The Quamby Project Area 3D Model and Mineral Potential Study

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Intro / Contents

- Past Work – Mount Dore 3D prospectivity study
- Quamby Project
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  - Weights of Evidence modelling

3D Prospectivity Studies

- As part of the NWQMEP Study, smaller areas were nominated for more detailed 3D prospectivity analysis

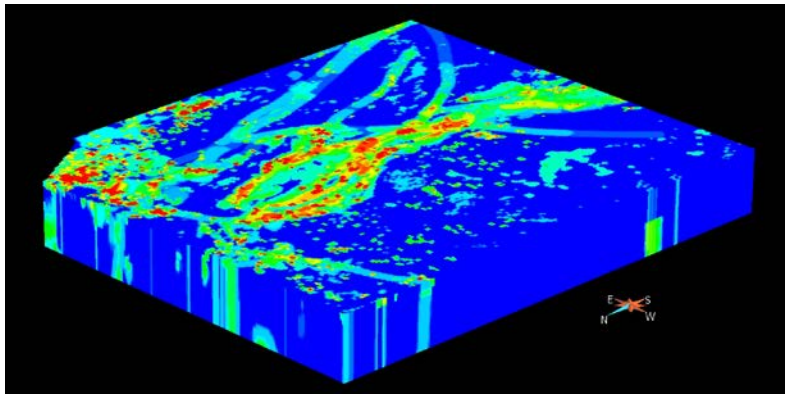
- A 3D prospectivity study of the 175km X 70km Mount Dore Project region in the Mount Isa Eastern Succession was proposed as the pilot project and results were presented last year.

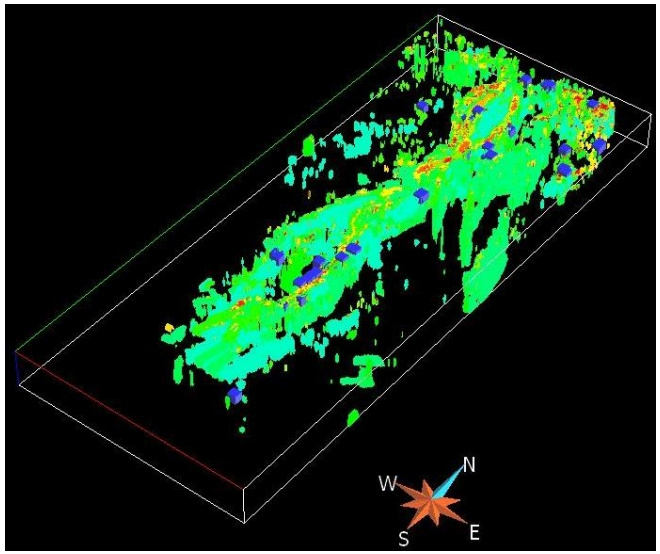
- GPU required updated methodologies and workflows to integrate the latest geophysical data manipulation and 3D modelling techniques

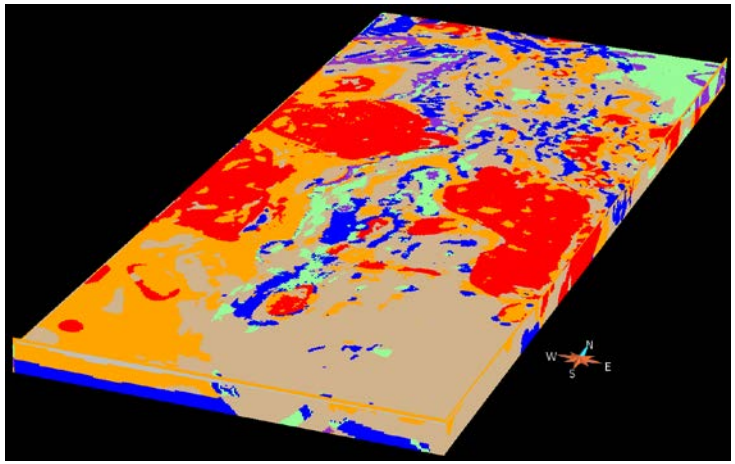
- Mira Geoscience was commissioned to develop and implement the appropriate methodologies for this study → aimed at (i) producing useful targeting outcomes for the exploration industry, and (ii) enabling adoption of skills that the GPU could usefully apply to prospectivity assessments elsewhere in Queensland

3D Prospectivity Studies – Mt Dore Project

- Full 3D model and potential field inversions.
- Two main outputs:
  - Pseudo-Lithology
  - 3D mineral prospectivity potential volume created from evidential properties and their associated statistical weights
- Available as part of 2010 NWQMEP Report

