

3D mineral potential modelling of the Quamby area, north-west Queensland.

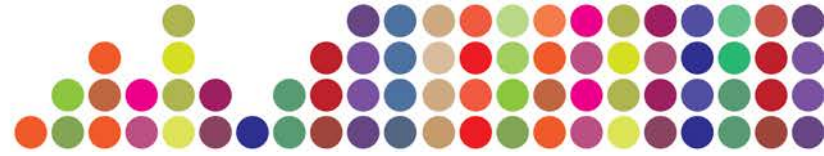
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Department of Natural Resources and Mines



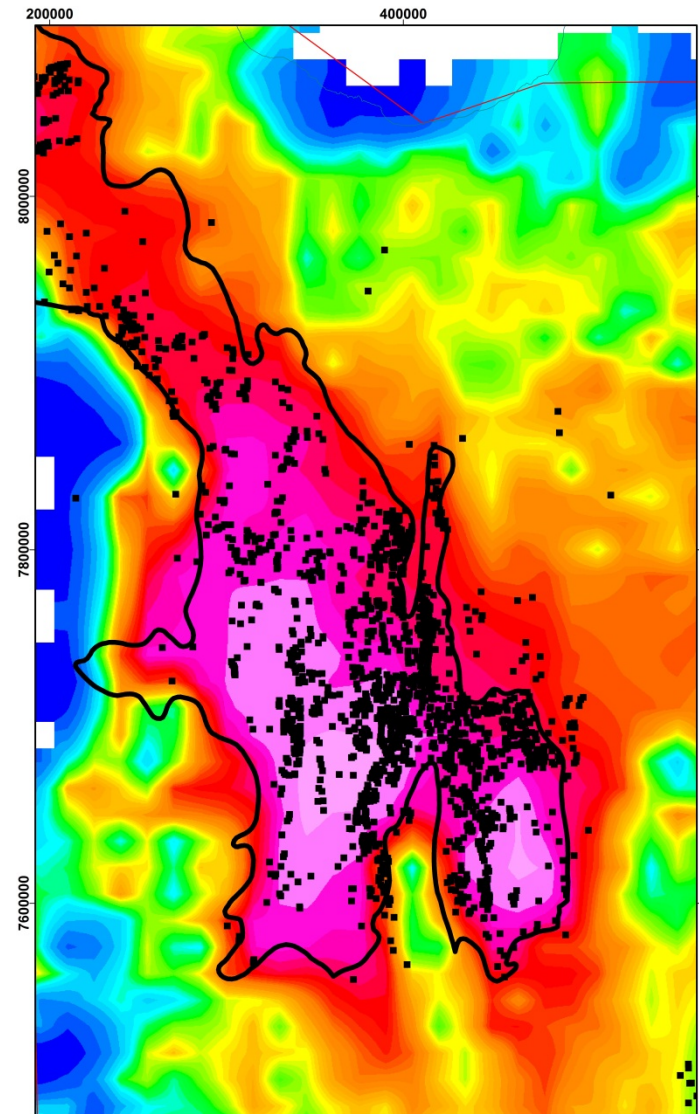
Contents

- Finalisation of work presented last year
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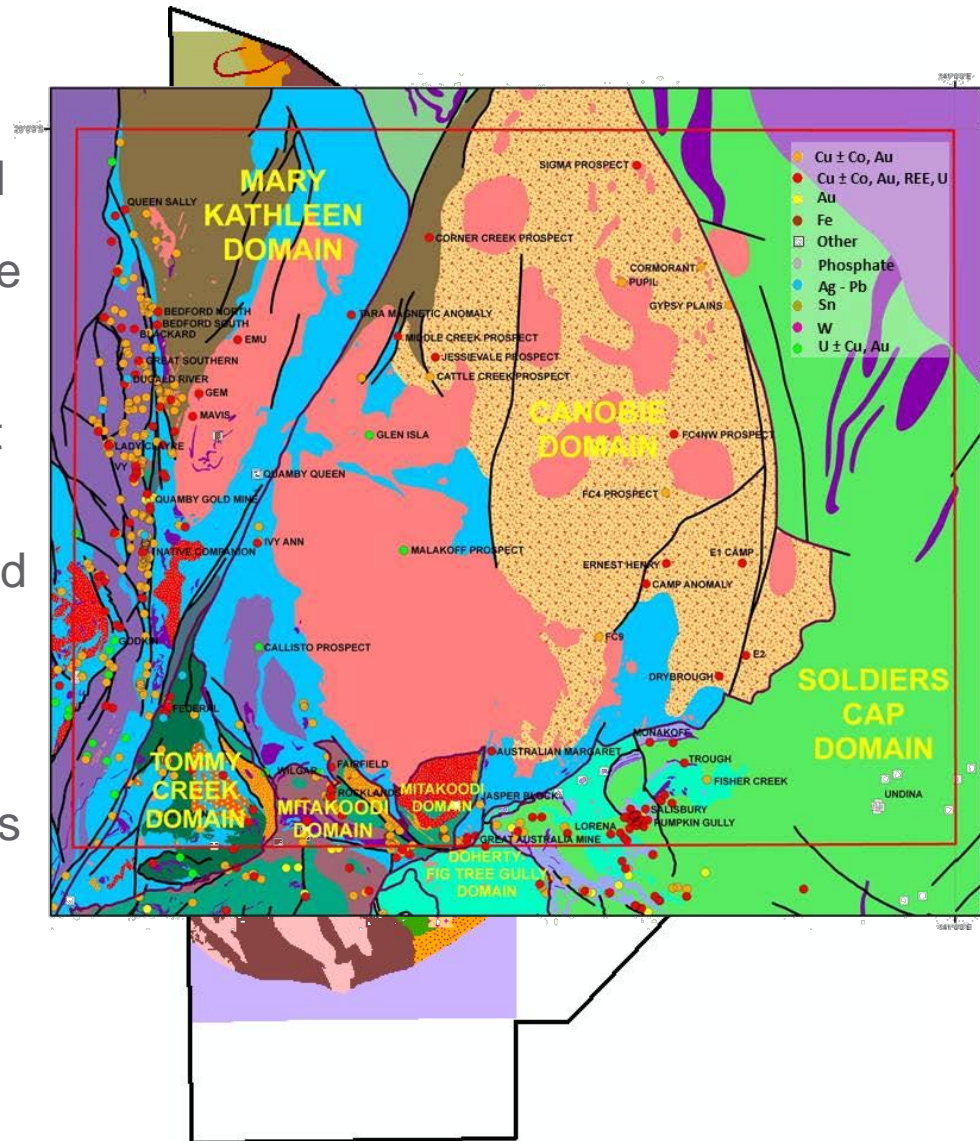
Rationale

- The Greenfields Prospectivity Unit was created to:
 - Expand exploration opportunities in underexplored areas where favourable environments for resources are concealed beneath cover that has previously been considered too difficult or costly to explore under.
