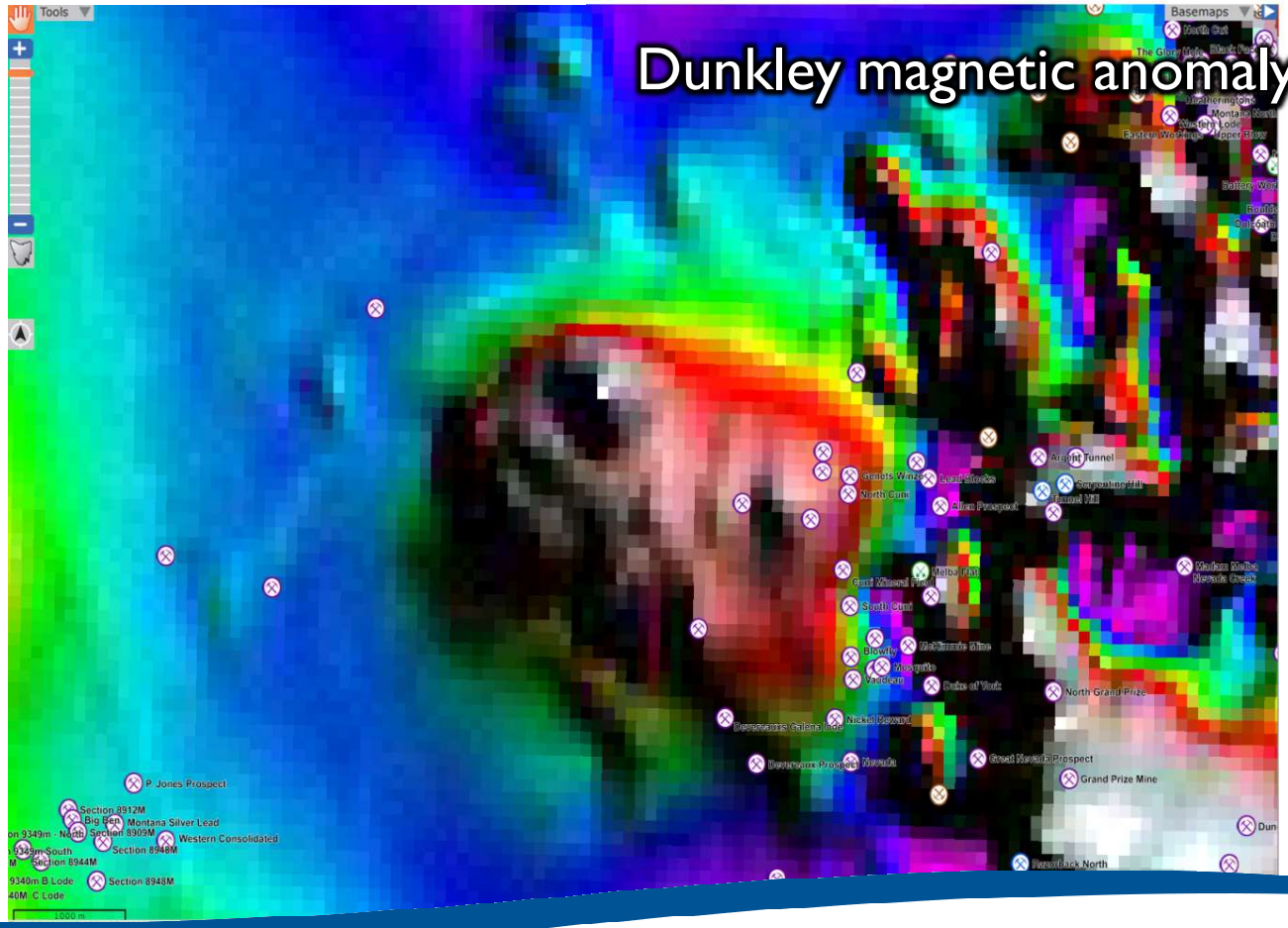
Mark Duffett
Senior Geophysicist
4 December 2020

Dunkley magnetic anomaly (re-)revisited

An exploration case history



Tasmanian Government

Dunkley magnetic anomaly

Also known as Rayne

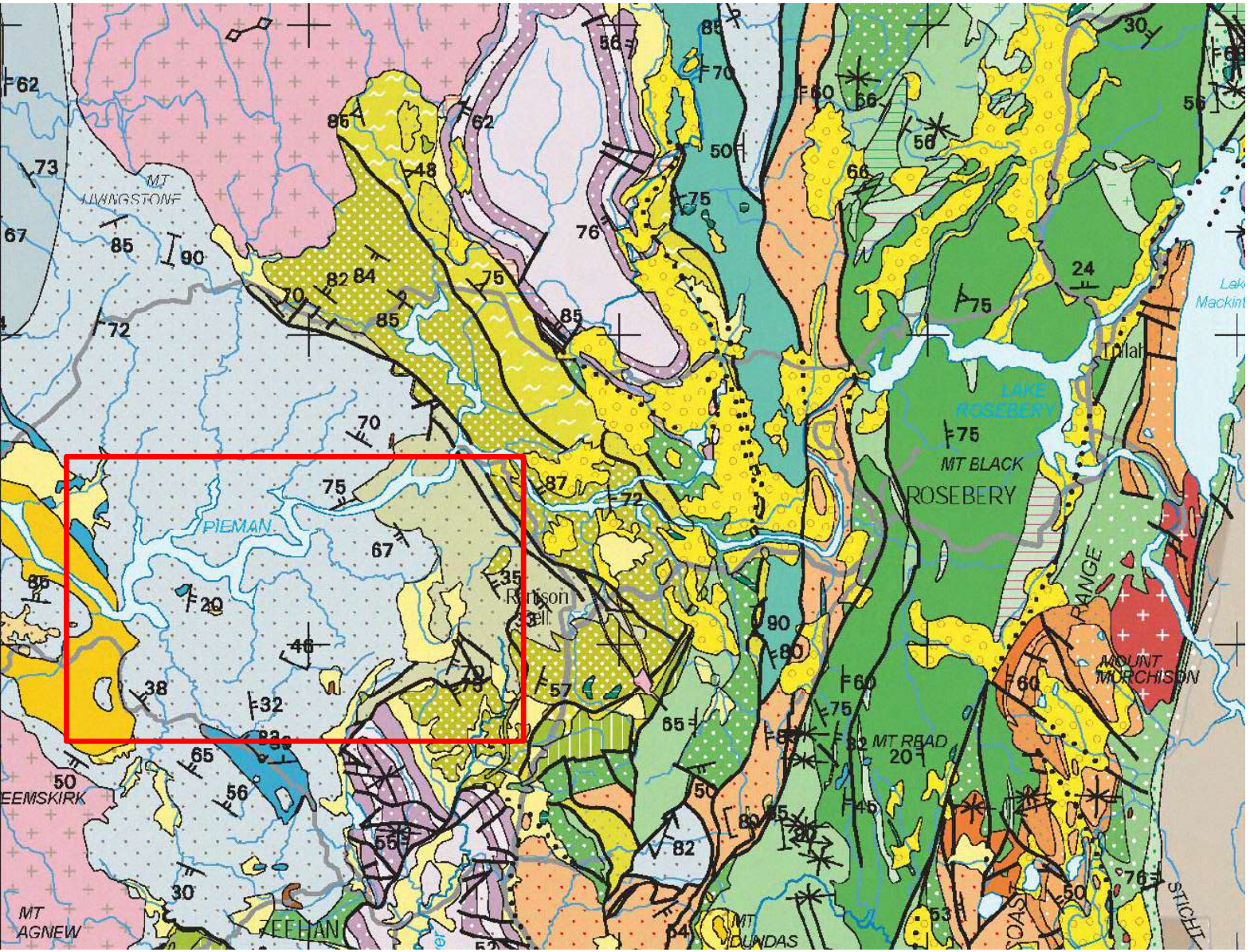
Not just a magnetic feature, but anomalous in context of host unit

Exploration history

- Rio Tinto 1960 – "ultrabasic intrusive"
- Renison Ltd 1983-86 (Dunkley Fault grid)
- MMG-Stellar 2008-11

The upshot – importance of understanding full suite magnetic properties, and homework