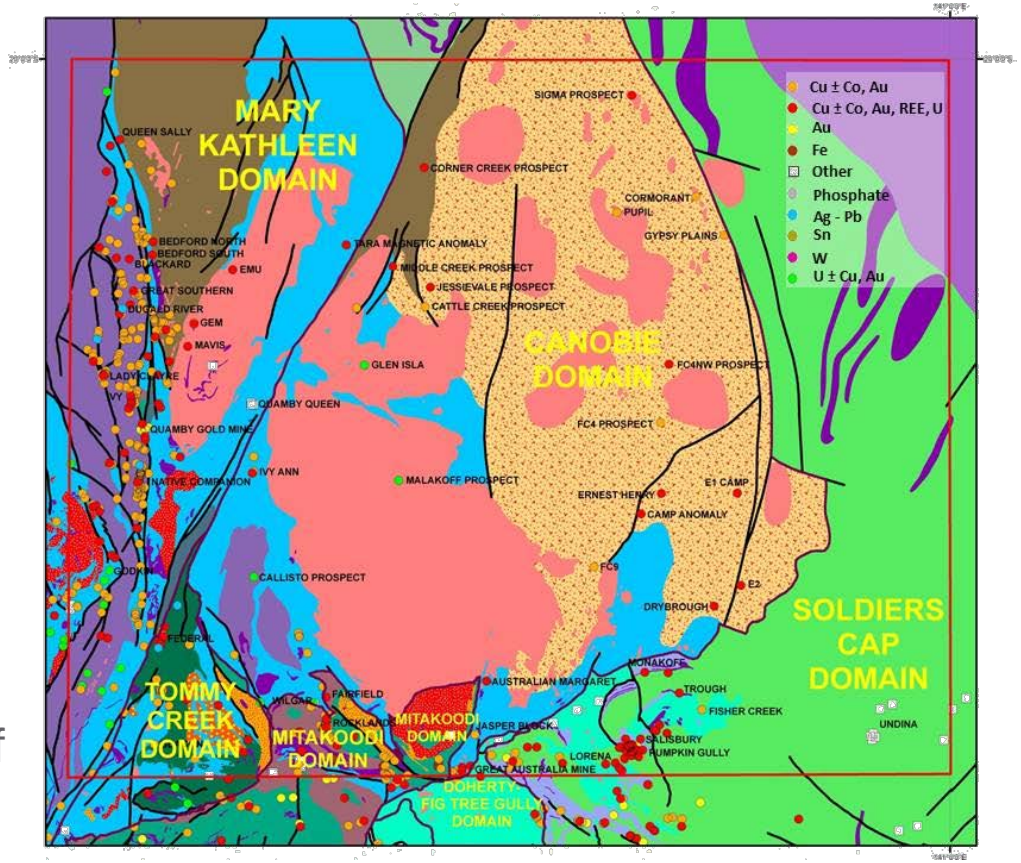






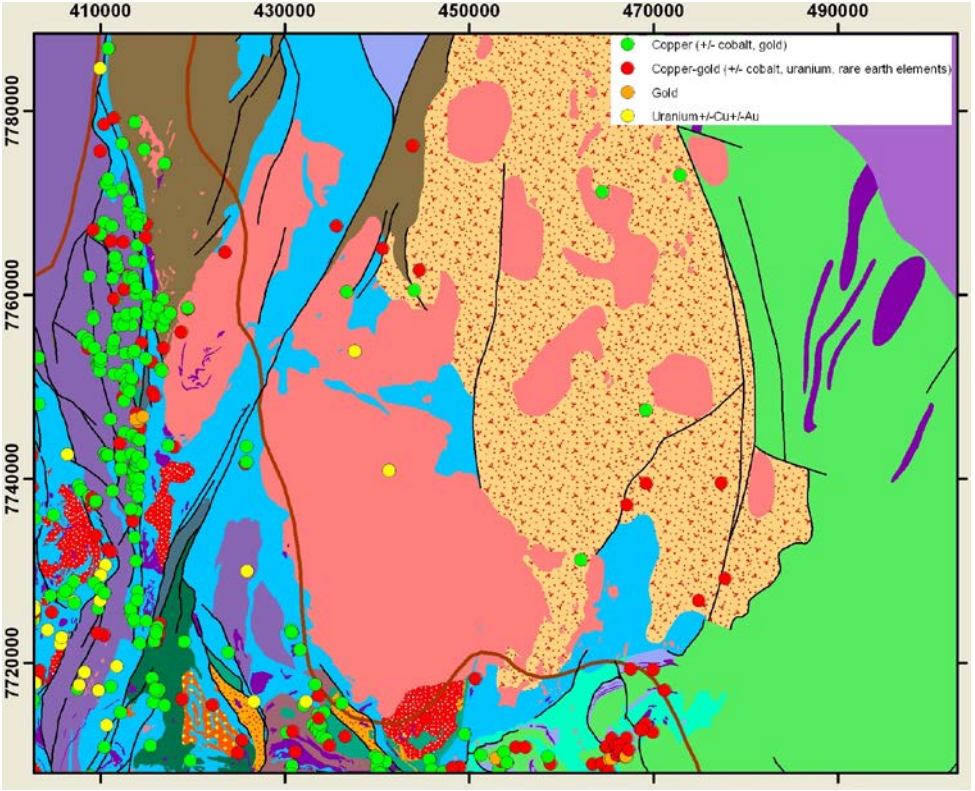
Quamby Project Area

- Quamby project area covers an area 95km long by 80km wide extending east from the Mount Rose Bee Fault and north from Cloncurry. Located immediately north of the Mount Dore project area
- The Quamby project area includes the major operating Ernest Henry Cu-Au mine as well as significant Cu-Au projects such as E1 Camp, Rocklands and Roseby, and the Dugald River Ag-Pb-Zn deposit.
- The Quamby study is centred on the Canobie geological domain but the project area contains regions of the Mary Kathleen, Tommy Creek, Mitakoodi and Soldier's Cap domains.



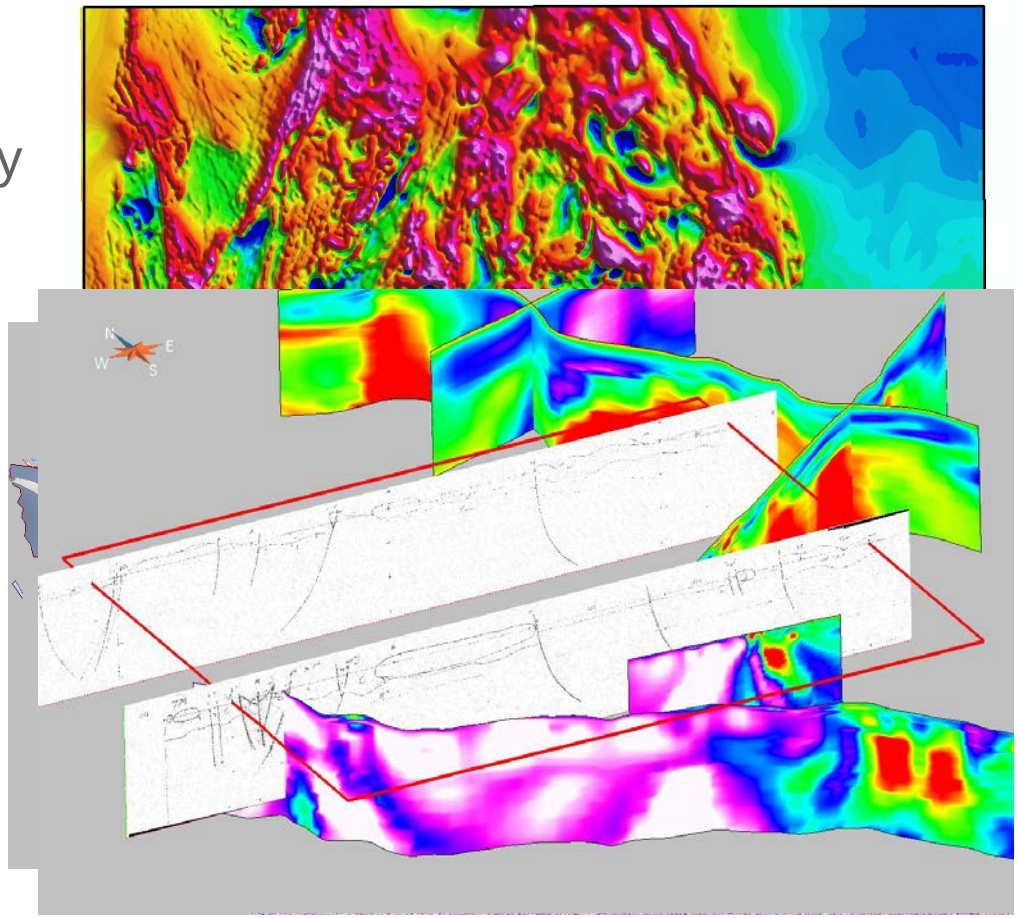
Quamby Project Area – Mineralisation Potential

- Proterozoic outcrop in the Quamby project area varies from good to poor in the west to completely concealed in the east. Mesozoic sediments cover >50% of the area (with most cover depths interpreted to be less than 200m). Consequently, much of the area has been under-explored.
- Quamby area is prospective for multiple styles of mineralisation including Cu±Au±iron oxide deposits, sediment-hosted Cu deposits, sediment-hosted Ag-Pb-Zn deposits, Au and Cu veins and Cu skarns.
- Known mineralisation mostly confined to outcropping areas. But some large systems discovered under shallow cover. High potential for greenfield discovery



Quamby Project – input datasets

- New NWQMEP solid geology and MINOCC mapping.
- Company and GSQ/GA Gravity
- Company and Government Magnetic data
- Fault and horizon surfaces from 2010 NWQ 3D Model
- GSQ/GA Deep Seismic
- Cross-Sections created from solid geology mapping and results from NWQMEP report
- GSQ Magnetotelluric Surveys conducted along seismic profiles



Quamby Project - Workflow

- Data compilation (magnetic, gravity new GSQ mapping)
- Field work to collect samples for density and magnetic susceptibility measurements and to gain a better understanding of relationship between structures and lithologies.
- Preparation of geological cross-sections (using updated structural/stratigraphic interpretation delivered from latest GSQ regional mapping program)
- Creation of GoCAD/SKUA geological surface and block model (~20km depth)
- Gravity and magnetic geometric and homogeneous unit inversion using VPmg
- Gravity and magnetic heterogeneous unit inversion starting with optimal range identified above
- Future work:
  - Development of a ‘local’ model (upper few km) and high-resolution inversion of magnetic property values for upper 2.5km of crust using UBCGIF
  - Populate Common Earth Model of upper 2.5km with properties from gravity and magnetic inversions, inversion of TEM data and lithology; create 3D pseudofacies.
  - 3D prospectivity analysis of Common Earth Model using Weights of Evidence (WoE) and GSQ MINOCC (Mineral Occurrence) training data sets and Mineral Systems analyses to create an Mineral Potential Index.