 - Reappraise mature regions using new ideas to identify latent or new types of resource potential.



Quamby Project Area

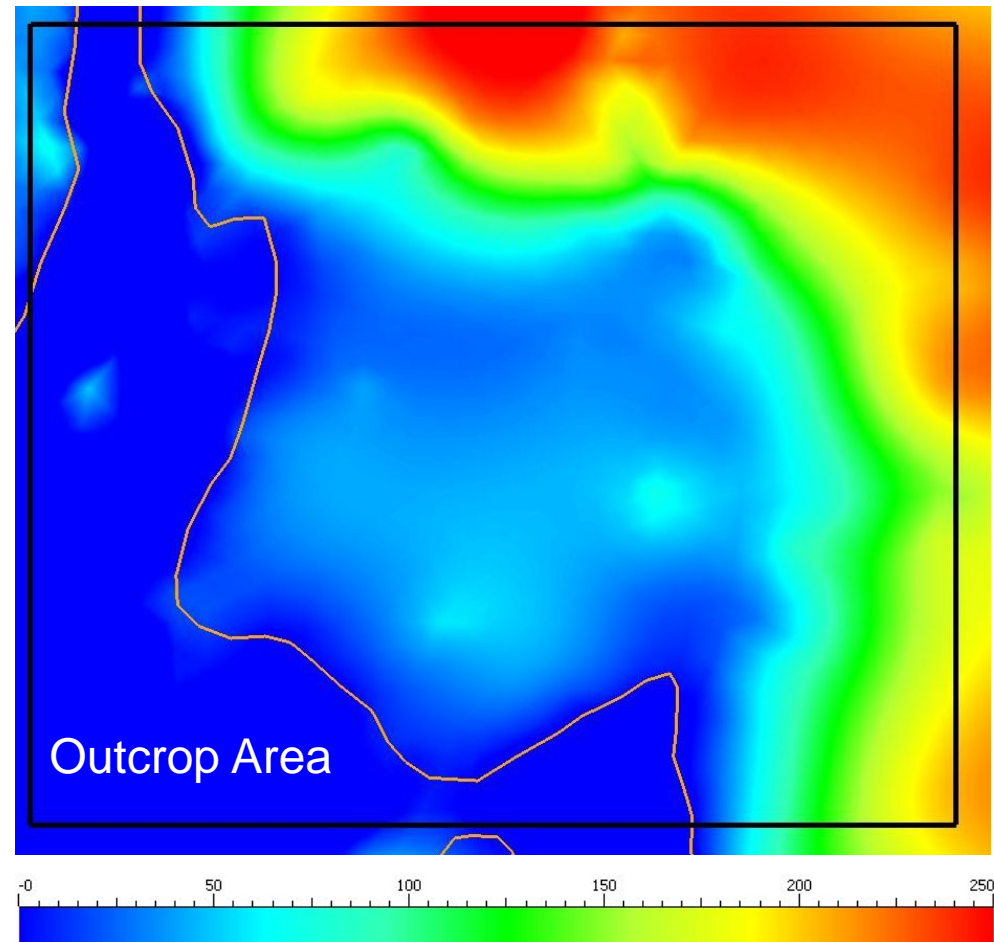
- Project area covers an area 95km long by 80km wide extending east from the Mount Rose Bee Fault and north from Cloncurry. Located immediately north of the Mount Dore project area (NWQMEPS, 2010)
- Includes the major operating Ernest Henry Cu-Au mine as well as significant Cu-Au projects such as E1 / Mount Margaret, Rocklands and Roseby, and the Dugald River Ag-Pb-Zn deposit.
- 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