Rosebery region geology



Dgaf / Dg Devonian granite

Cambrian gabbro

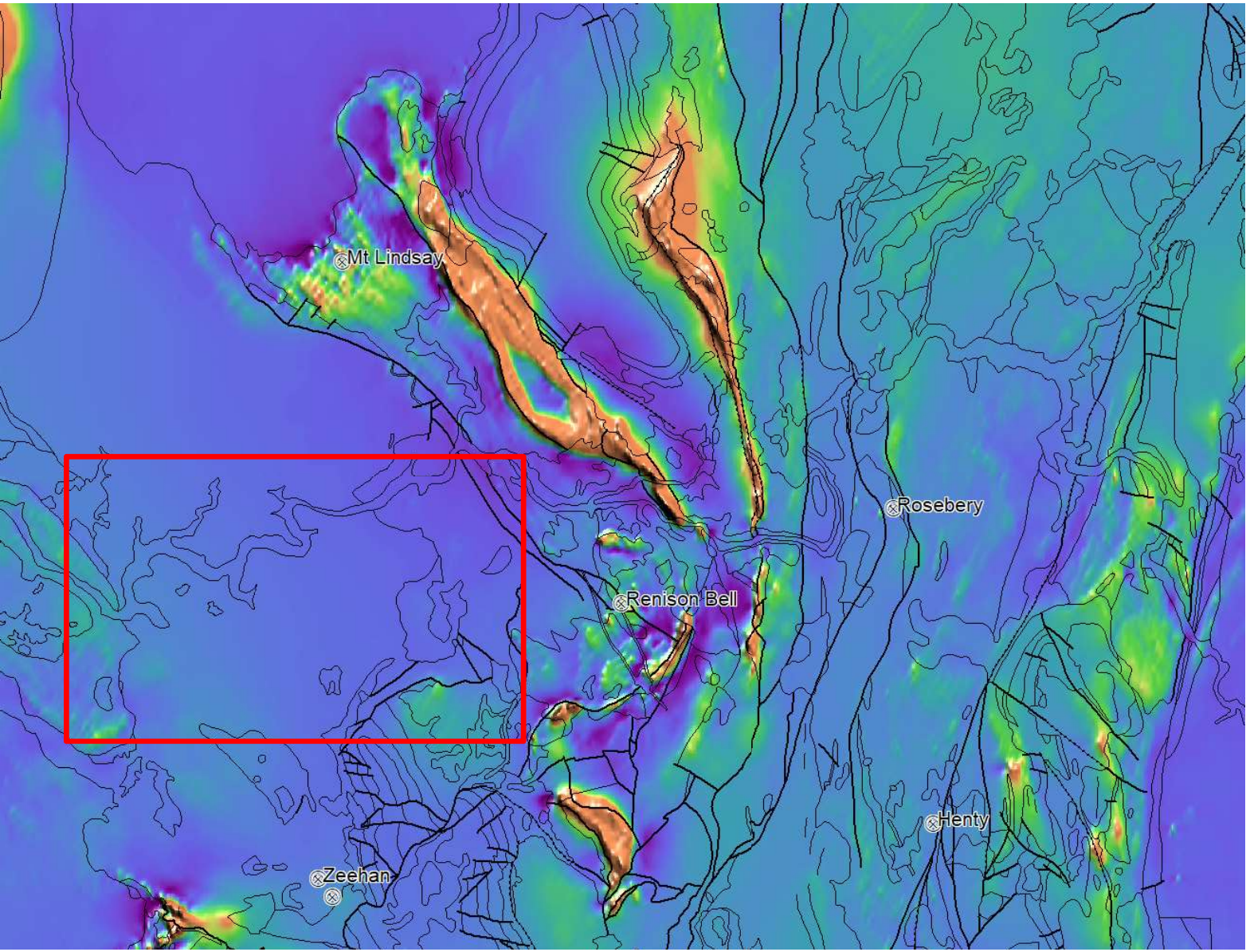
Pdv Crimson Ck Fm

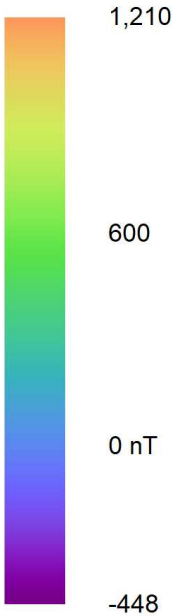
Success Ck Gp

Po Oonah Fm

Rosebery region

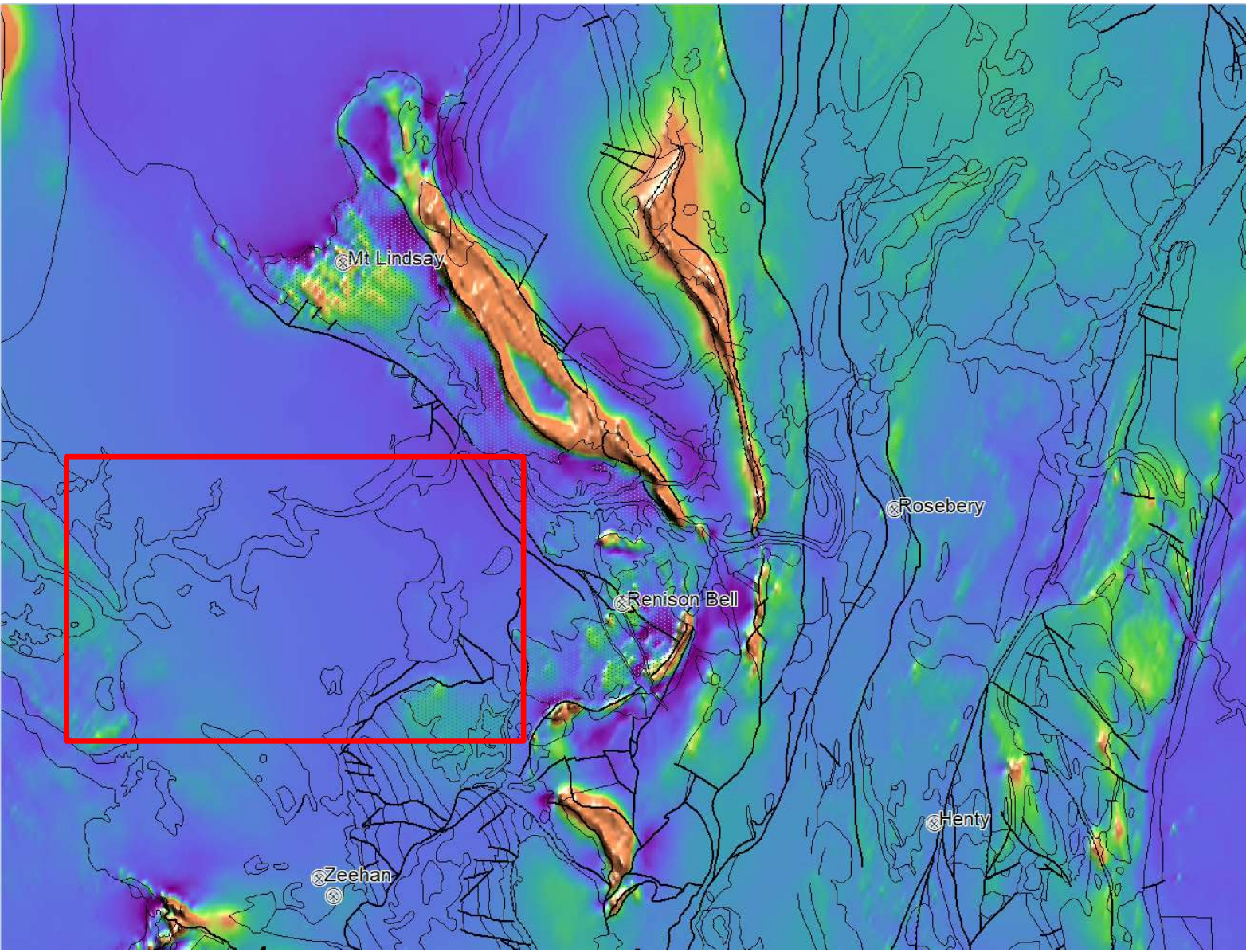
RTP

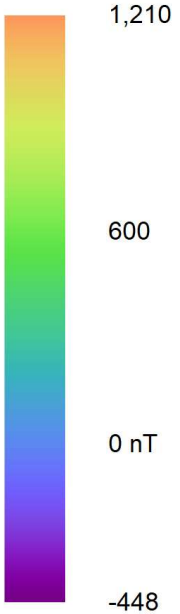


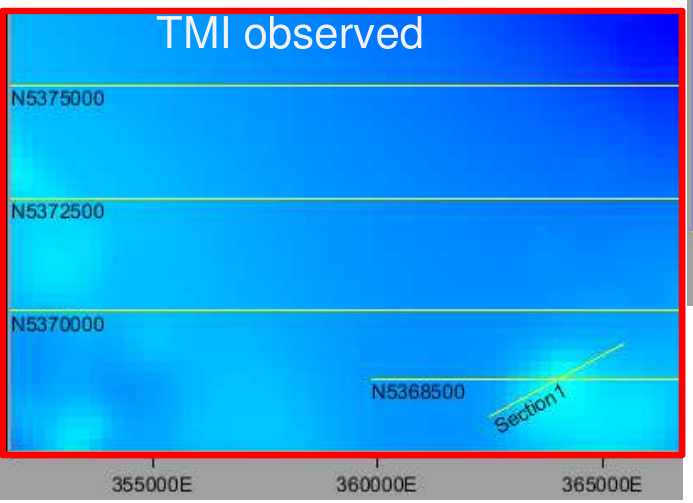


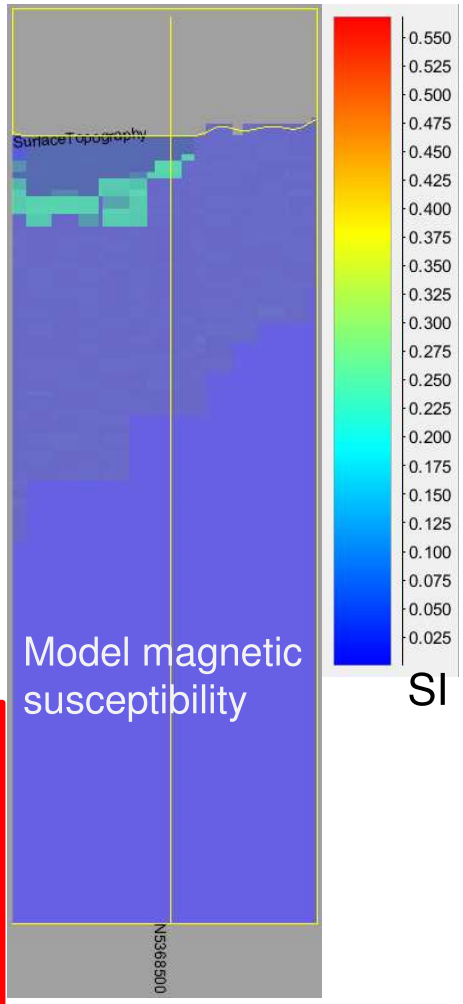
Rosebery region

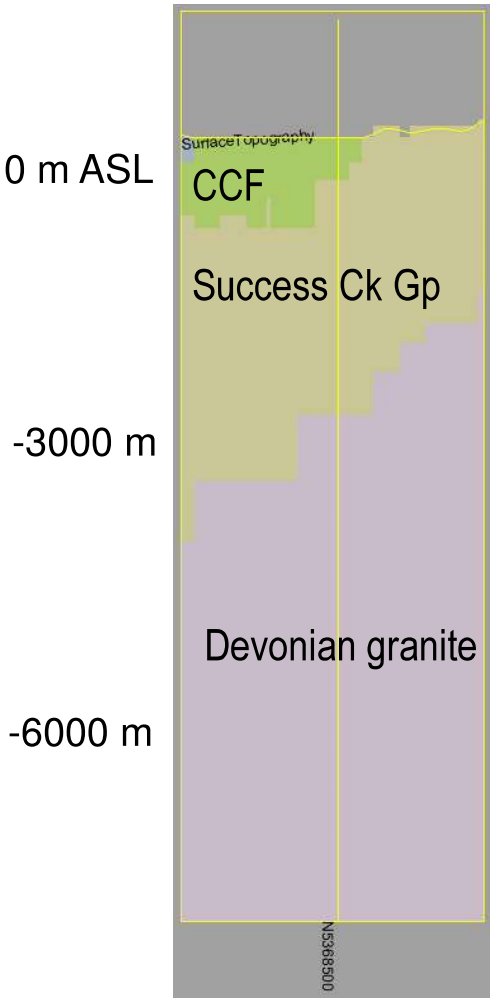
RTP



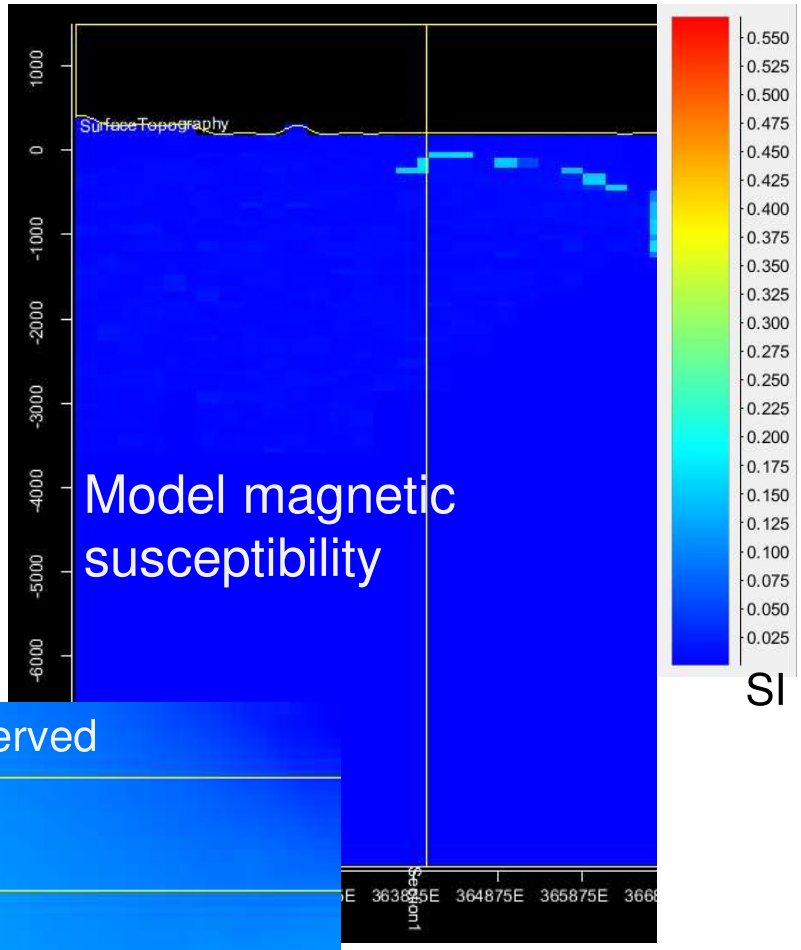


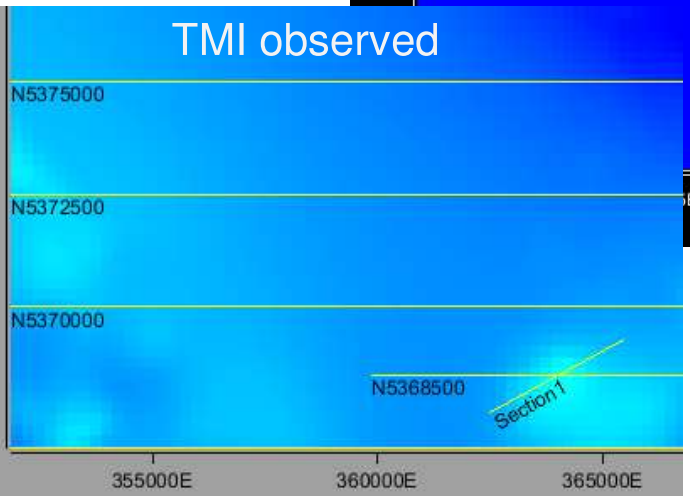


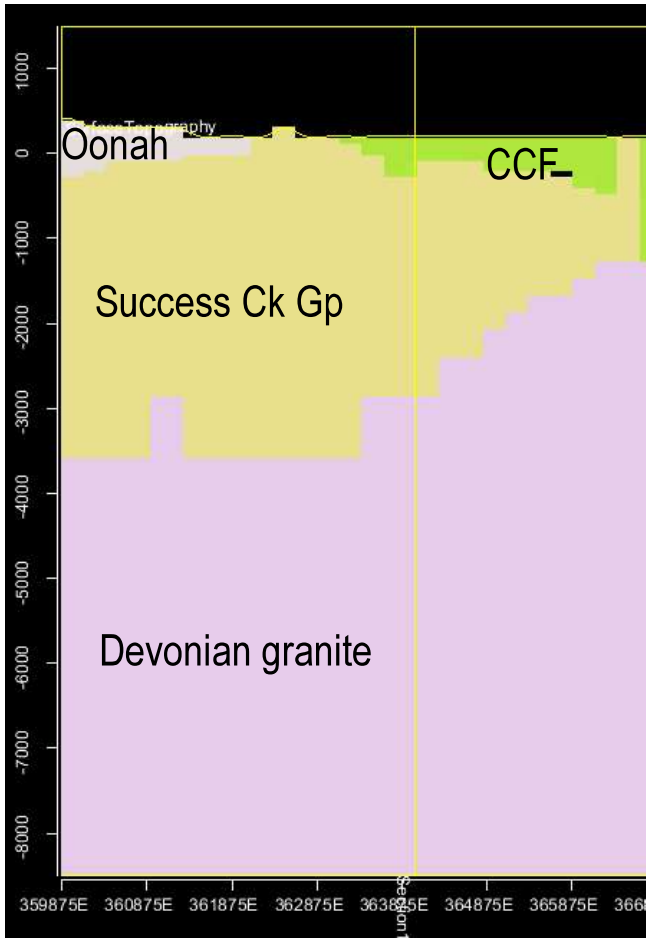




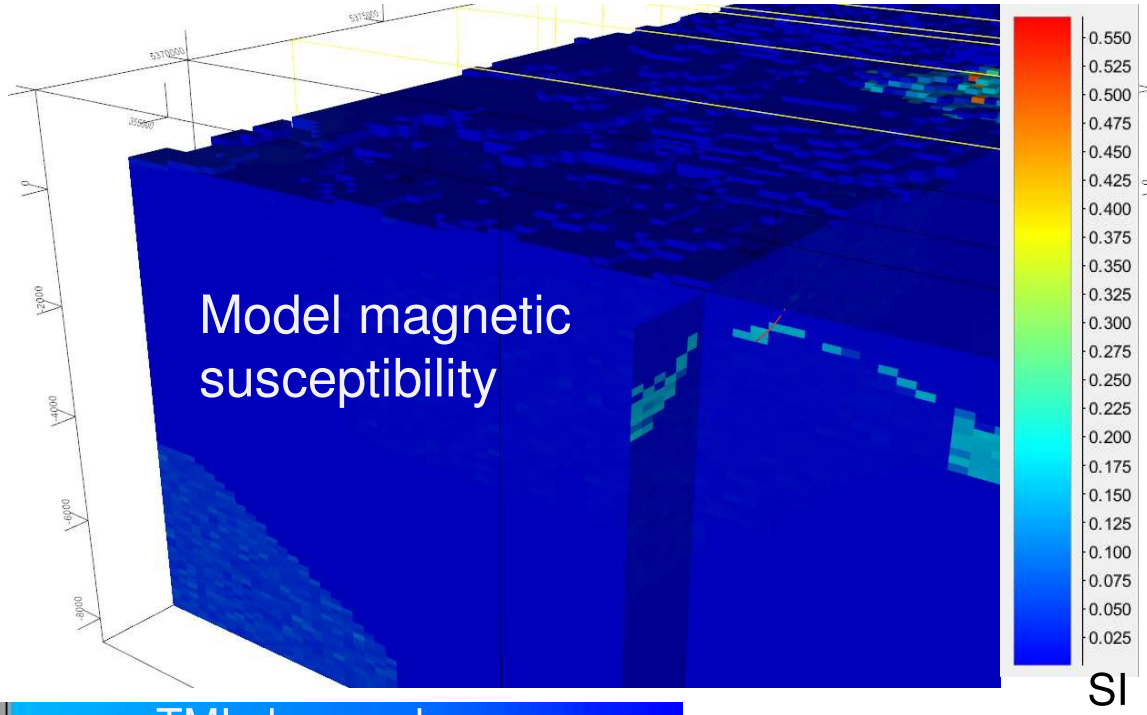
Rosebery region 3D model section 1