Quamby Project Field Work

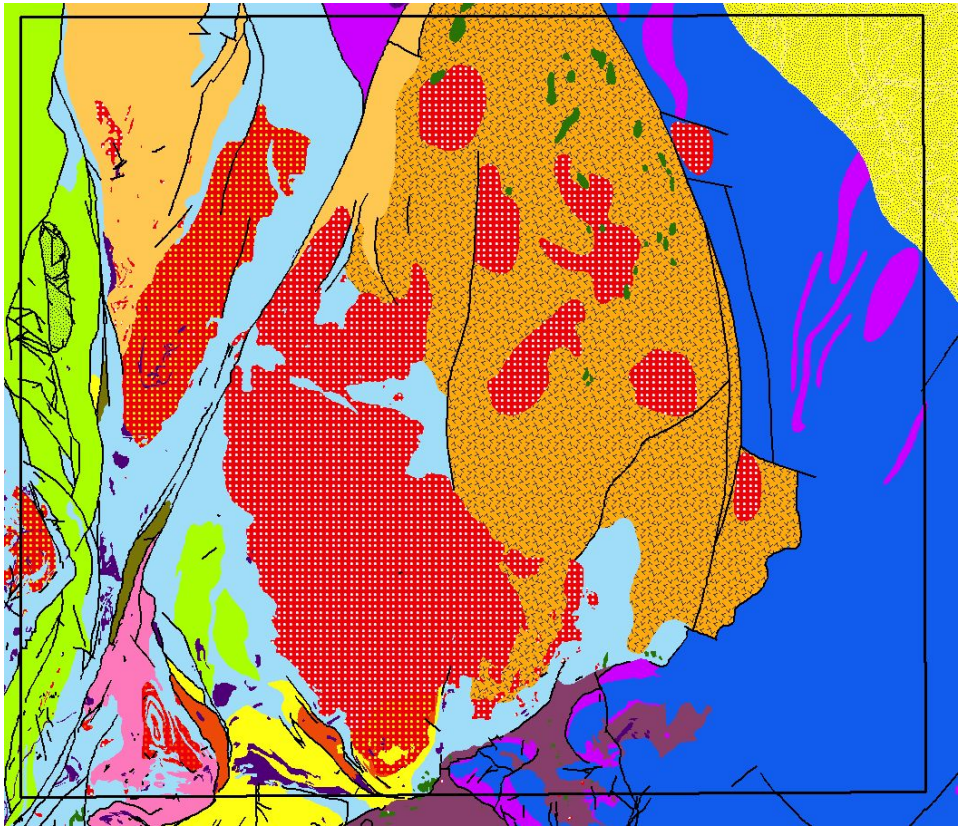
- Combined field trip to Quamby and Lawn Hill Regions undertaken in May-June 2011
- Field work assisted with defining major units to model, structural relationships, fault orientations and the relationship with inferred subsurface geometries.
- Collected magnetic susceptibility readings and samples for density measurement

Petrophysical Properties

- Developing workflow integrating field-measured magnetic susceptibility and post field-trip density measurements from laboratory into modelling
- Building physical property database of modelled regions to include in 3D geophysical inversions.

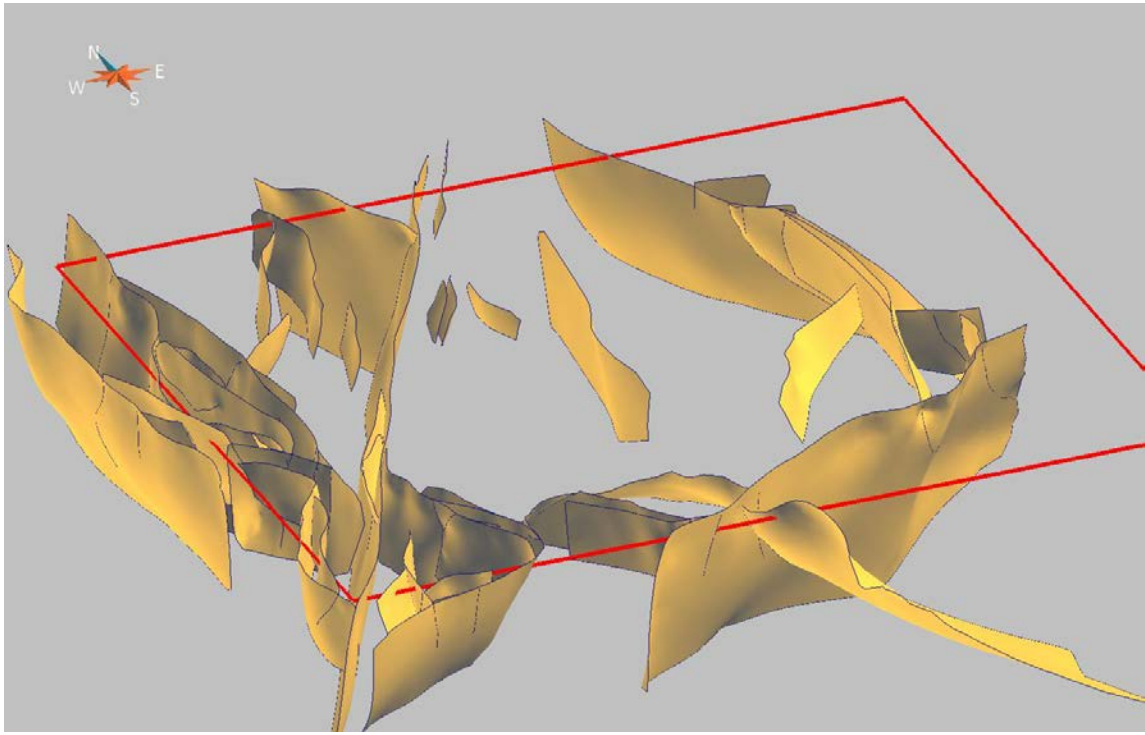
Modelling Workflow

- Mapped lithologies were required to be simplified into broader groupings based on their geological and geophysical properties and significance.