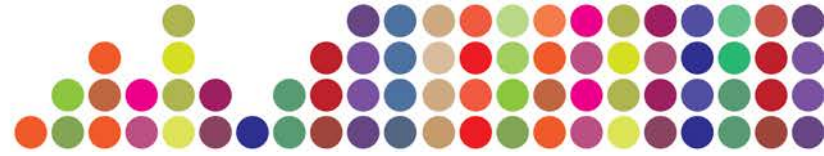
- Sediments cover >50% of the area. However, most cover depths interpreted to be less than 200m. Consequently, much of the area has been under-explored.
- Quamby area is prospective for multiple styles of mineralisation including Cu±Au±iron oxide deposits, sediment-hosted Cu deposits, sediment-hosted 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





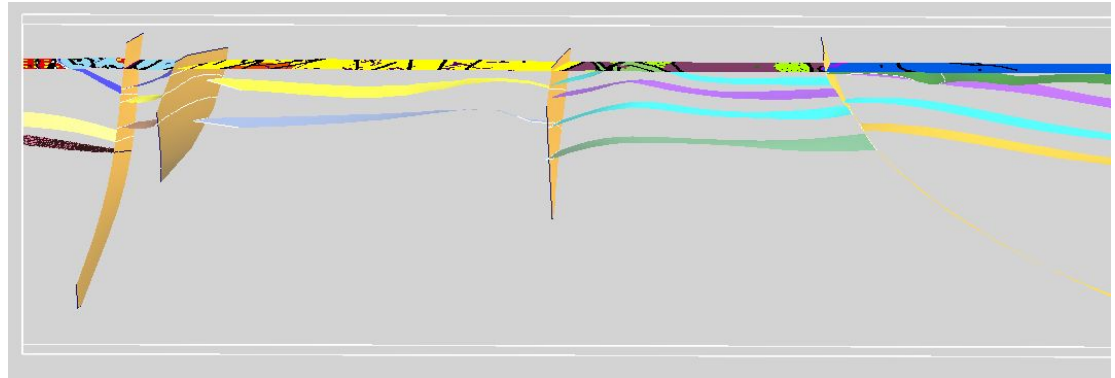
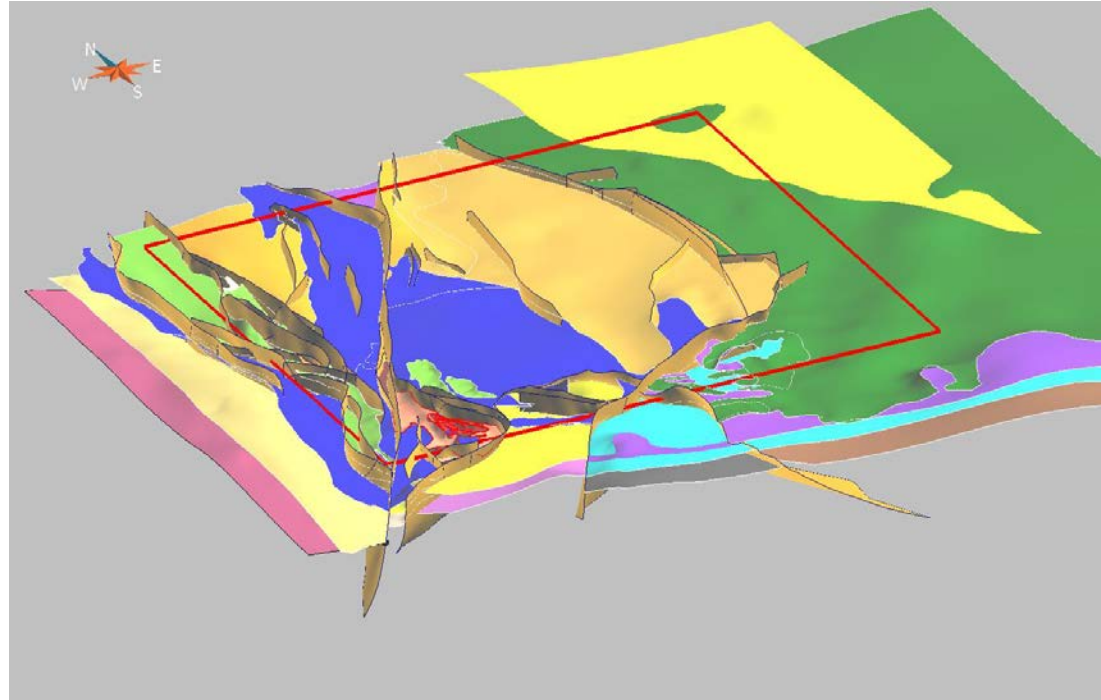
Quamby Project - Workflow