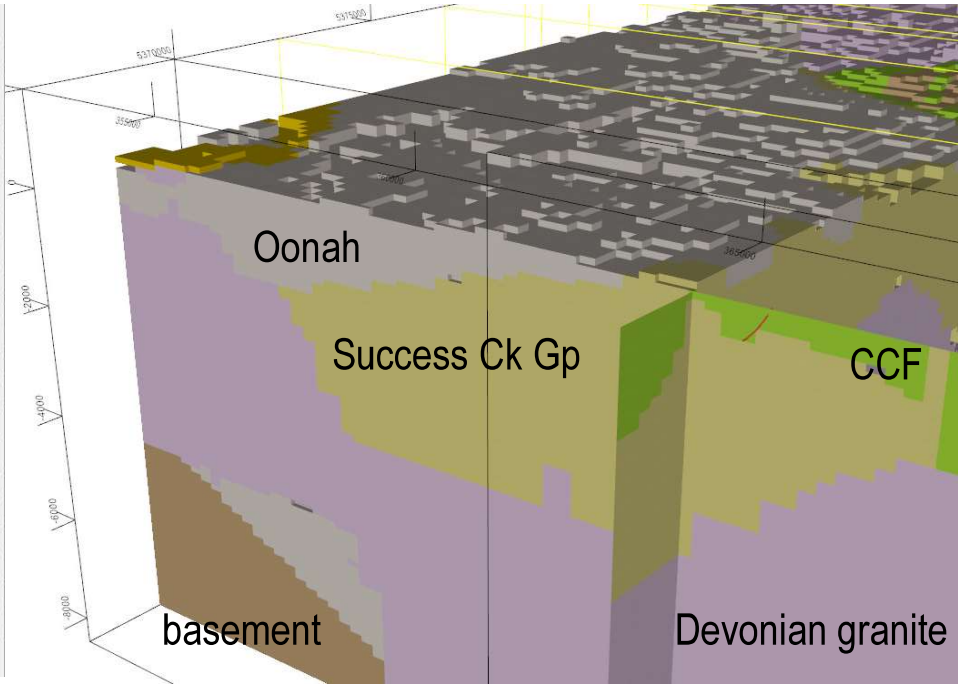


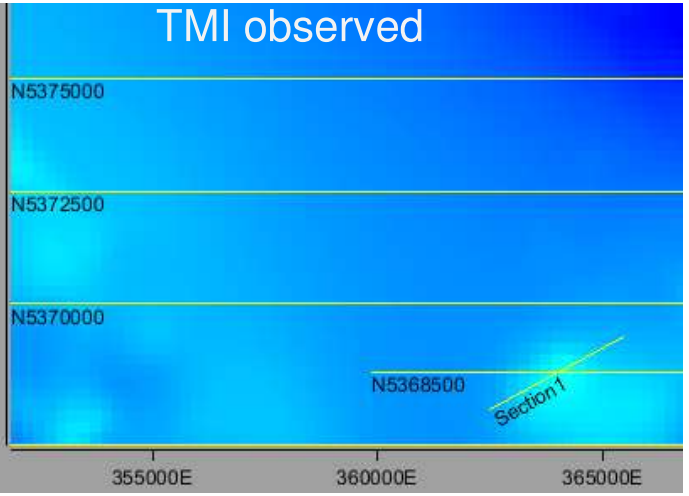




Rosebery region 3D model section 5368500N





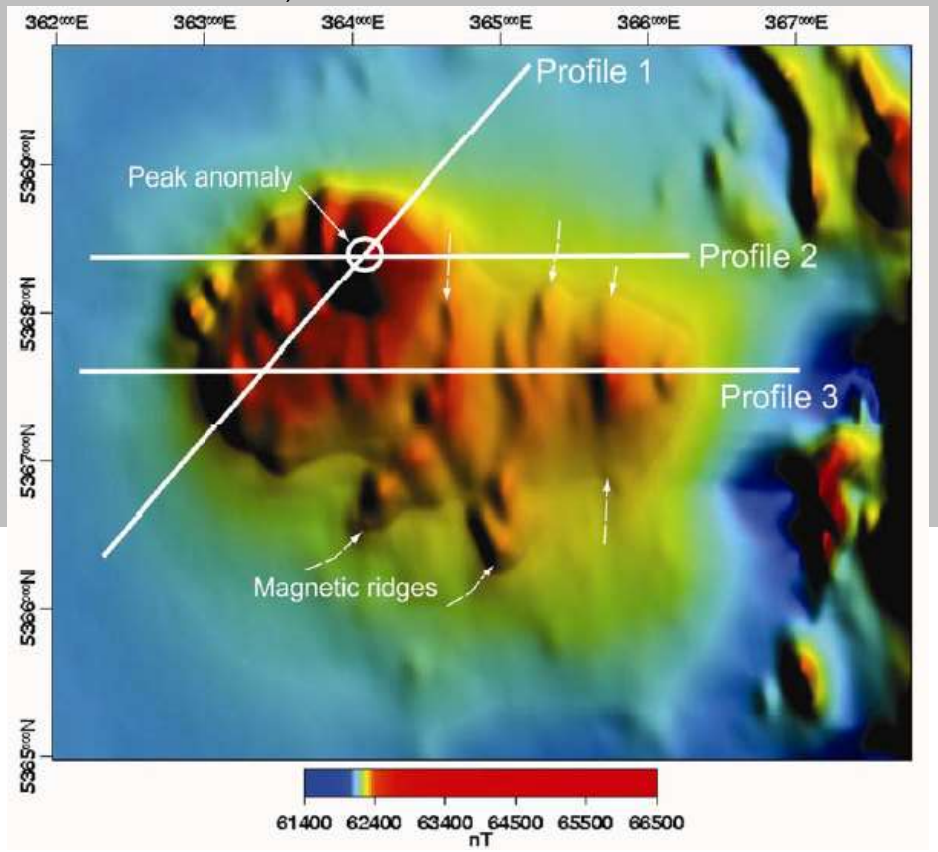


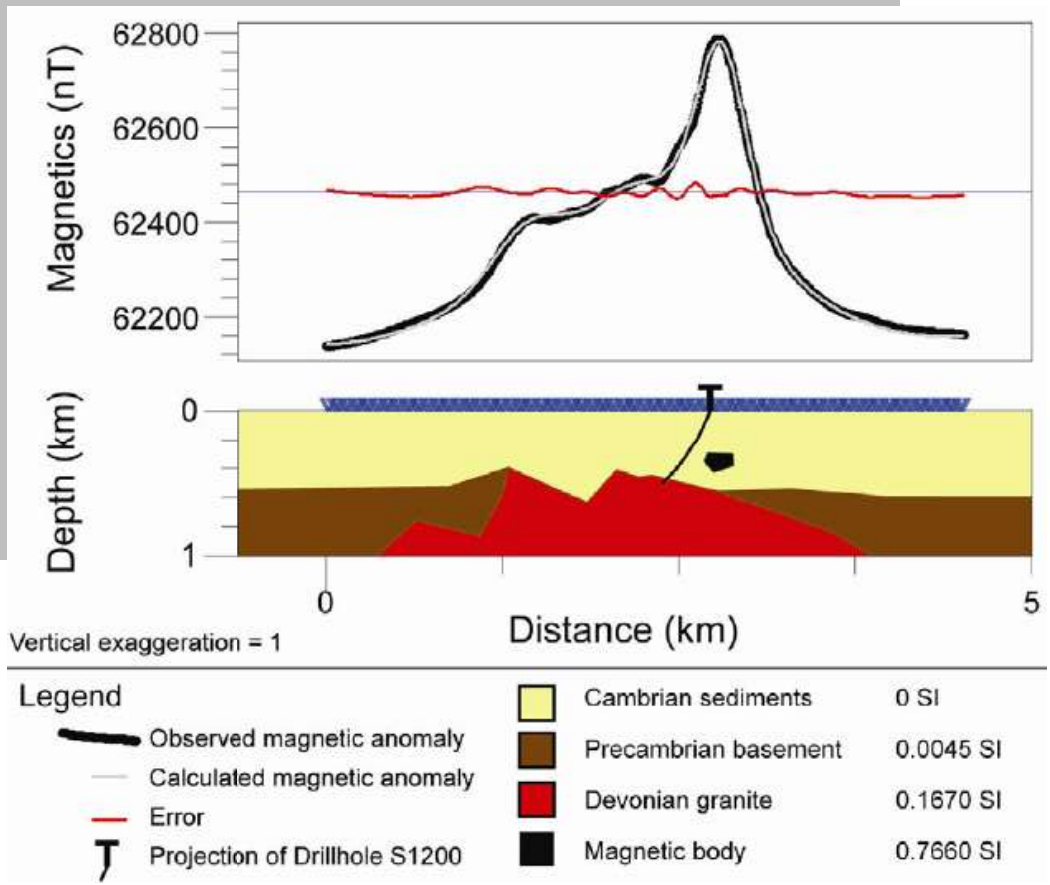
Rosebery region 3D model section 5368500N

MMG-Stellar modelling 2008

Assumptions

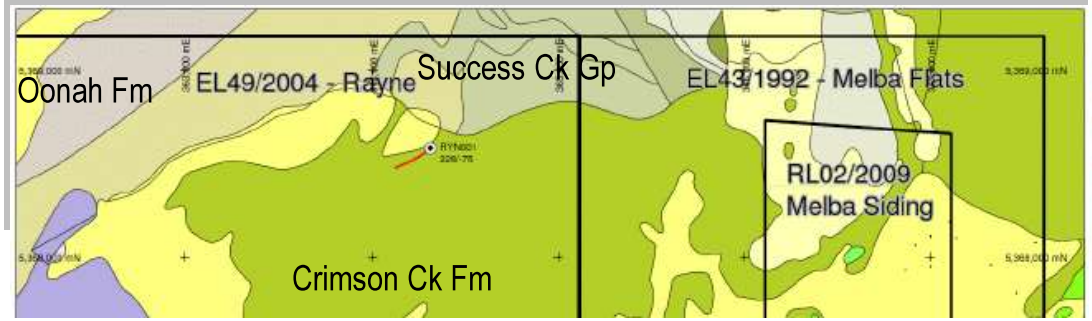
- S1200 "penetrated only non-magnetic Cambrian CCF" based on mag susc data in Kilpatrick 1985
- but aware of regionally accepted higher values (>0.01 SI) for CCF (not Success Ck Gp though)
- Basement (Oonah + Arthur Lineament equivalents) 0.0025-0.006 SI)
- Devonian granites & granodiorites ~0.0025 SI, described as "low" given aureole signatures (apparent misreading of Leaman & Webster 2002)