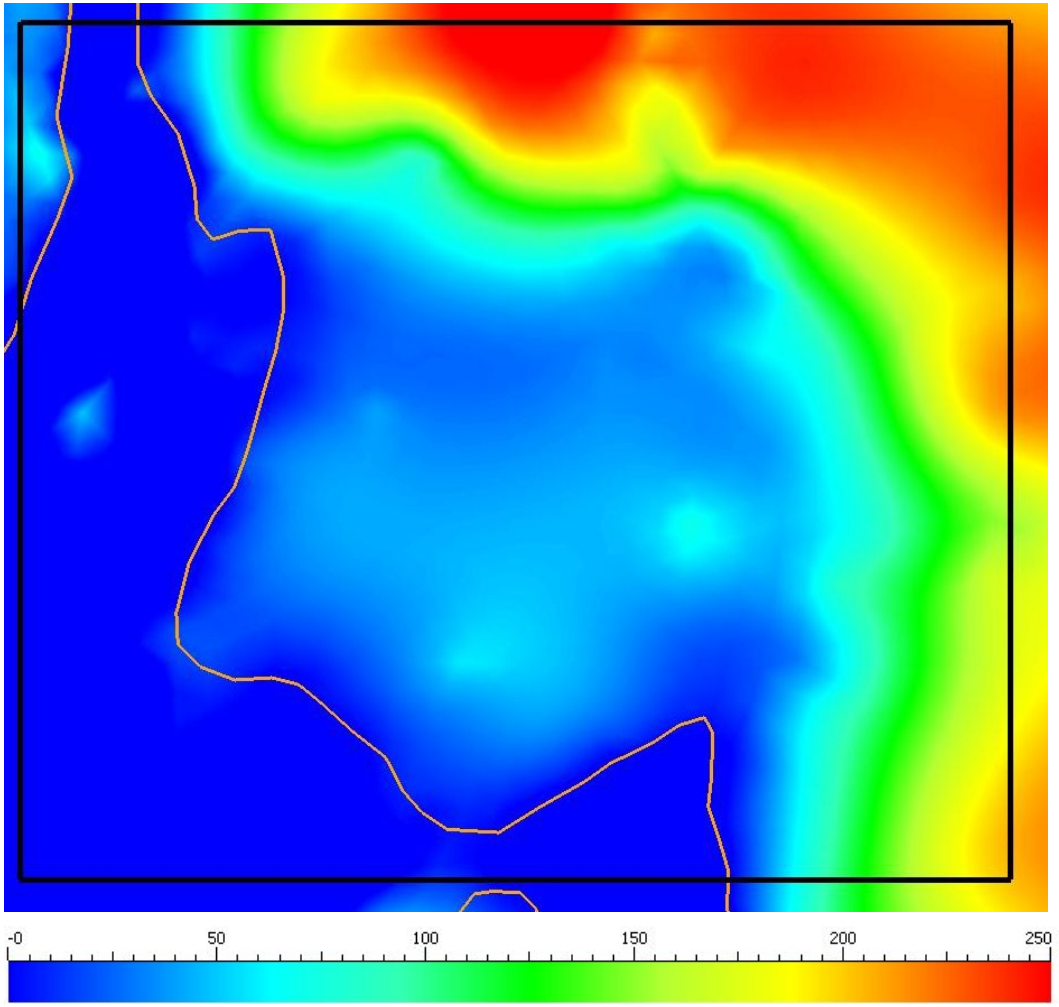
Modelling Workflow

- Cross-Sections created from mapping, seismic data, magnetotelluric data, potential field data and filters, worms (multi-scale edge detection).
- 3D fault model created from all available information.

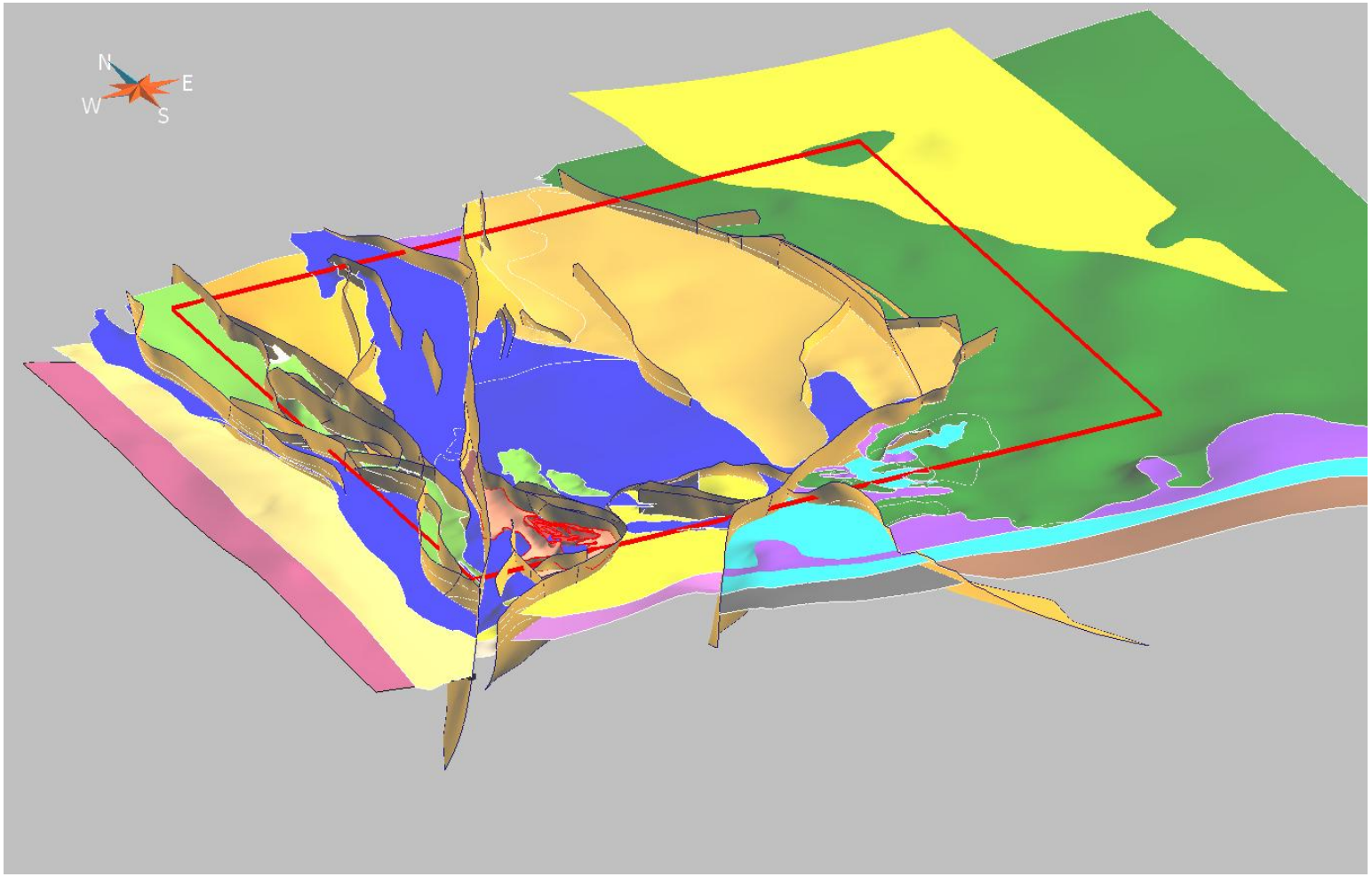


Depth to Basement (Depth of Cover) Modelling

- Over 50% of Quamby area is covered by Phanerozoic sediments.
- Depth to the Proterozic units under this cover is important for exploration.
- Thickness of cover determined from mineral exploration holes, water bores and magnetic depth to source modelling