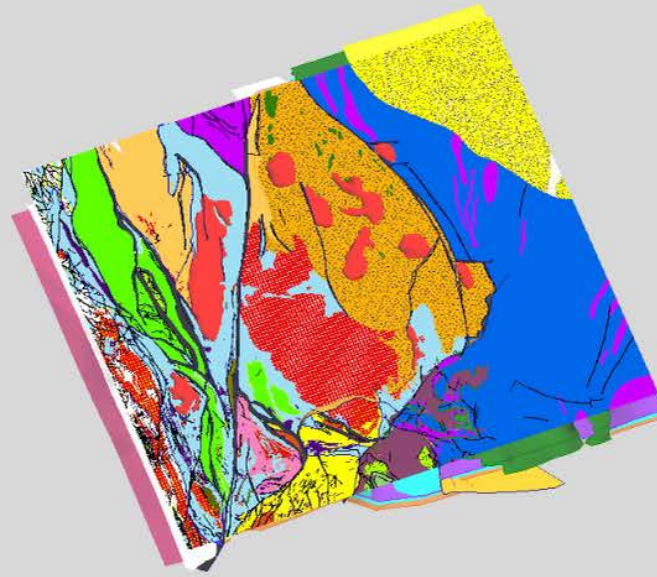
- Data compilation and field work to collect samples for density and magnetic susceptibility measurements.
- Preparation of new geological cross-sections (using updated structural/stratigraphic interpretation delivered from latest GSQ regional mapping program).
- Creation of GoCAD/SKUA geological surface and block model (~20km depth).
- Gravity and magnetic inversions using VPmg.
- Development of a Common Earth Model of upper 2.5 km of crust with properties from inversions.
- 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 a Mineral Potential Index.



Modelling Workflow

- 3D Lithology Surface modelling
- Surfaces representing base of lithological packages built in GOCAD/SKUA from:
 - Seismic
 - Cross-sections
 - Mapping
 - Potential Fields