MMG-Stellar 2011 RYN001 drilling

- 644.2 m targeting magnetic source based on 2008 2D forward and later 3D inversion models
- Crimson Ck Fm black shale, greywacke, siltstone except magnetite-phyric gabbro dykes @ 447 & 596 m (few m thick)
- Trace to weakly disseminated pyrite-pyrrhotite zones throughout
- Magnetic anomaly remains untested



cross-section ~ Section 1/Profile 1

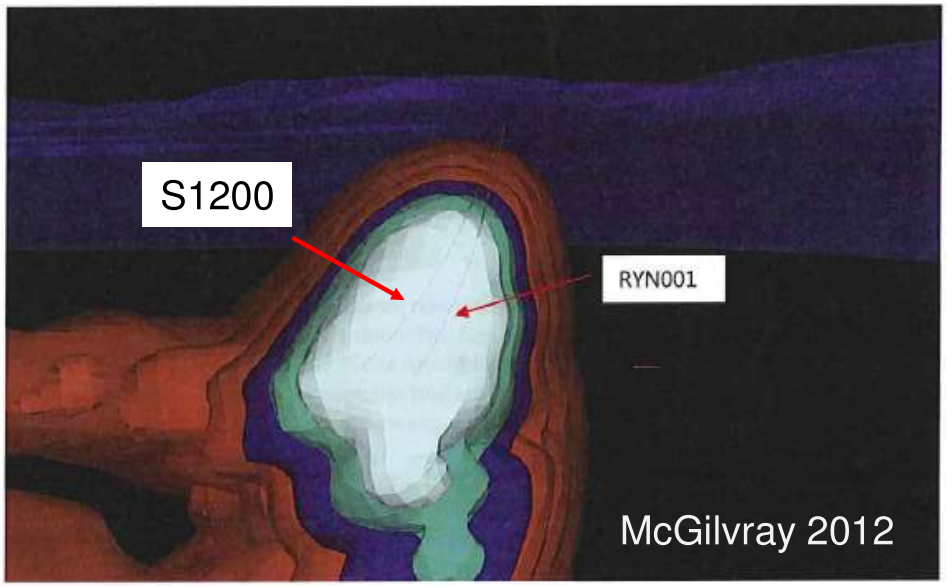


Figure 1: TMI inversion model anomaly with magnetic susceptibility shells

Model 1

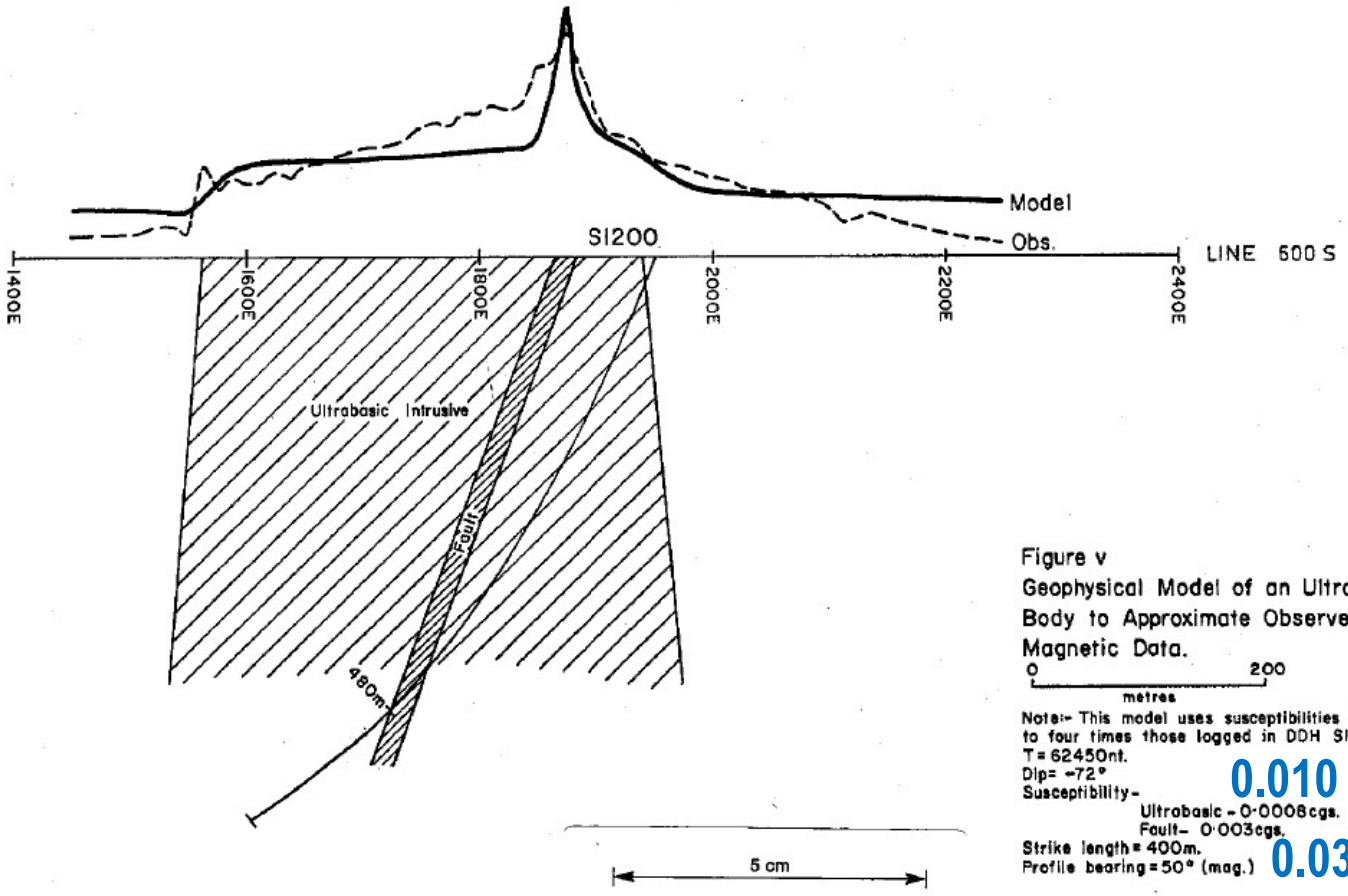


Figure v
Geophysical Model of an Ultrabasic Body to Approximate Observed Magnetic Data.

