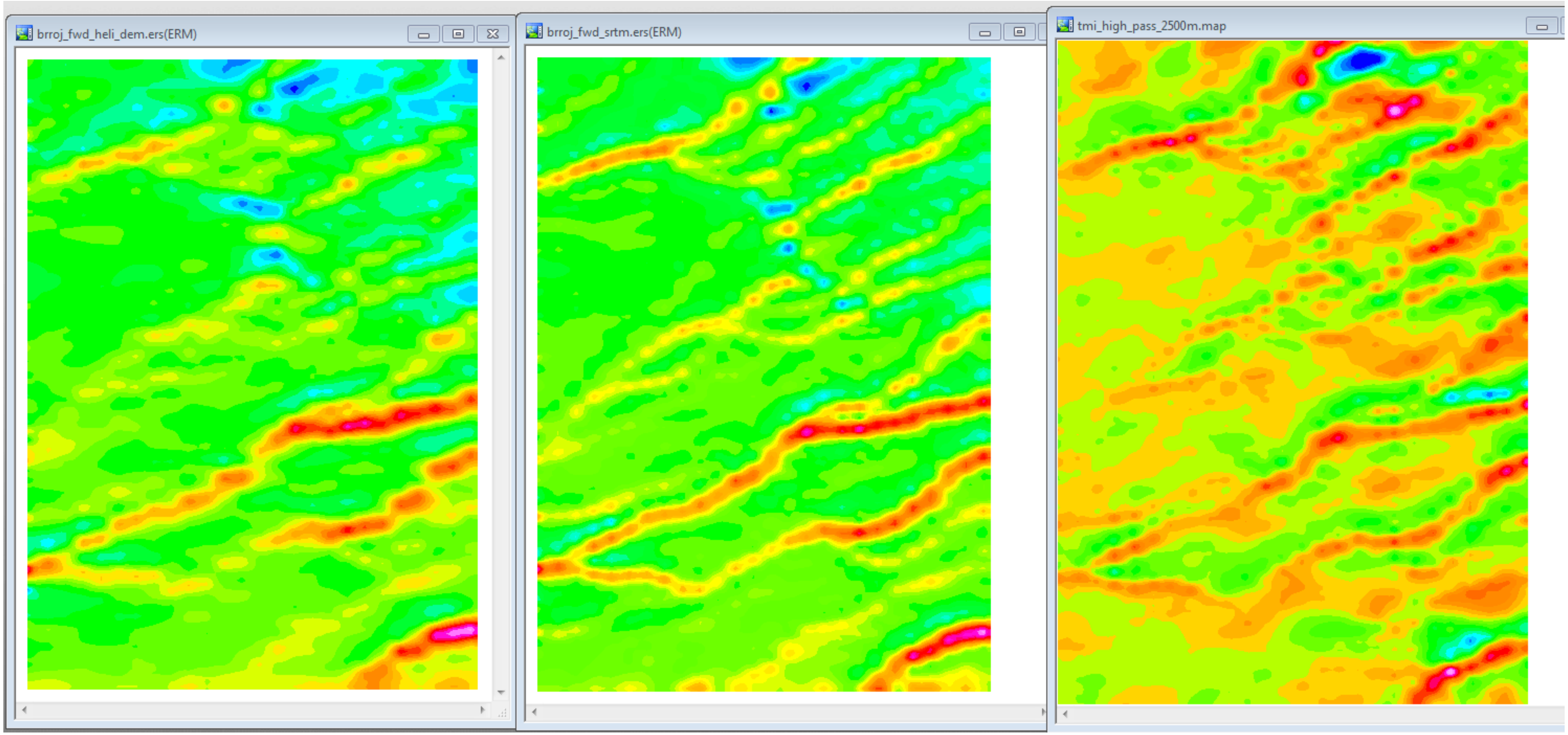
Chile - Santuario

All images with a linear stretch

Fwd model using the DEM from the heli mag survey

Fwd model using the DEM from SRTM data

High pass filter (2500m) of the tmi.