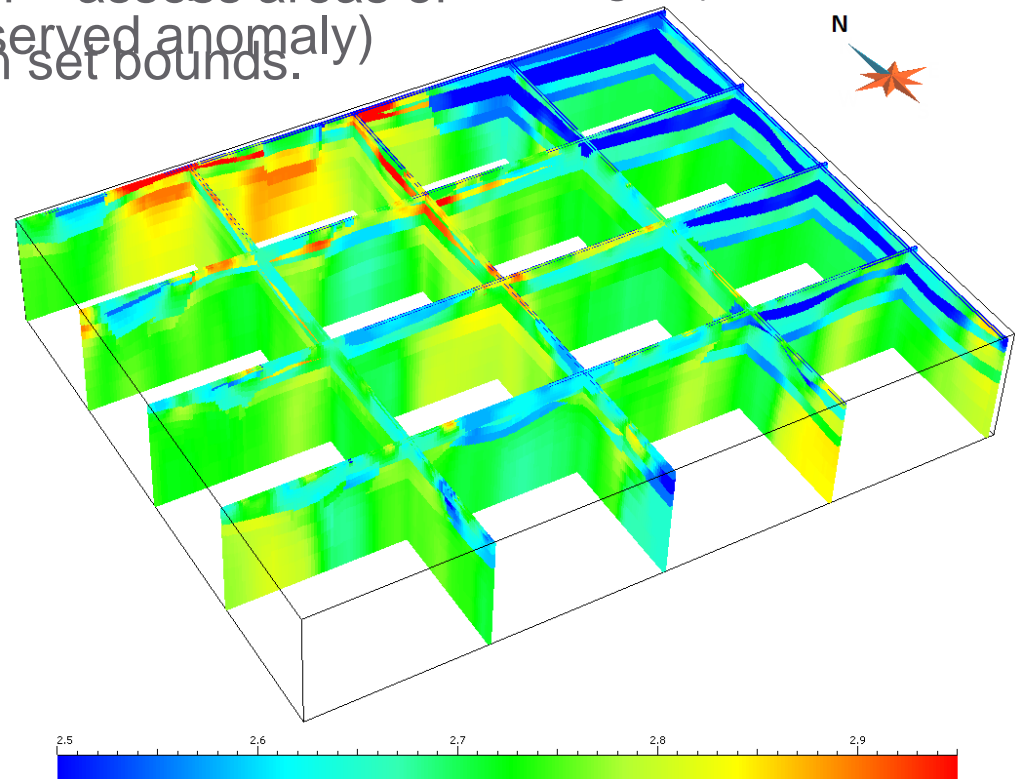
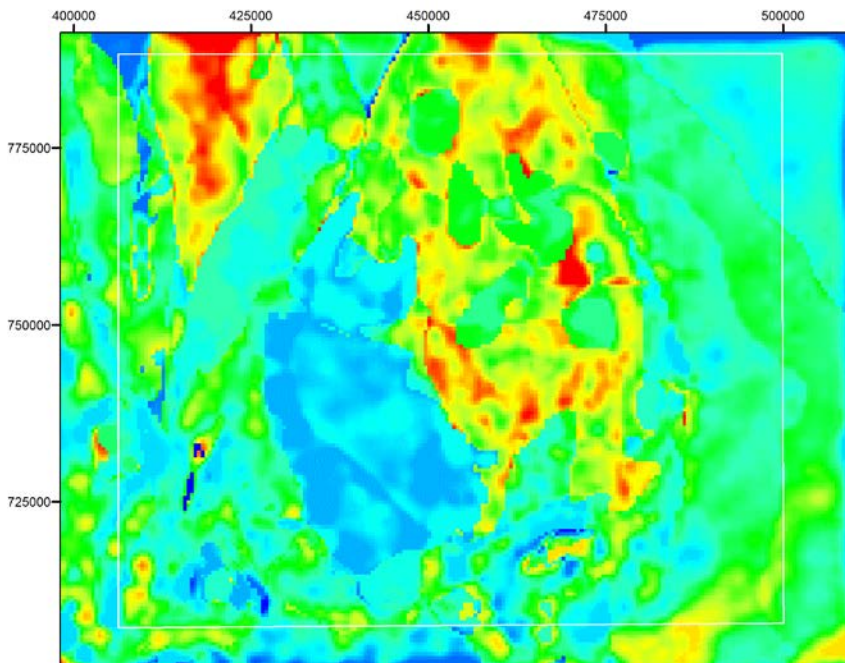
Potential Field Inversions

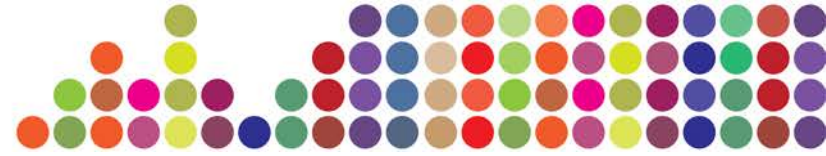
- Regional Voxet model (crustal-scale model to 20km depth), cell dimensions of 500m, 500m, 100m (X,Y,Z)
- Voxet populated with available physical properties (density and magnetic susceptibility) collected in field, calculated in laboratory or from literature.
- Forward modelling to ascertain regions of high misfit
- Initial inversion focused on modifying the geometry of the granites, depth of cover and broad areas of misfit to fix geometric issues in initial model.
- 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.