0 200
metres

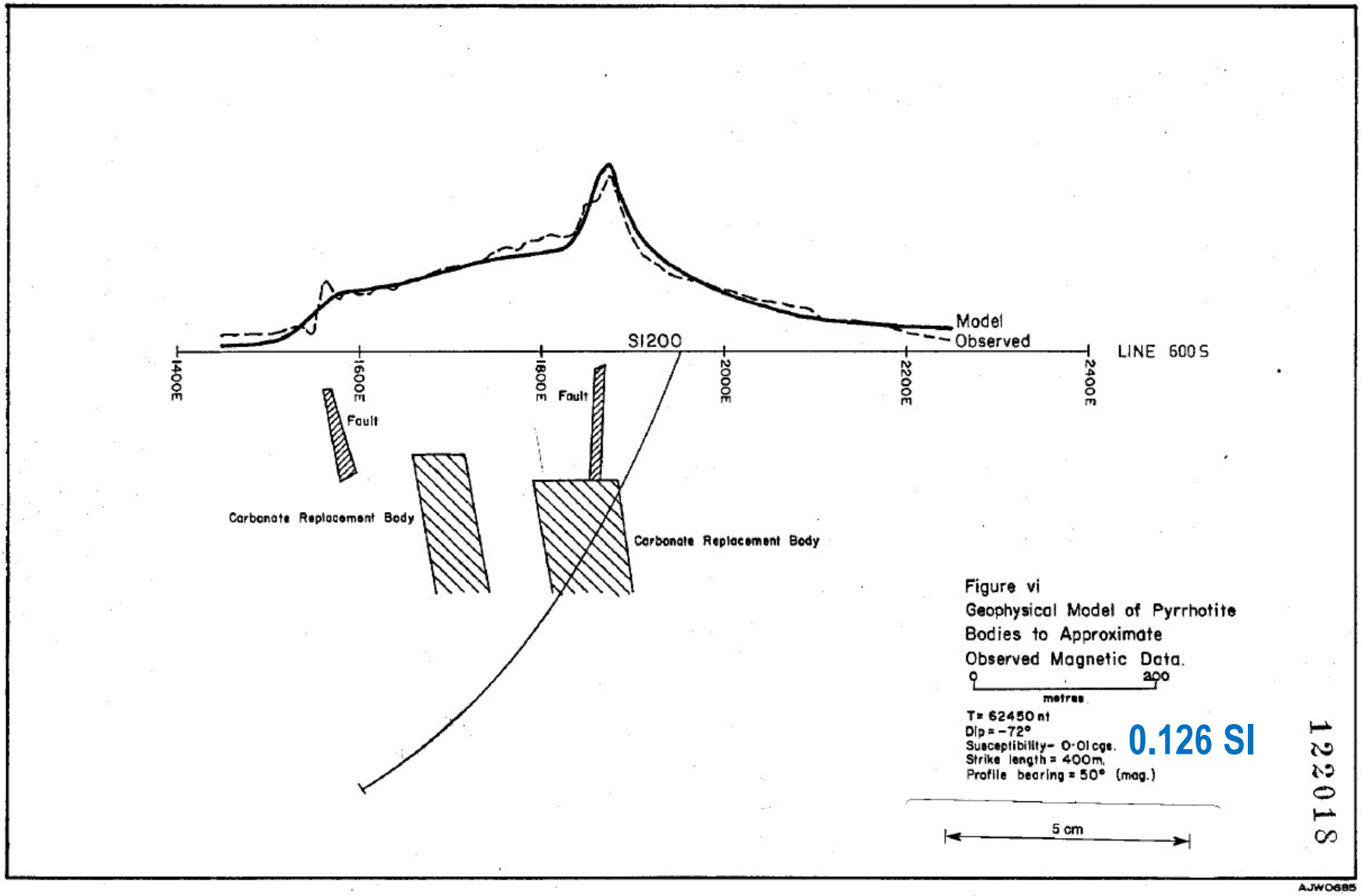
Note:- This model uses susceptibilities of three to four times those logged in DDH S1200.
T = 62450nt.
Dip = -72°
Susceptibility - 0.010 SI
Ultrabasic - 0·0008cgs.
Fault - 0·003cgs.
Strike length = 400m.
Profile bearing = 50° (mag.) 0.038 SI

122017

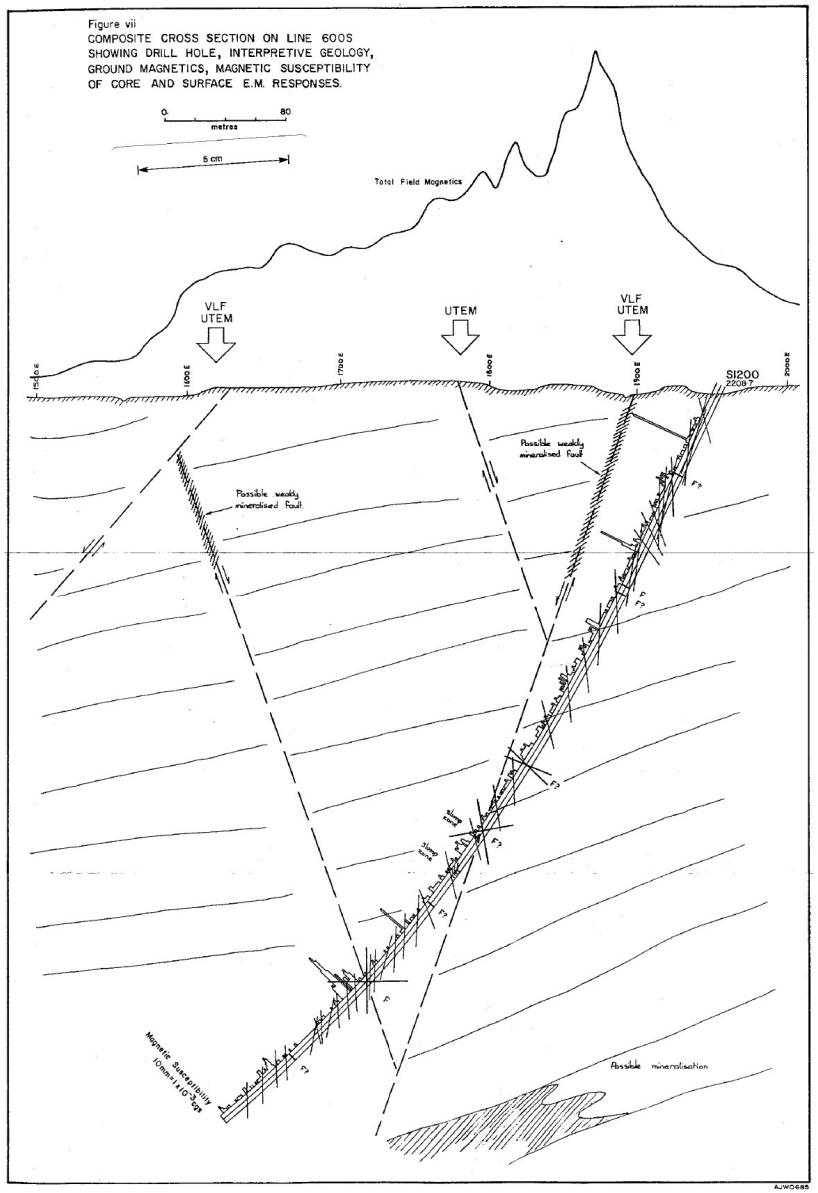
AJW0685

Kilpatrick, 1985

Model 2



Kilpatrick, 1985

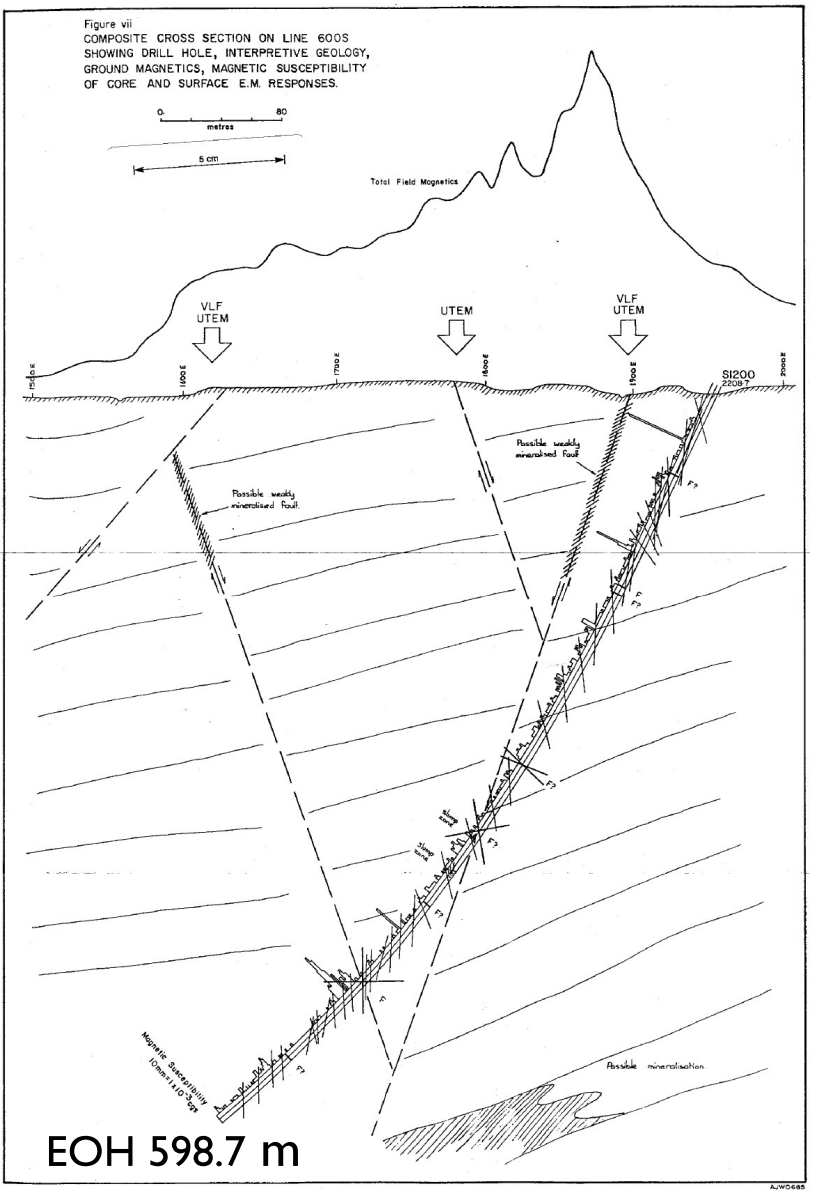


S1200 drill hole, 1984

"only isolated zones of moderate susceptibility which could not produce the anomaly"

- Model 1 invalid
  - mafic body of size required could not have been missed
- massive pyrrhotite should have been intersected if Model 2 correct
- only minor EM responses, suggesting any massive pyrrhotite > 250 m deep
- plausible alternate geometry
- possibility of significant magnetic remanence recognised