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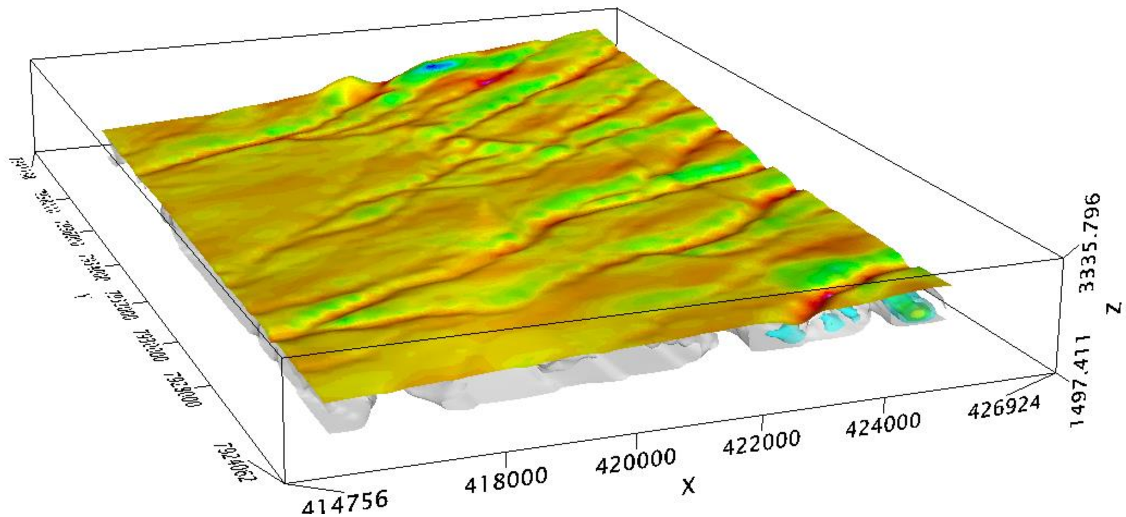
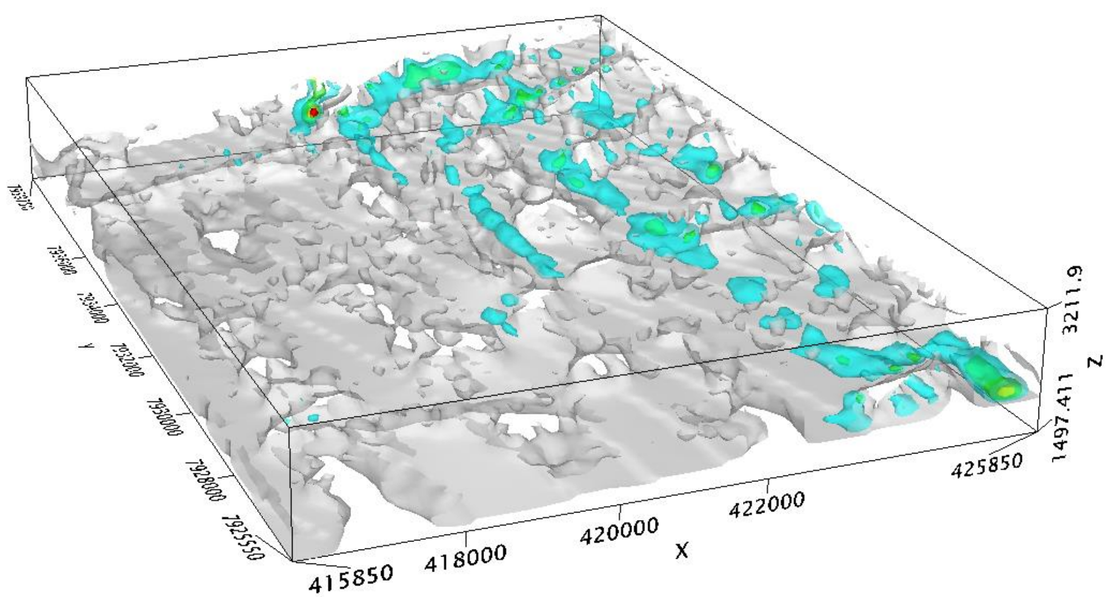


Susceptibility inversion model of the high pass filtered tmi data.