Gravity Inversions

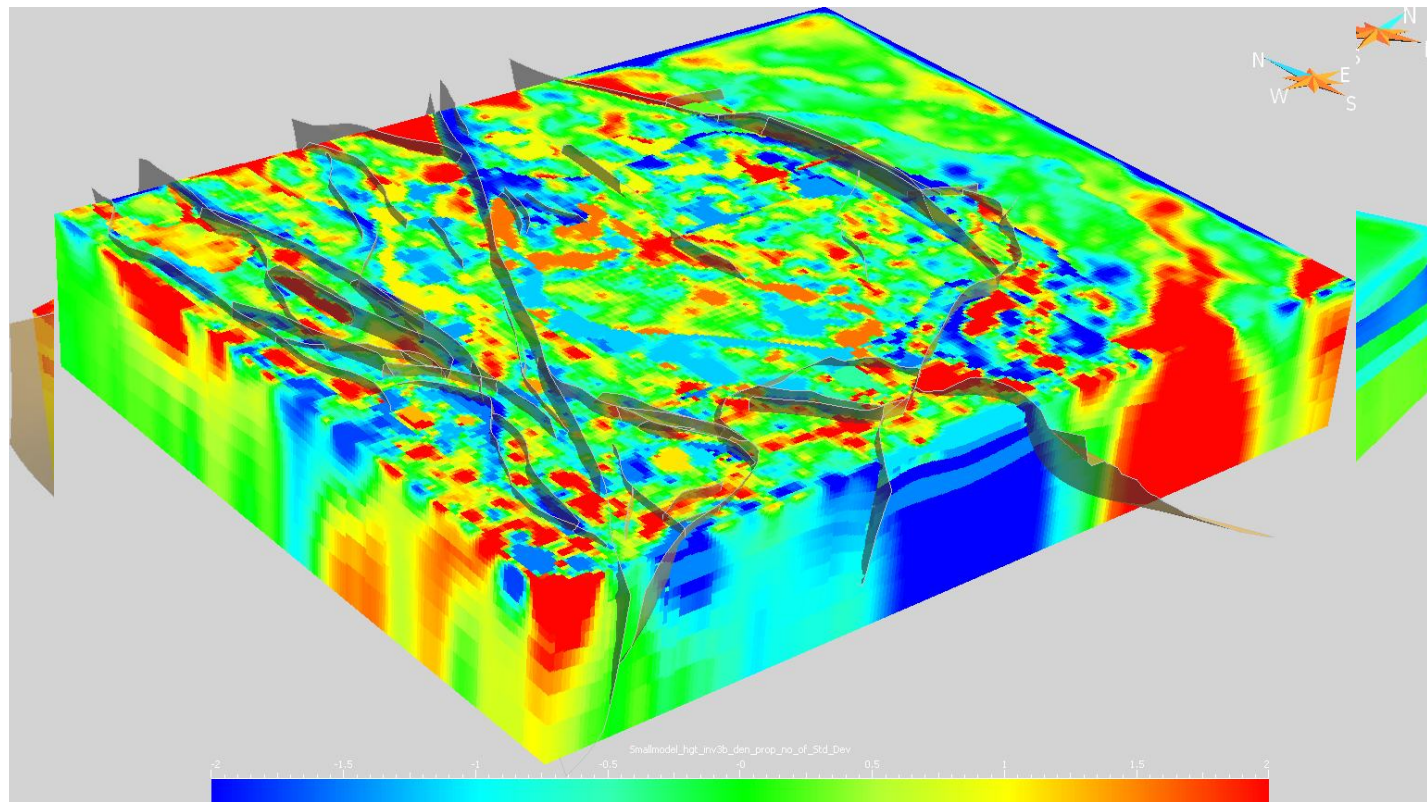
- Initial RMS misfit decreased from 1.22 mgal to 0.32 mgal (11.2% of the dynamic range of the observed gravity anomaly)
- Homogeneous unit optimisation - optimised mean densities for units
- Heterogeneous unit inversion - assess areas of heterogeneity in model within set bounds.





3D Density model

- Final 3D density model result of several generations of iterative inversion. Constrained by geological model and the set density range of the units.