Kilpatrick, 1985



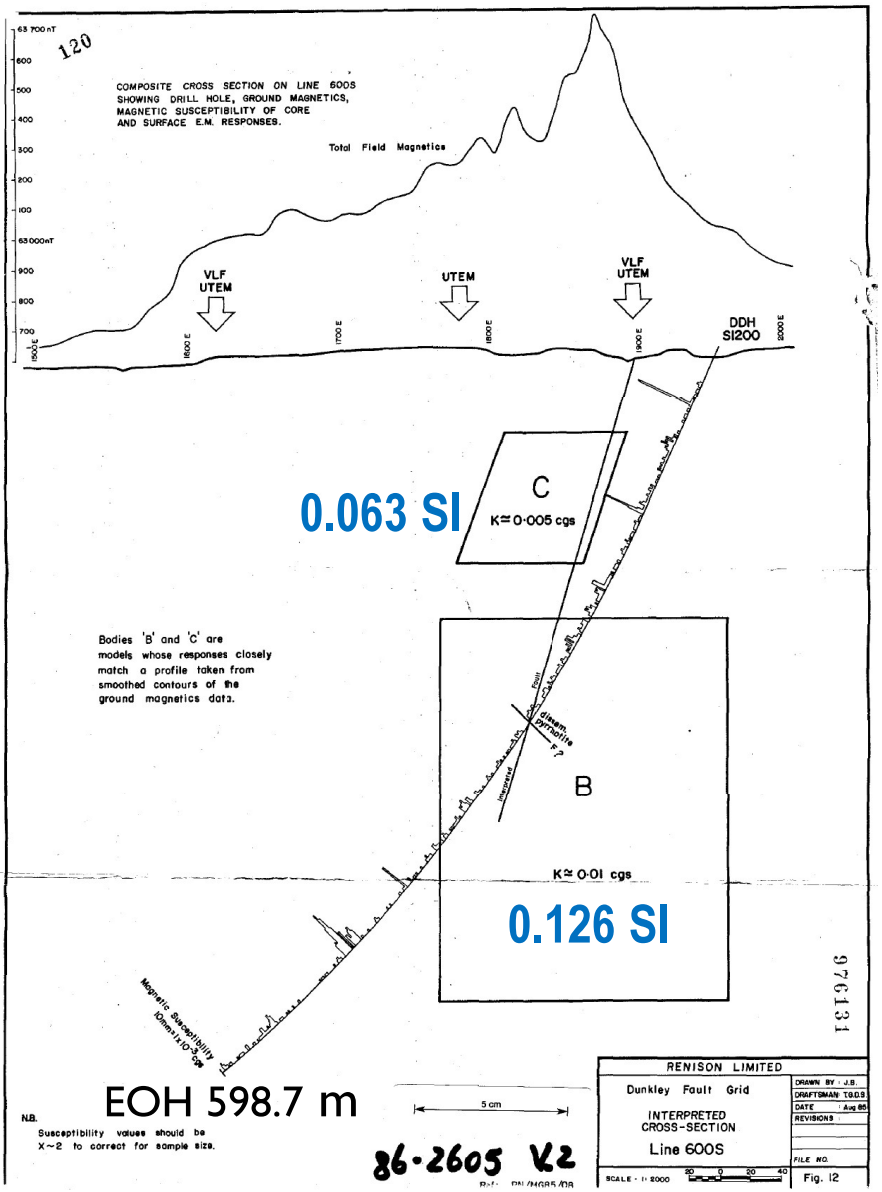
S1200 drill hole, 1985

CR86_2605

- follow-up IP
  - diffuse highs ‘minor pyrite towards top of hole
- DHEM
  - -ve response centred 220 m within broader +ve
  - interp as in-hole source po 219-222 m
- Petrology
  - “quite abundant magnetite” below 411 m + *disseminated to locally semi-massive pyrrhotite from 75 m (not noted in main report), conspicuous @ 193 m, pervasive @ 351 m*
  - deep source at least 150 m beyond EOH

Evans, 1986

S1200 drill hole, 1985



CR86_2605A

- follow-up IP
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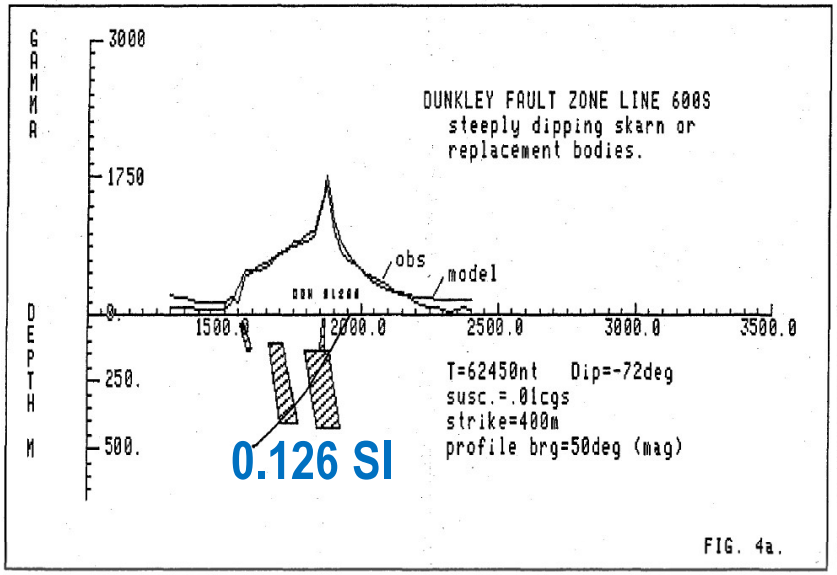
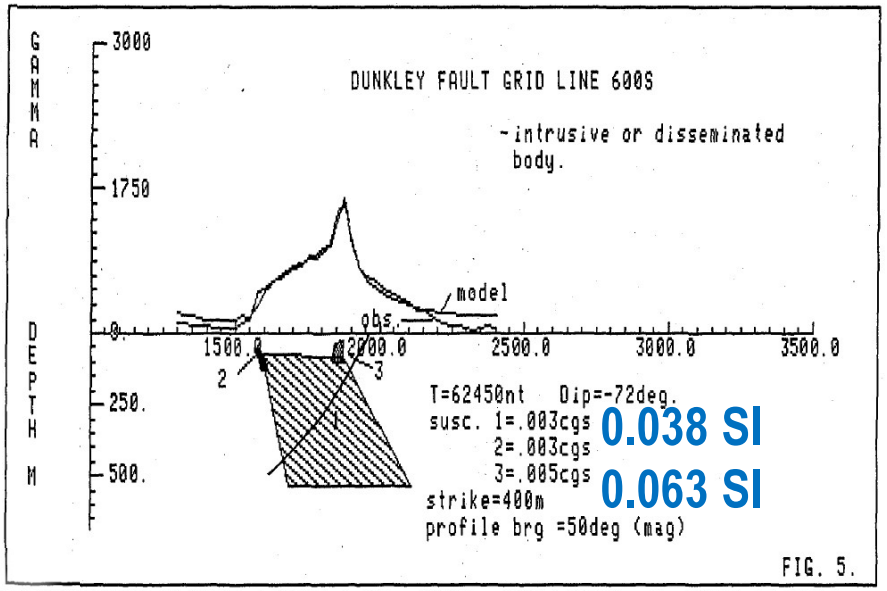
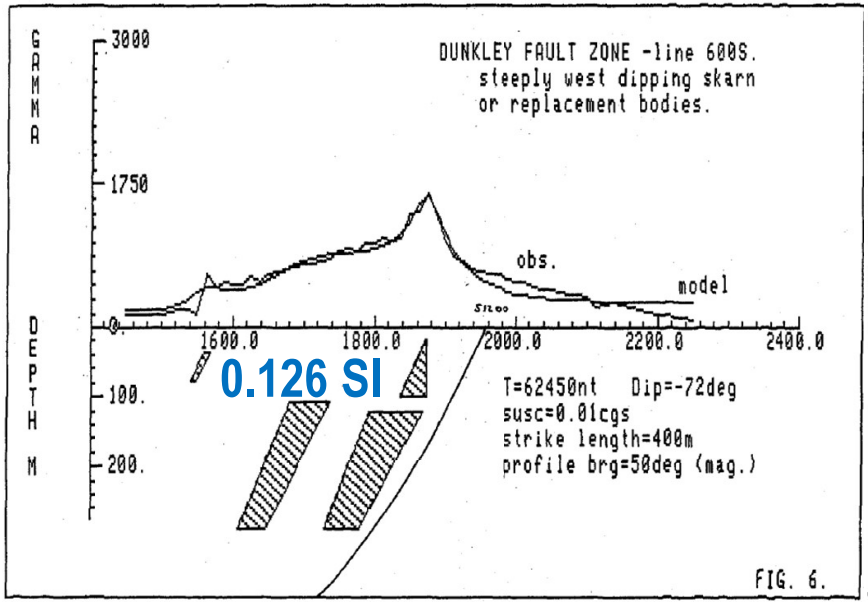
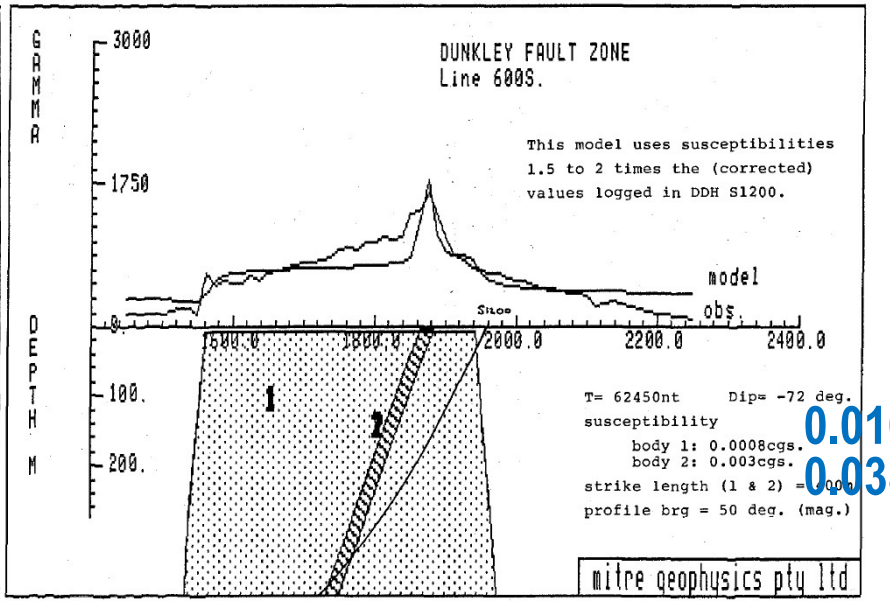
Bishop, 1986

Alternatives









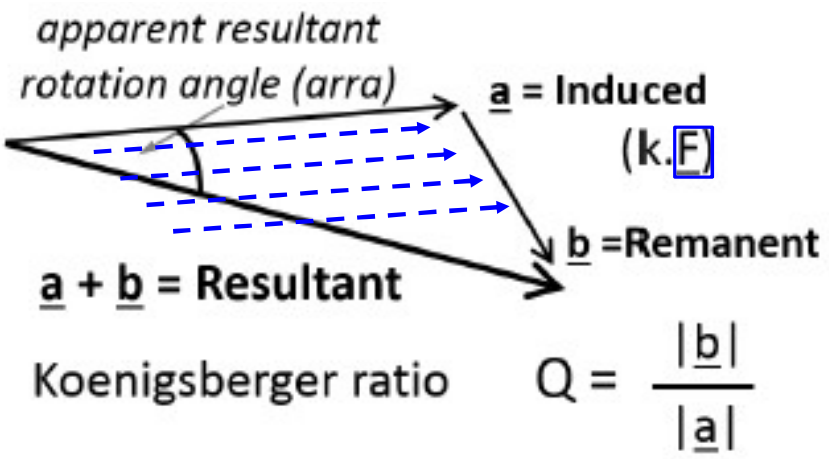
Bishop, 1986

Magnetic susceptibility re-measured

SAMPLE NO.	DEPTH (M)	SUSCEPTIBILITY OF ORIGINAL CORE MEASUREMENT (CGS UNITS, UNCORRECTED)* (x 0.001)	SUSCEPTIBILITY OF SAMPLE AS RE-MEASURED BY 'ELLIOT' SUSC. METER (CGS UNITS x 0.001)	CORRECTED VALUE* (CGS UNITS x 0.00
1.	116.8	0.2	0.3-0.4	0.6
2.	280.2	0.2	0.5-0.7	1.1
3.	421.	0.0	1.0	1.7
4.	472.	0.7	0.8-0.9	1.5
5.	447.3	0.0	0.0-0.1	~0.2

Bishop, 1986

Magnetic remanence and Q – a refresher



F = Earth main field

k = susceptibility

- i.e. what mag susc meters measure

Resultant = total magnetisation

- i.e. what magnetic surveys measure

Clive Foss 2017
Resultant-Magnetization Based Magnetic Field Interpretation
Exploration '17 Conference Proceedings
http://www.dmec.ca/Resources/Exploration-17.aspx