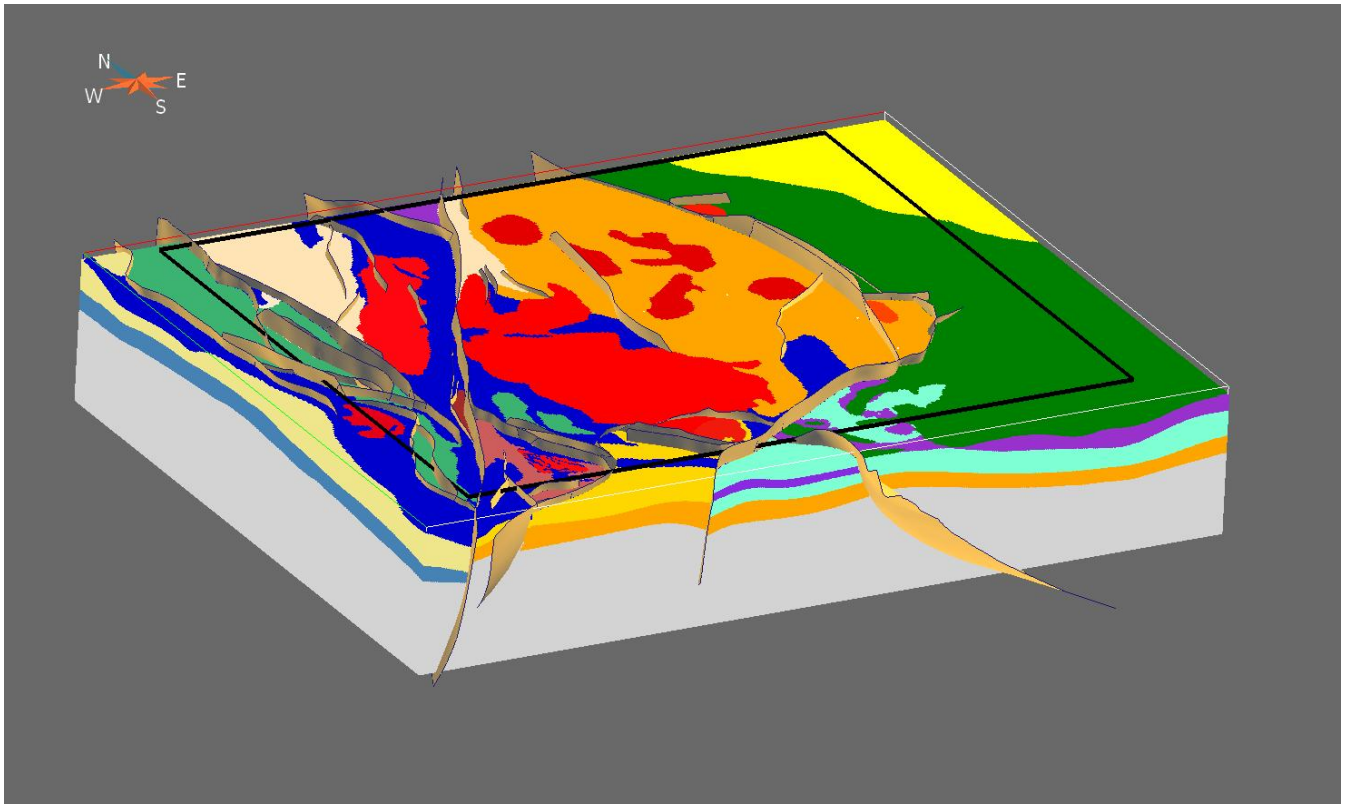


3D Lithology Surface modelling



3d Voxet Modelling

- The 3D surface model (vector model) is discretised into a 3D voxet model (raster model) to facilitate geophysical inversions and 3D weights of evidence modelling.



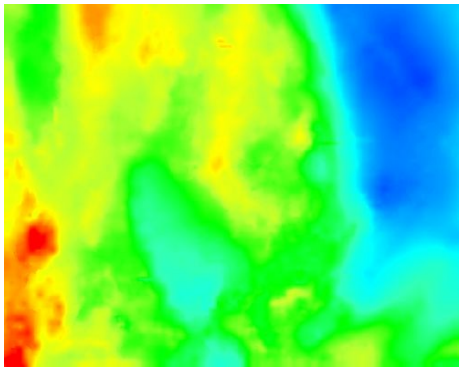
Potential Field Inversions

- Regional Voxet model (crustal-scale model to 20km depth) populated with available physical properties (density and magnetic susceptibility) collected in field, calculated in laboratory or from literature.
- Forward modelling to ascertain regions of high misfit
- Initial inversion focused on modifying the geometry of the granites and depth of cover.
- Homogenous Property Inversion of magnetic and gravity data to optimise mean values of properties
- Resultant optimised magnetic and gravity distributions subjected to Heterogeneous Property Inversion.

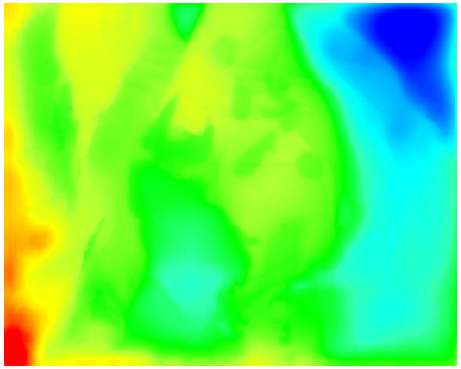
Potential Field Inversions

- Forward Modelling Results

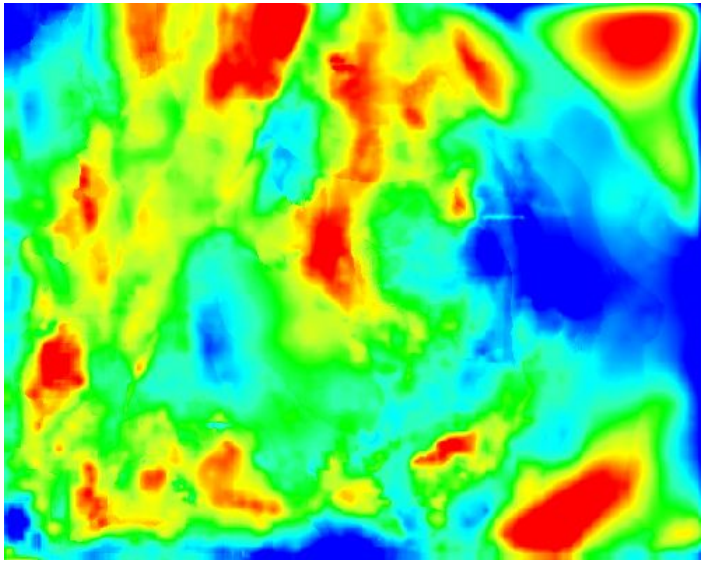
Observed



Calculated



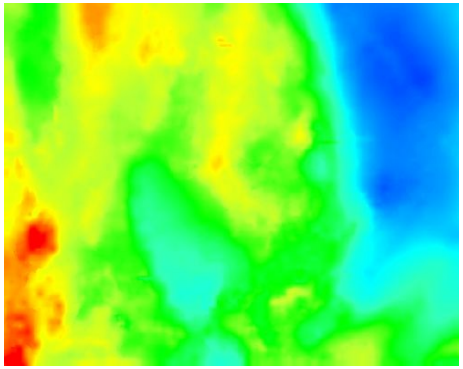
Residual / Misfit



Potential Field Inversions

- Homogenous Property Optimisation

Observed



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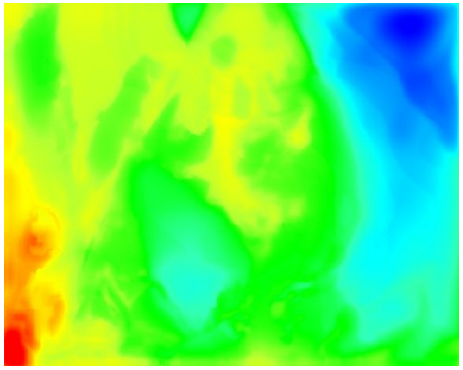