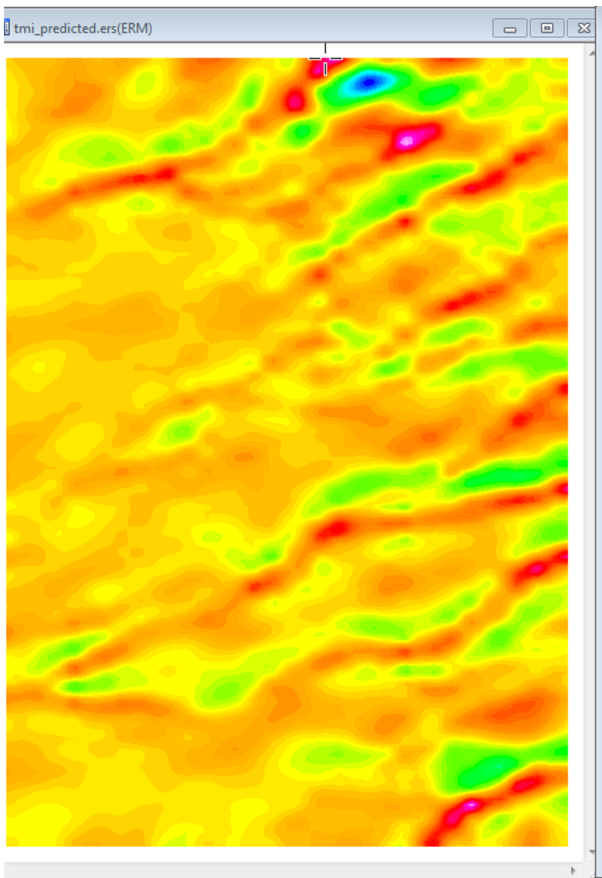
Susceptibility inversion isosurfaces of the high pass filtered tmi data.
Areas with perhaps no ignimbrite can be seen.
The aqua coloured areas may be thicker ignimbrite.

Chile - Santuario

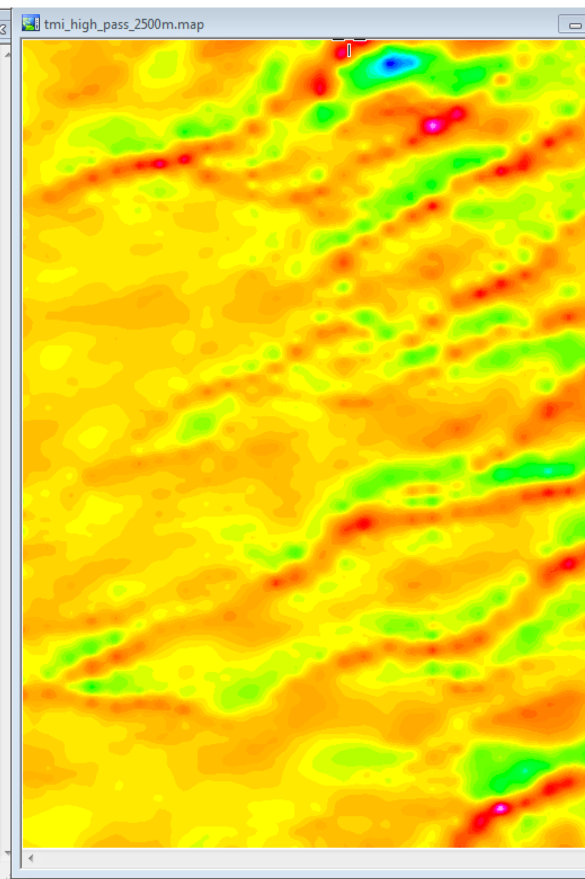
All images with a linear stretch

Results from the magnetic susceptibility inversion of the dissected surface layer