"some rotation of magnetization away from the present field direction is the norm rather than a special case…"

CSIRO magnetic laboratory measurements – S1200

SAMPLE	DEPTH (M)	k^{x} (CGS UNITS x 0.001)	J	Q	ROCK-TYPE
1.	116.8	0.590	4850	13	black siltstone
2	280.2	0.930	8505	15	" "
3.	421.0	2.870	1910	1.1	silty sandstone
4.	472.0	1.610	1500	1.5	sandstone/mudstone
5.	447.3	0.090	80	1.4	" "

D.A. Clark via Bishop, 1986

CSIRO magnetic laboratory measurements – S1200

SAMPLE	DEPTH (M)	k^{x} (CGS UNITS x 0.001)	J	Equivalent susceptibility (SI)	Q	ROCK-TYPE
1.	116.8	0.590	4850	0.1038	13	black siltstone
2	280.2	0.930	8505	0.1870	15	" "
3.	421.0	2.870	1910	0.0757	1.1	silty sandstone
4.	472.0	1.610	1500	0.0506	1.5	sandstone/mudstone
5.	447.3	0.090	80	0.0027	1.4	" "

assuming remanence vector in same direction as Earth main field

D.A. Clark via Bishop, 1986

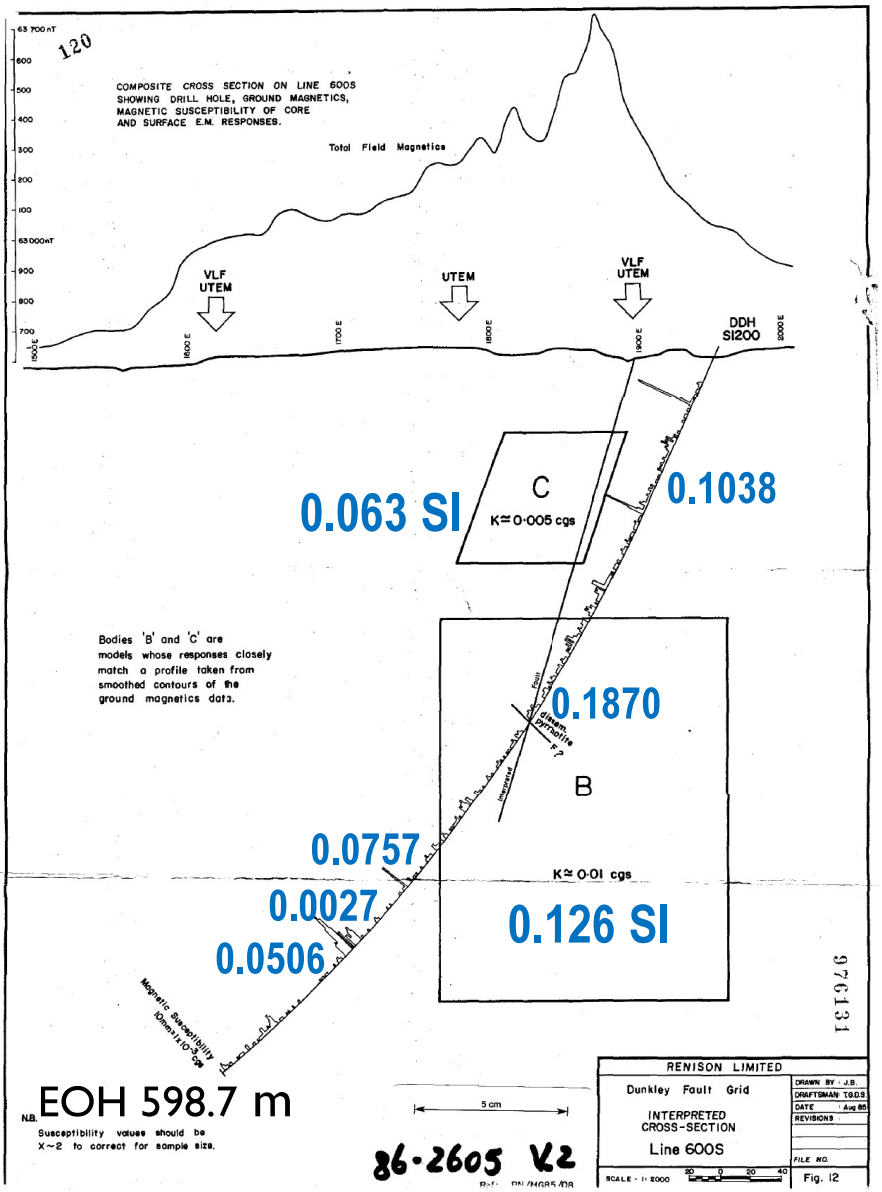
CSIRO magnetic laboratory measurements – S1200

SAMPLE	DEPTH (M)	k^{x} (CGS UNITS x 0.001)	J	Equivalent susceptibility (SI)	Q	ROCK-TYPE	Selected petrology (Cowan)
	42.5						partly martitised clastic magnetite
1.	116.8	0.590	4850	0.1038	13	black siltstone	
	121.8						conspicuous fine-ultrafine pyrrhotite
	255.7						spongy films of pyrrhotite
2	280.2	0.930	8505	0.1870	15	" "	
	281.7						ultrafine dissem. & clots of pyrrhotite
	411.5						traces of pyrrhotite
3.	421.0	2.870	1910	0.0757	1.1	silty sandstone	
	422.0						conspic. detrital martitic magnetite
	471.0						conspic. partly martitised magnetite
4.	472.0	1.610	1500	0.0506	1.5	sandstone/mudstone	
	481.9						conspicuous magnetite (clastic)
	446.3						relatively abundant martitised clastic magnetite
5.	447.3	0.090	80	0.0027	1.4	" "	
	465.4						conspicuous martitised opaques

assuming remanence vector in same direction as Earth main field

D.A. Clark via Bishop, 1986

S1200 drill hole, 1985



CR86_2605A

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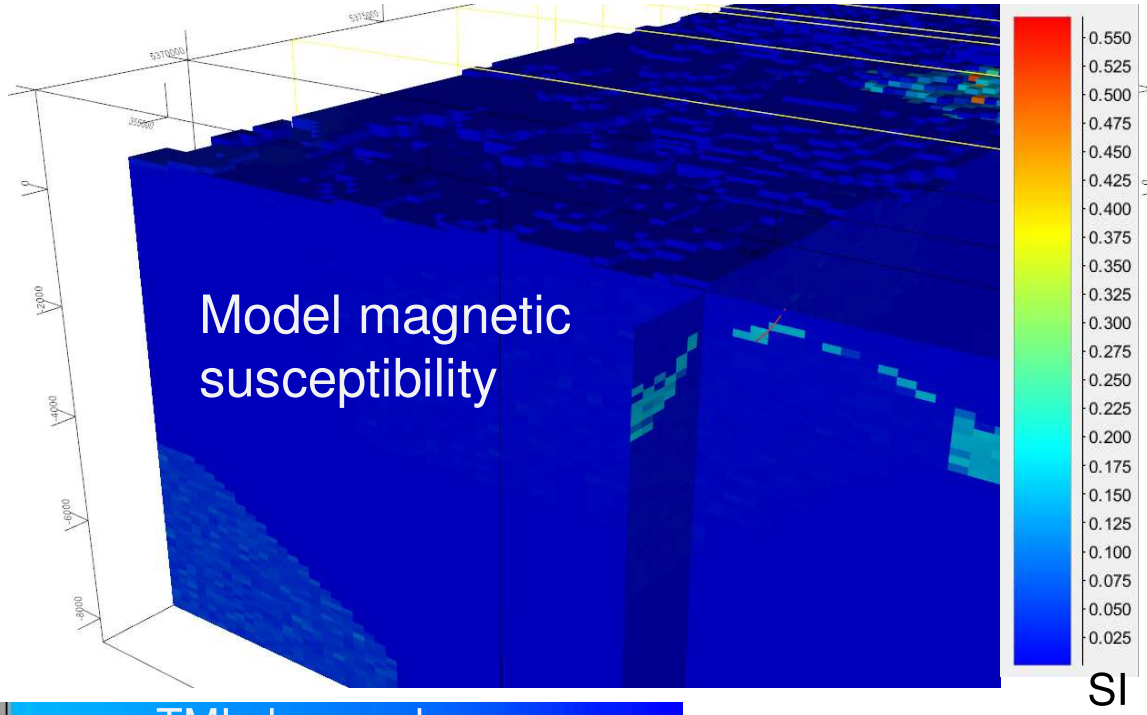
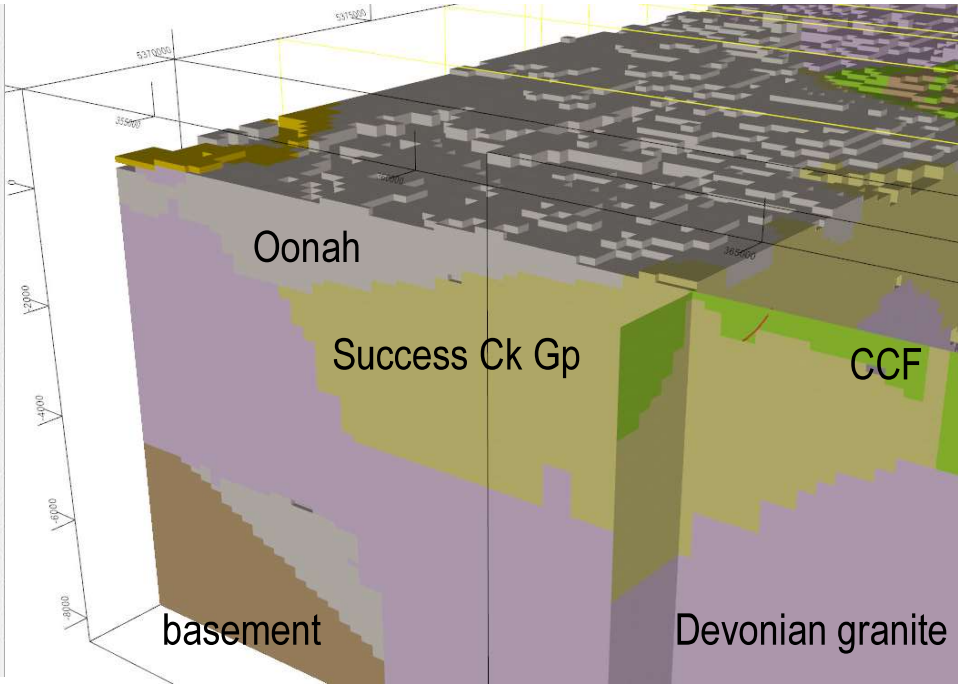
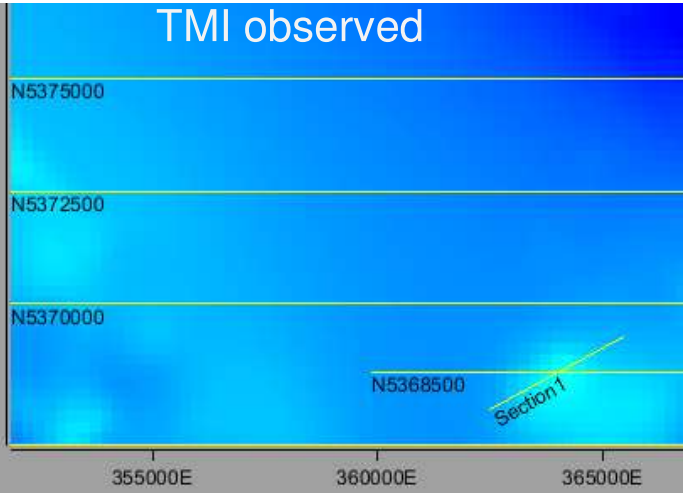
Bishop, 1986