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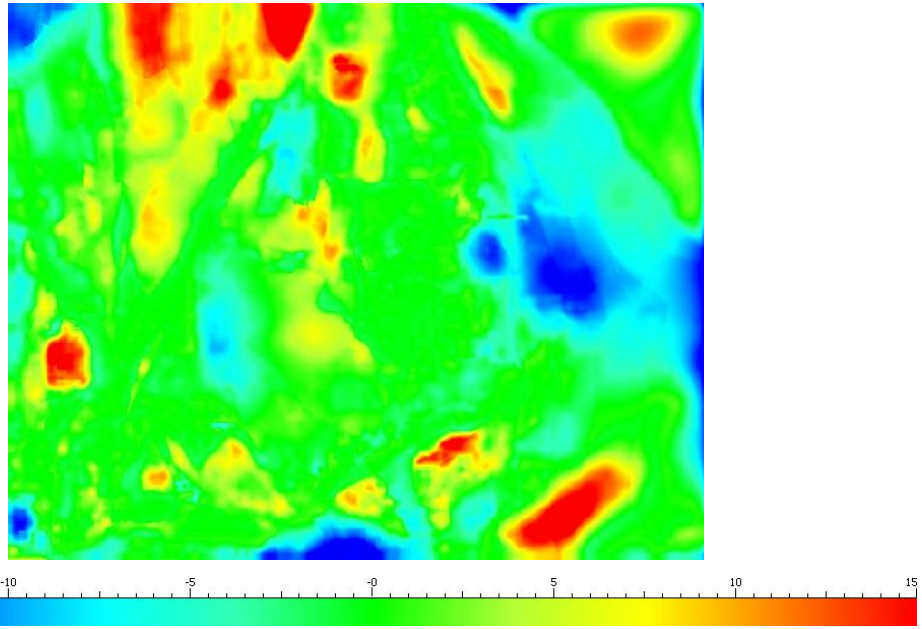


Common Earth Model

Upper few kilometres of crust for project area represented as voxet in GoCAD

Voxet populated by:

- Rock Properties derived from:

  (i) High-resolution UBC Magnetic inversion

  (ii) Regional VPmg Gravity inversion (scaled to the smaller cell size)

  (iii) Initial litho-domains used for inversion.

- Common Earth Model is the input for pseudo-lithology modelling and 3D weights of evidence modelling

Pseudo-Lithology

- Natural multi-parameter statistical groupings of cells according to their properties

- Used to test the validity of the starting model, allowing interpretation of additional geological complexity, and to identify areas which may represent metamorphism or alteration.

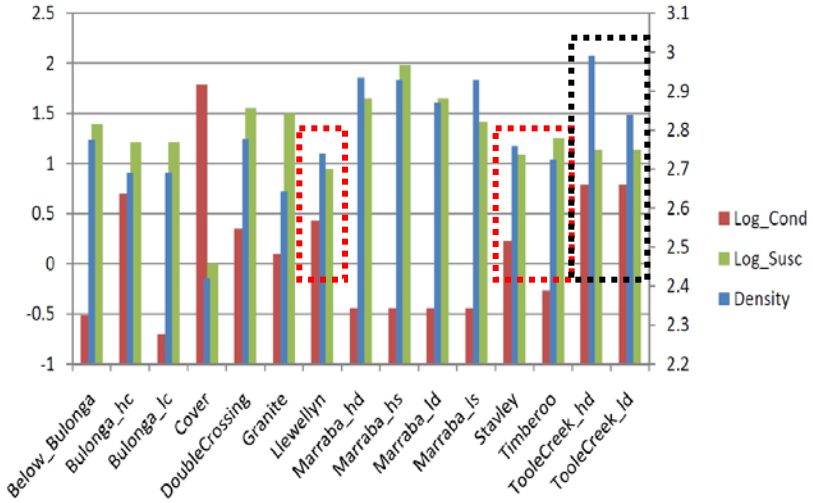
- Highlights

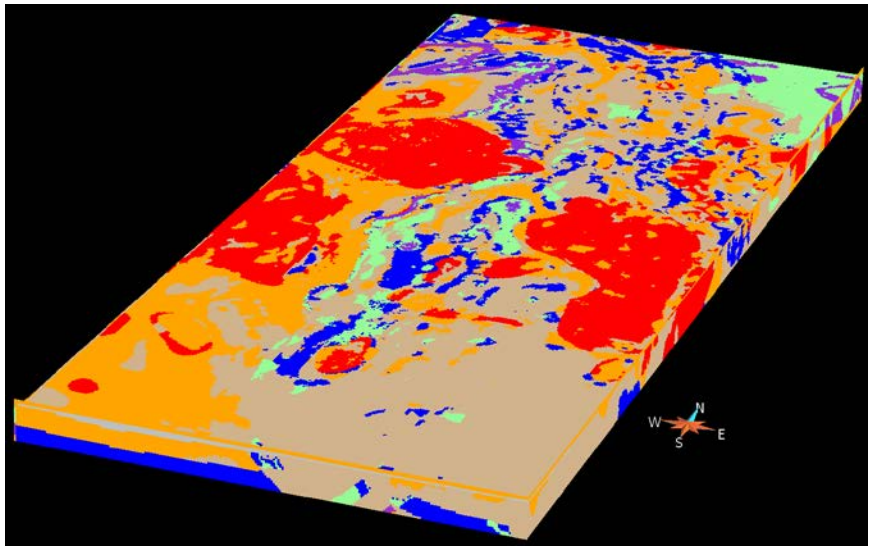
  (i) property variation due to geometrical errors/unknowns in the reference litho-model

  (ii) property variation due to internal lithological variability and/or alteration

Assignment of Pseudofacies

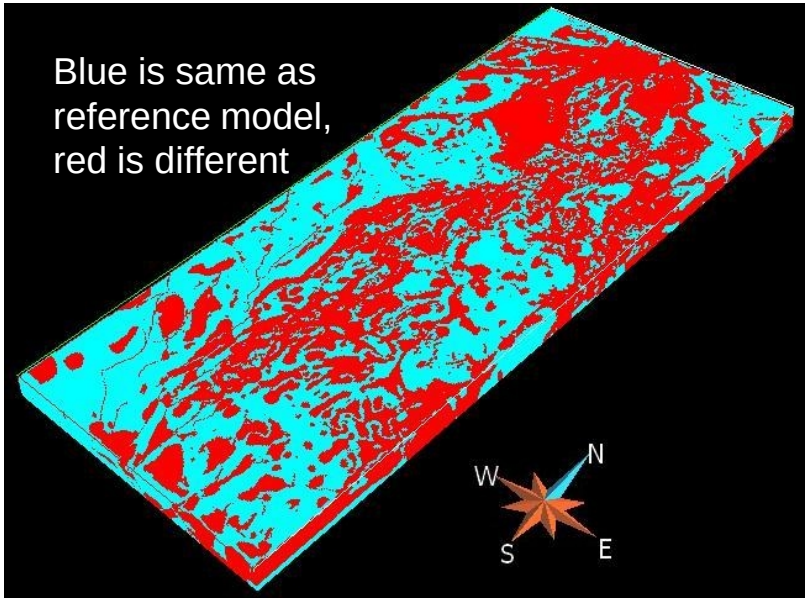
- Each unit interrogated in GOCAD for property statistics (median and ranges for density vs. log sus vs.log conductivity)
- Some units may have bimodal distribution (Black) and some undistinguishable from others (red)
- Each cell in the model then evaluated to see which of the litho-classes it most likely belongs to → assigned via a new property called "Pseudofacies"