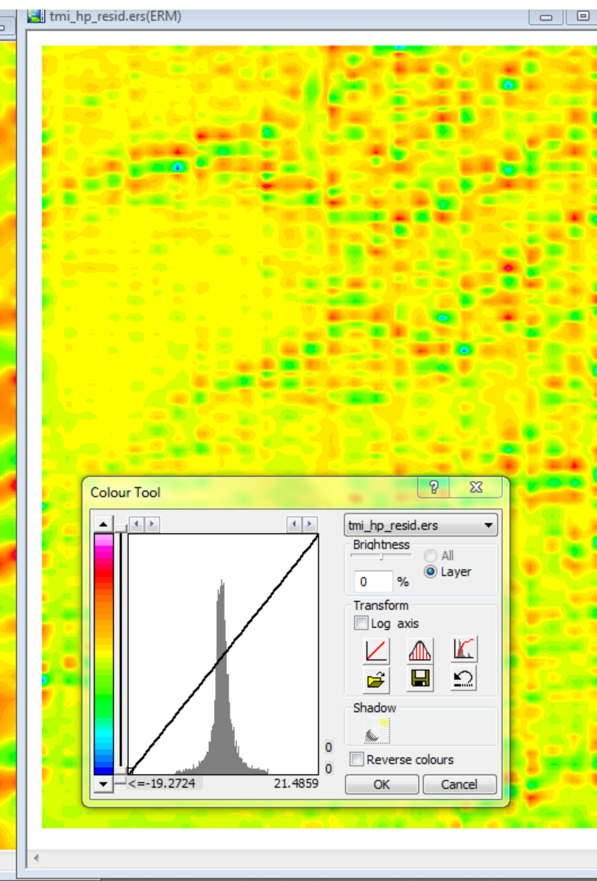
Predicted response



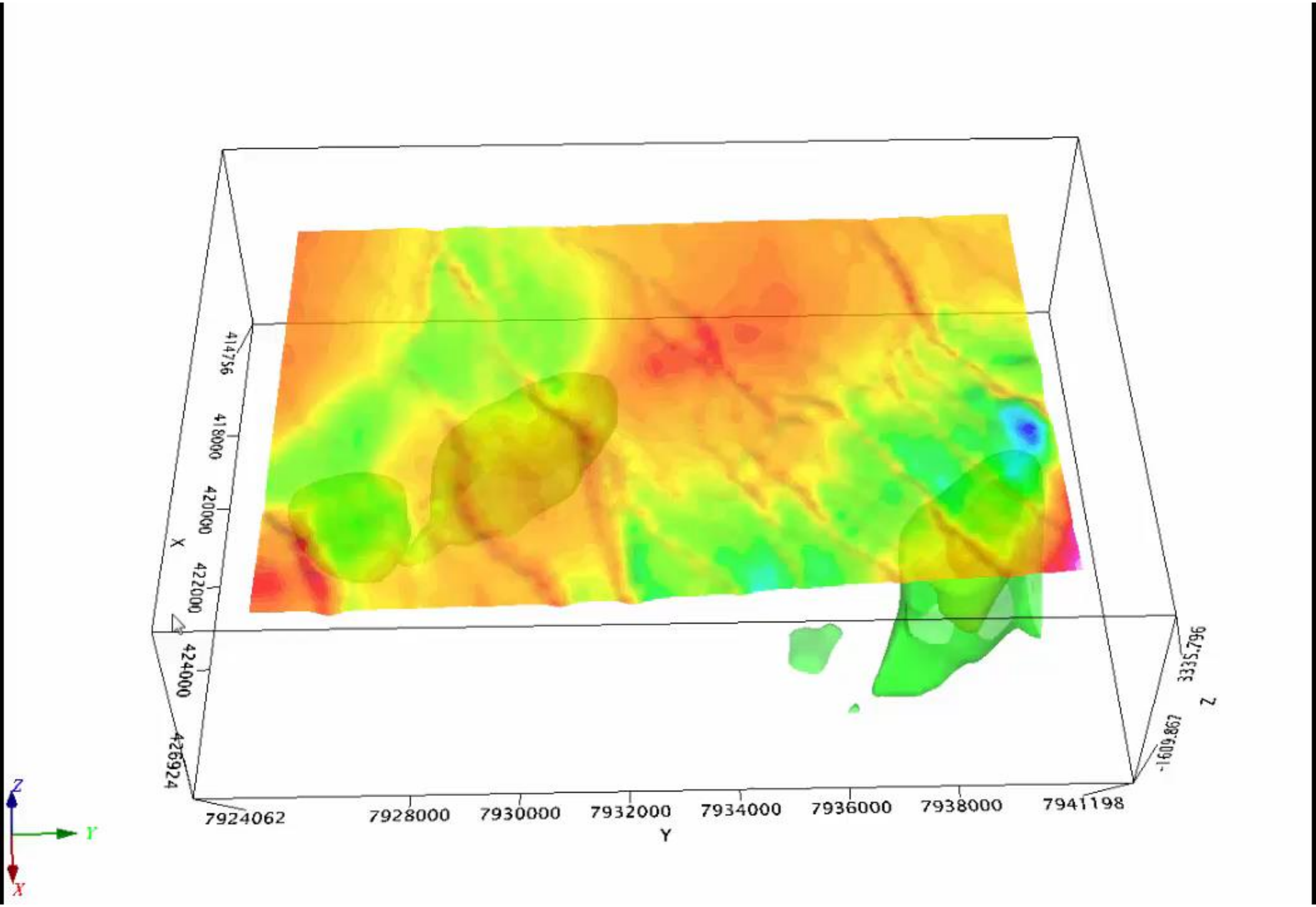
High pass filtered data



Difference grid



Video – magnetic susceptibility and magnetic vector inversions at Santuario



Acknowledgements

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