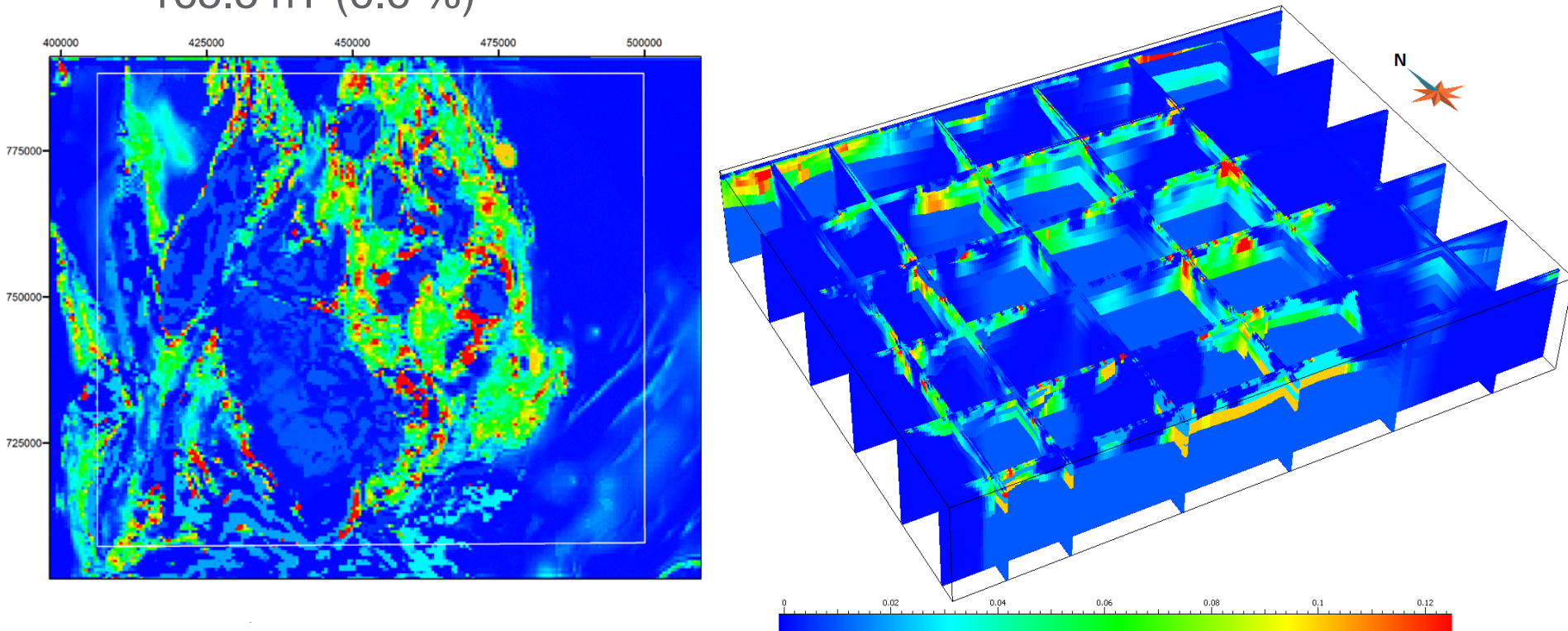


Standard deviations from mean unit density
Final 3D density model



Magnetic Inversion

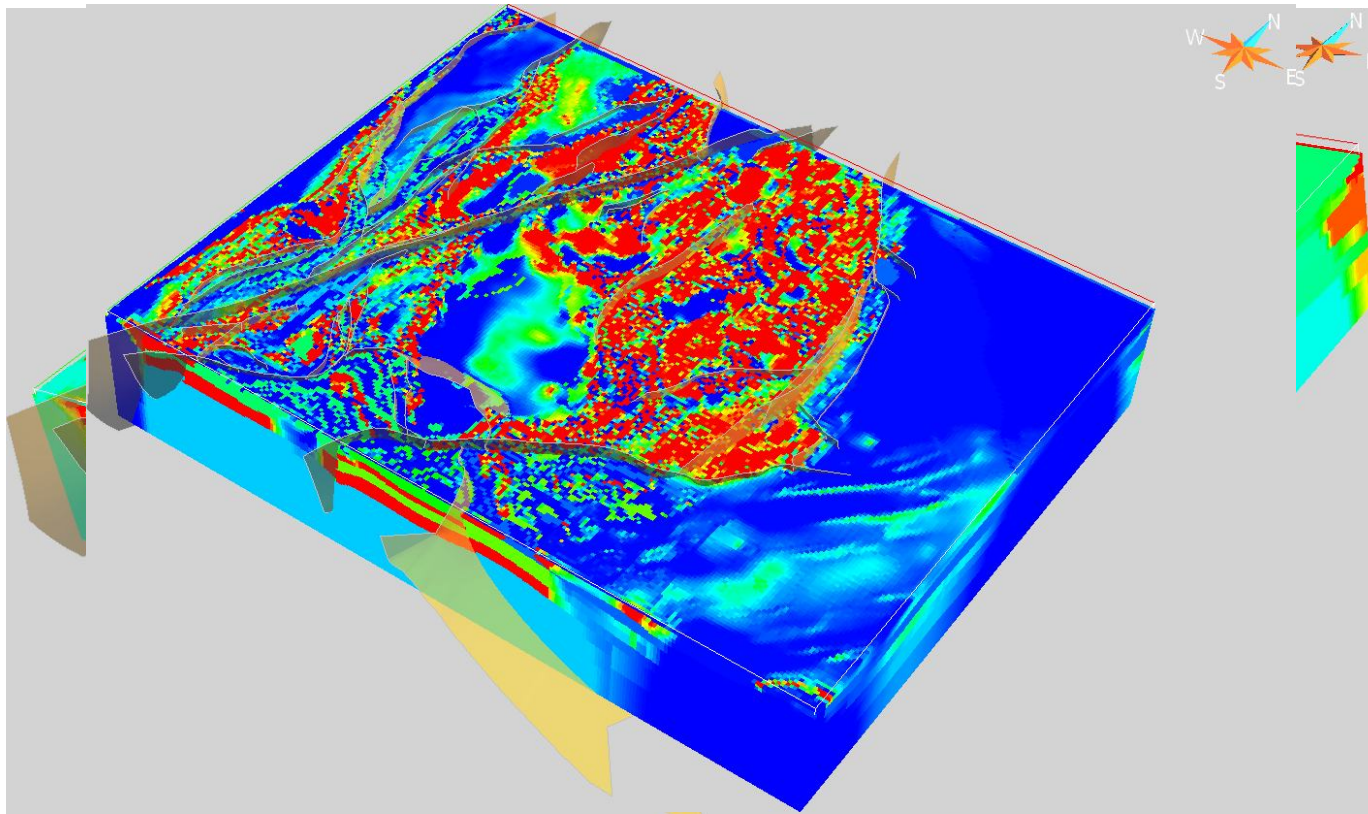
- Similar process to gravity inversion
- Forward modelling and homogenous inversion less able to fit observed response due to inherent heterogeneity of magnetic susceptibility within units
- Reduced misfit from 459.59 nT (18.4% of dynamic anomaly) to 165.5 nT (6.6 %)





3D Magnetic Susceptibility Inversion

- Final 3D magnetic susceptibility model result of several generations of iterative inversion. Constrained by geological model and the set magnetic susceptibility range of the units.