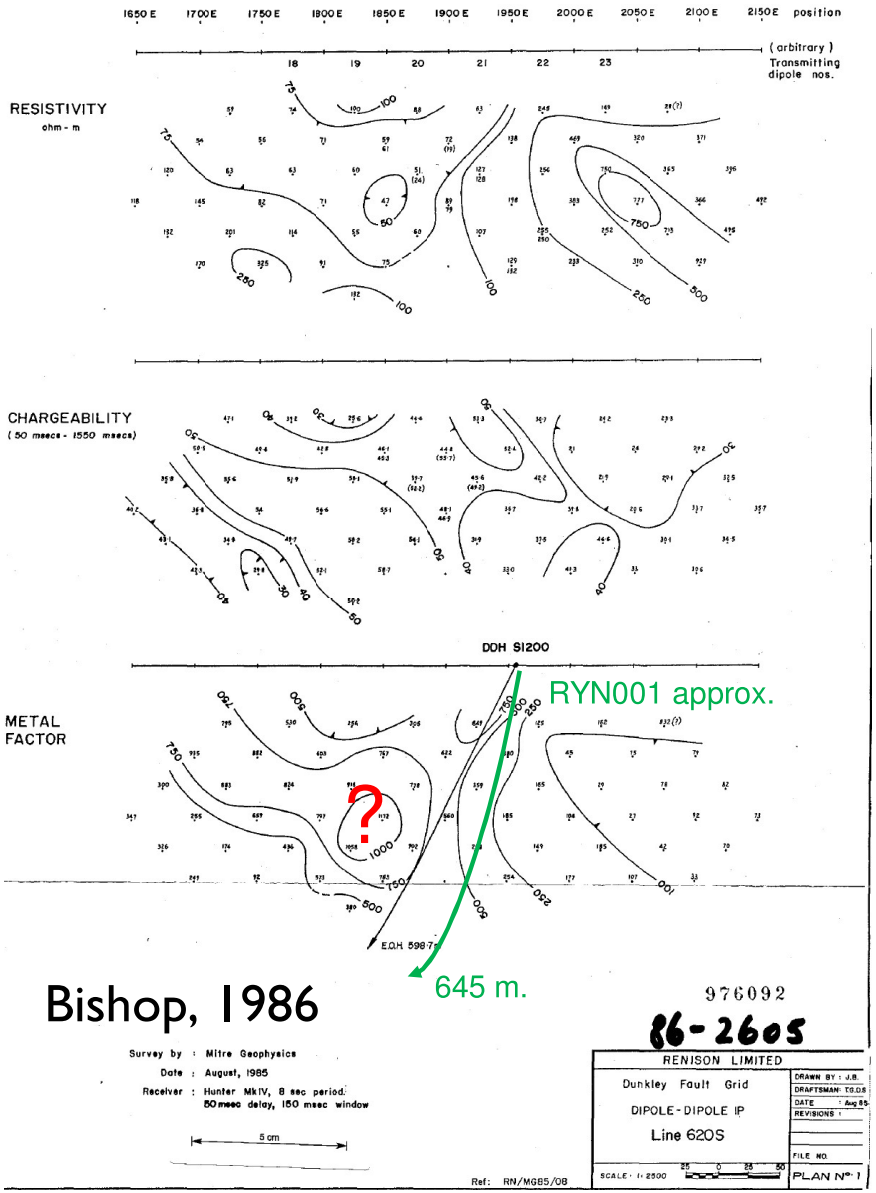




Rosebery region 3D model section 5368500N

Summary – a series of unfortunate events

- Initial magnetic susceptibility logging data too low by factors of 2-3 or more
- Geometric correction subsequently not applied, hence mag susc another factor of ~2 too low
- Significance of remanence possibly not fully recognised
    - If very high remanence intensities measured in S1200 sustained more broadly, can account for most if not all of the Dunkley magnetic anomaly
    - High intensity remanence associated with fine disseminated pyrrhotite
- Later explorers unaware of remanence data and other follow-up geophysical work
- Consequently more recent models incorrectly constrained…
- …leading to invalid magnetic source targets, subsequently drilled (again)
- Future exploration should ensure existing drill core magnetic properties fully characterised before revised modelling incorporating remanence (and any more drilling)

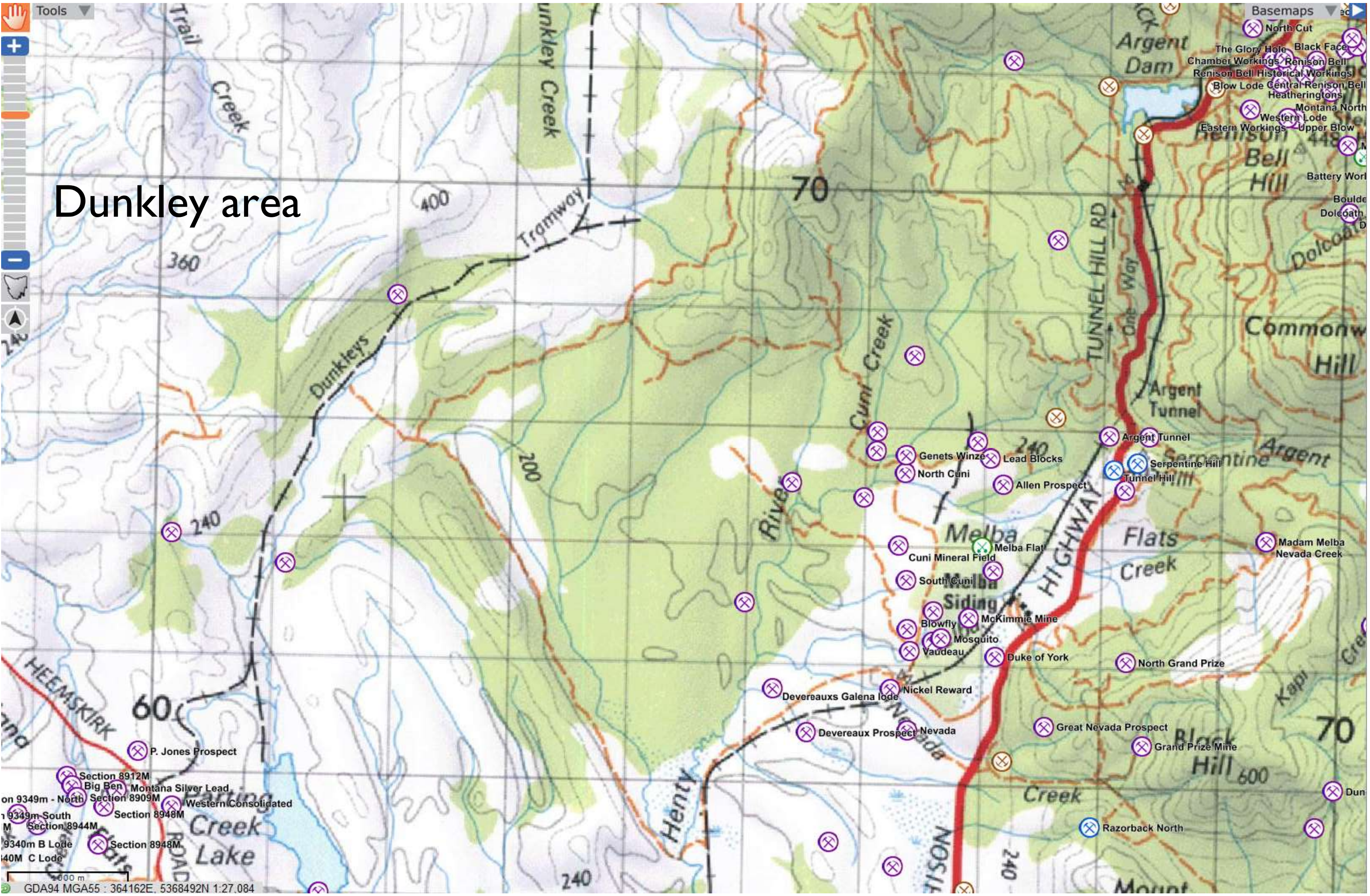


A way forward?

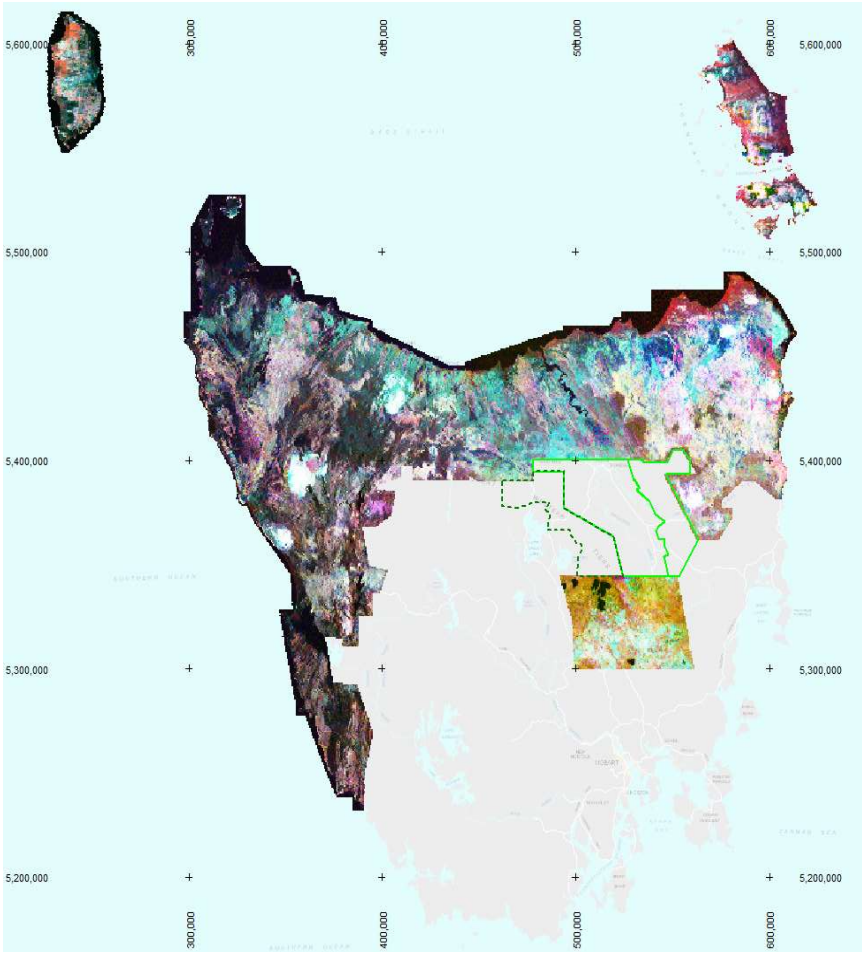
- If disseminated pyrrhotite responsible for at least the shallow-sourced components of the Dunkley magnetic anomaly, it should respond to IP
    - Metal factor peak east of/shallower than S1200
- EM source indications also east of/shallower than S1200
- as are most of the magnetic volumes in alternative models

suggesting a possible alternative drill target

Dunkley area



Geophysics



Tiers Airborne magnetic radiometric survey:

- Delayed by COVID-19
- Planned for January- February 2021
- Geoscience Australia managing contract

Gravity:

- Acquisition of infill data (Scotts Peak Road planned for this summer)
- New mantle model “completed”

Physical properties:

- Data capture ongoing
- Improvements to database

Contact details

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