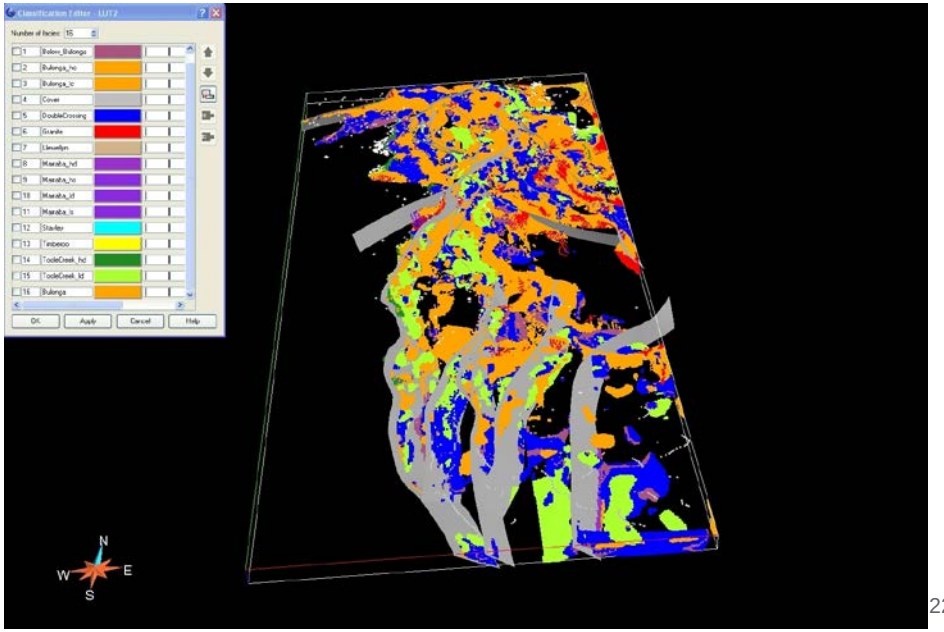


Pseudo-Lithology Applications

(i) examine validity of initial litho-domain model where pseudofacies and initial litholgy properties agree



(ii) use pseudofacies to define regions where pseudo-lithology does not match the reference litho-domains (e.g. ***blue cells*** = high/density susc; ***orange cells*** have slightly higher than average susc and lower density, while ***green cells*** have higher density with only moderate susc values



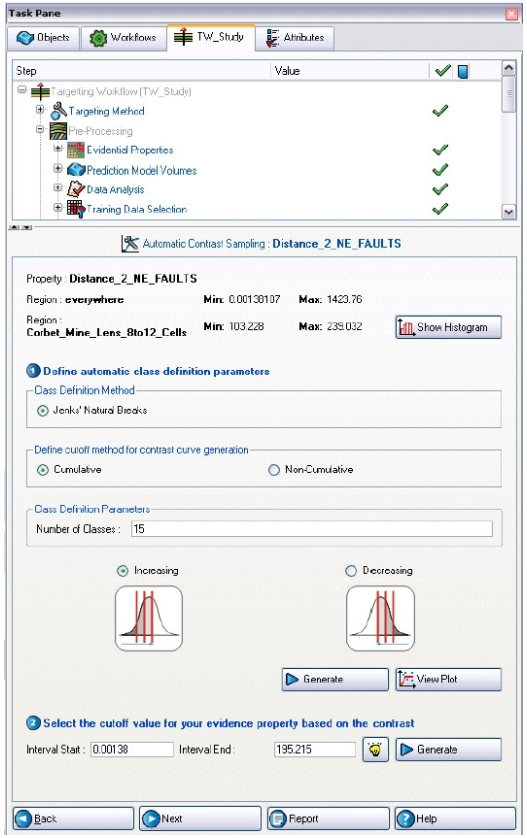
3D Weights of Evidence (WoE) Targeting

- Statistical evaluation of spatial relationships between known mineral occurrences and other spatial datasets (i.e. evidential properties such as rock type, structure, geochemistry) → used to define ***mineral potential probabilities***

- Mineral systems analysis undertaken as part of NWQMEP study identified exploration criteria believed to be associated with IOCG mineralisation in area.

- Exploration criteria represented in the Common Earth model as continuous or discrete variables (evidential properties)

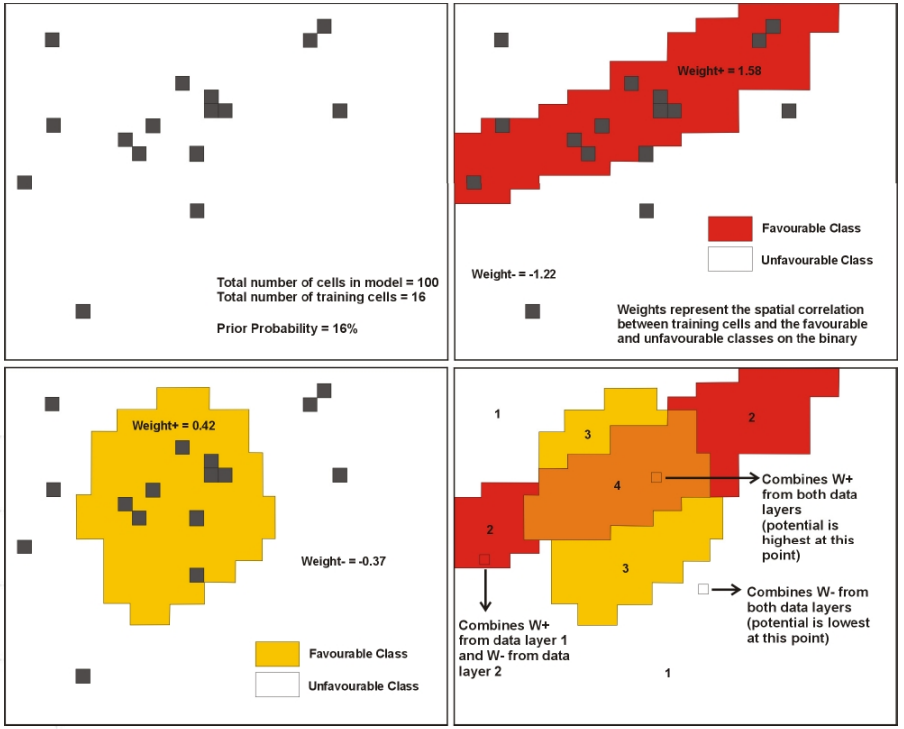
- GoCAD Targeting workflow used to assess the correlation of these evidential properties with known mineralisation (training data).

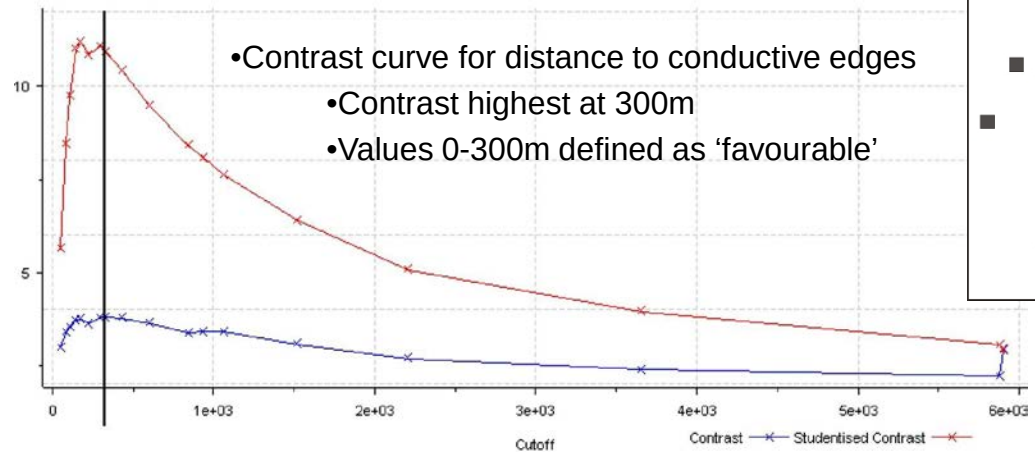


3D Weights of Evidence

- Weights (W+ and W-) assigned from correlation between training cells and evidential properties
- Contrast is defined as the difference between the W+ and W-
- Continuous evidential properties converted to binary properties by locating the ‘cut-off value’, that with the maximum contrast value

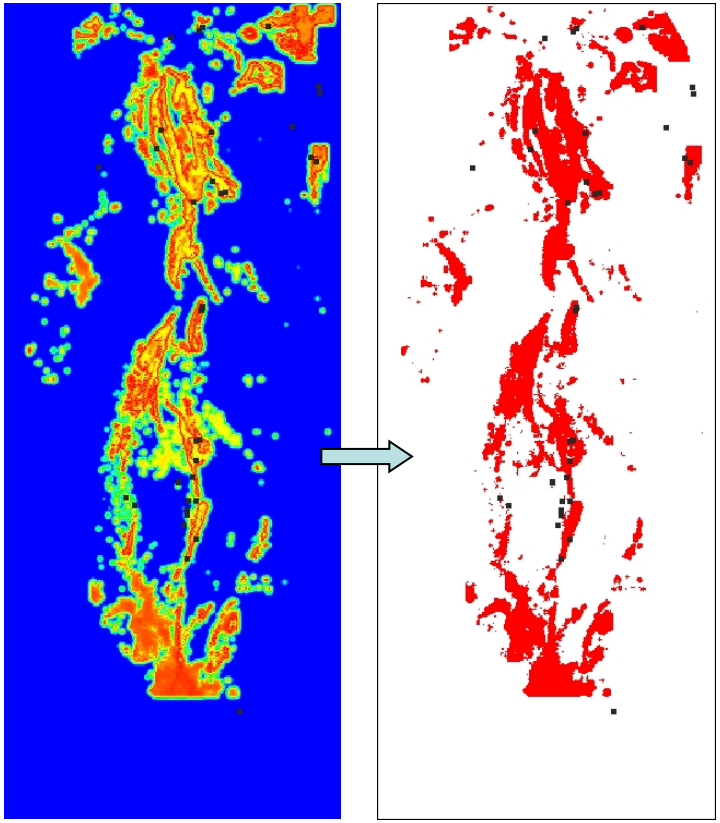
$$W = \{\frac{\frac{\#\text{ of training cells in region}}{\#\text{ of training cells}}}{\frac{\#\text{ of cells in region with no training data}}{\#\text{ of cells with no training data}}}\}$$





3D Weights of Evidence (WoE) Targeting

- In Mount Dore, of the 22 exploration criteria tested, 11 had significant correlation with mineralisation in the Mount Dore area.



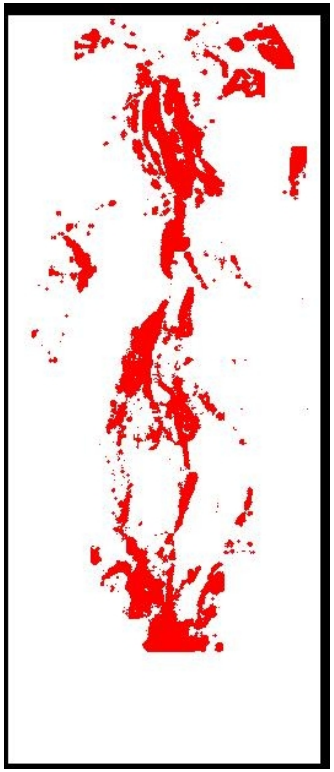
Distance to Conductive Edges

Exploration Criteria	Weight +	Weight -	Contrast	Stud. Contrast	Favourable Range - Start	Favourable Range - End
Coincident Gravity High-Magnetic High	2.29	-0.2	2.49	5.9	0.81	0.246
Distance C-Sharp Filter ISO <35	2.88	-0.91	3.79	11.09	0m	300m
Distance to Crustal faults	0.74	-0.32	1.06	3.12	0m	964m
Distance to faults intersecting mafics	1.12	-0.29	1.41	4	0m	921m
Fault Roughness	2.79	-0.17	2.96	6.63	0	0.00015
Geological Complexity	1.8	-0.35	2.15	6.09	0.107	0.0198
Normalised Susceptibility	3.25	-0.14	3.39	7.03	0.372	0.0884
Regional Density Model	3	-0.08	3.08	5.11	0.426	0.32
Uranium divided by Thorium	2.12	-0.58	2.7	8.1	1.289	0.274
Distance to Gold Anomaly <150	5.16	-0.29	5.45	14.15	0m	304m
Distance to Copper Anomaly <2000	5.72	-0.75	6.47	19.35	0m	250.7m

Variables with the highest studentised contrast values (C/stdevC) are the most significant contributors to the mineral potential model.

Mineral Potential Index

- The Binary evidential properties and their associated weights are combined to create a Mineral Potential Index.
- Final result is model-driven 3D mineral prospectivity potential volume



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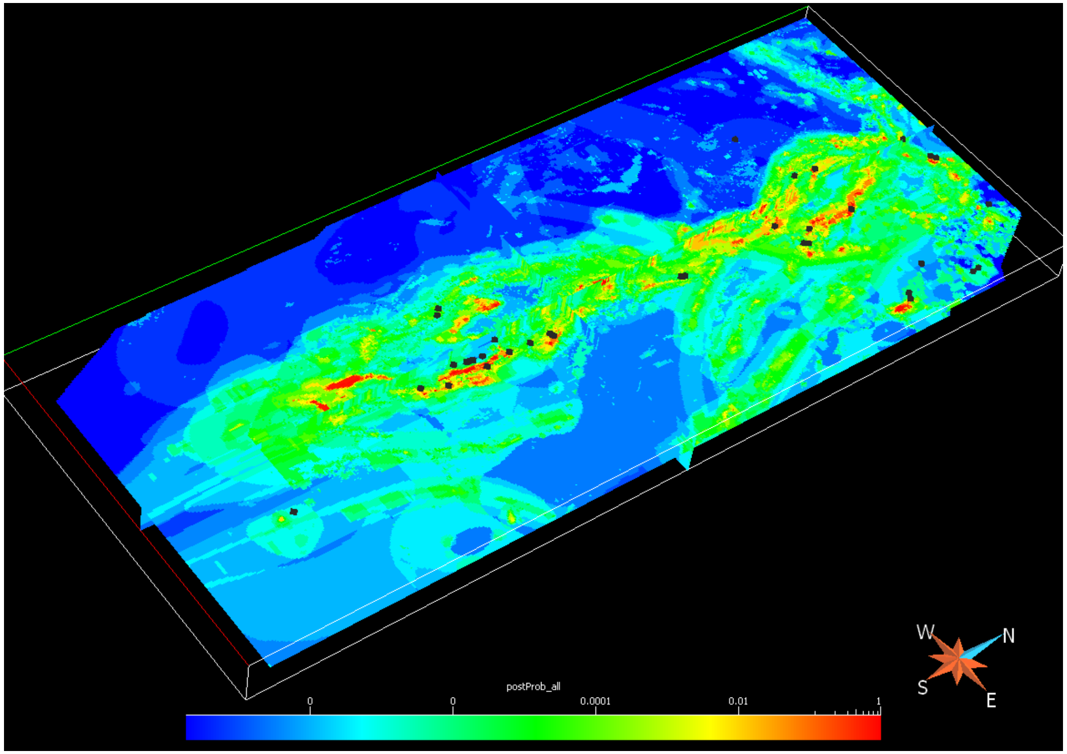

Questions???