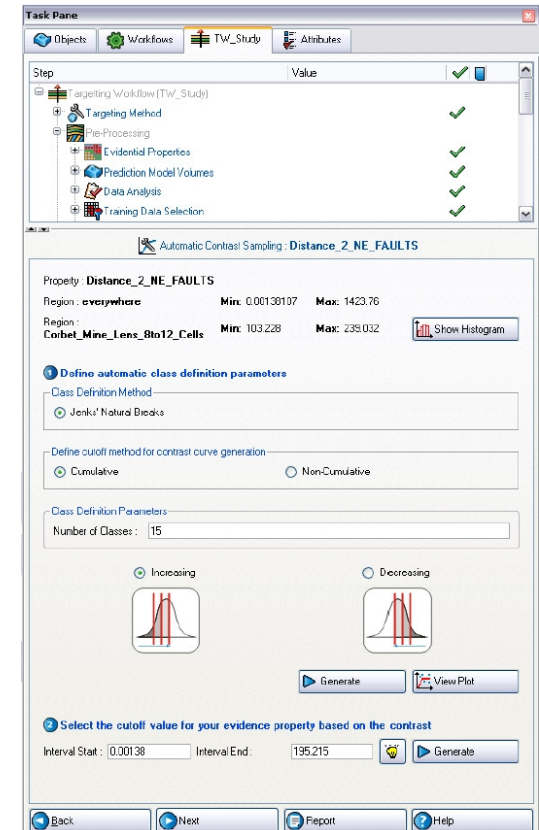


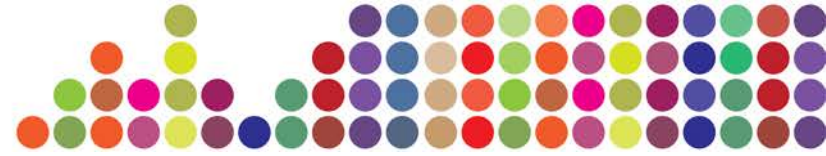
Standard deviation of Final 3D Magnetic Susceptibility Model



3D Weights of Evidence (WoE) Targeting

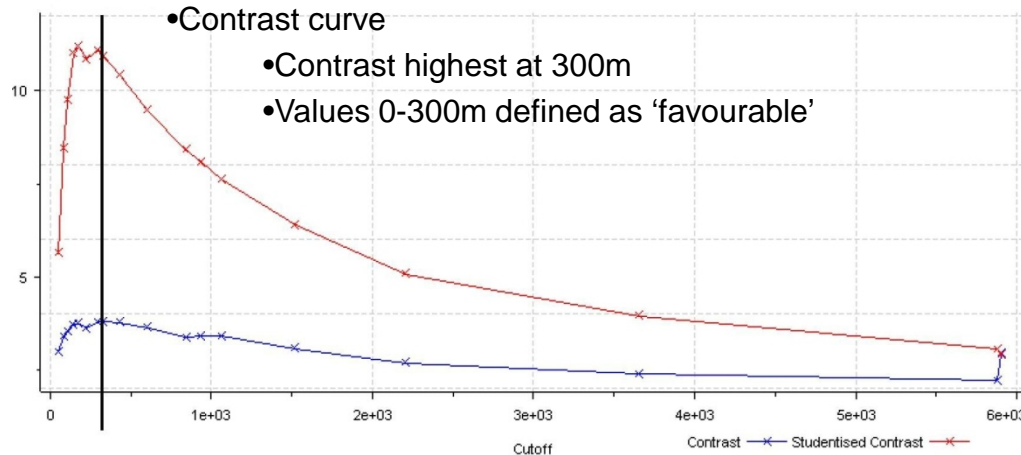
- Statistical evaluation of spatial relationships between known mineral occurrences and other spatial datasets (evidential properties/exploration criteria such as rock type, structure, geochemistry) → used to define ***mineral potential probabilities***
- Mineral systems analysis and literature review undertaken as part of NWQMEP study identified exploration criteria believed to be associated with Copper and/or Gold mineralisation in area.
- Exploration criteria represented in the Common Earth model in GoCAD as continuous or discrete variables (evidential properties)
- GoCAD Targeting workflow used to assess the correlation of these evidential properties with known mineralisation (training data).



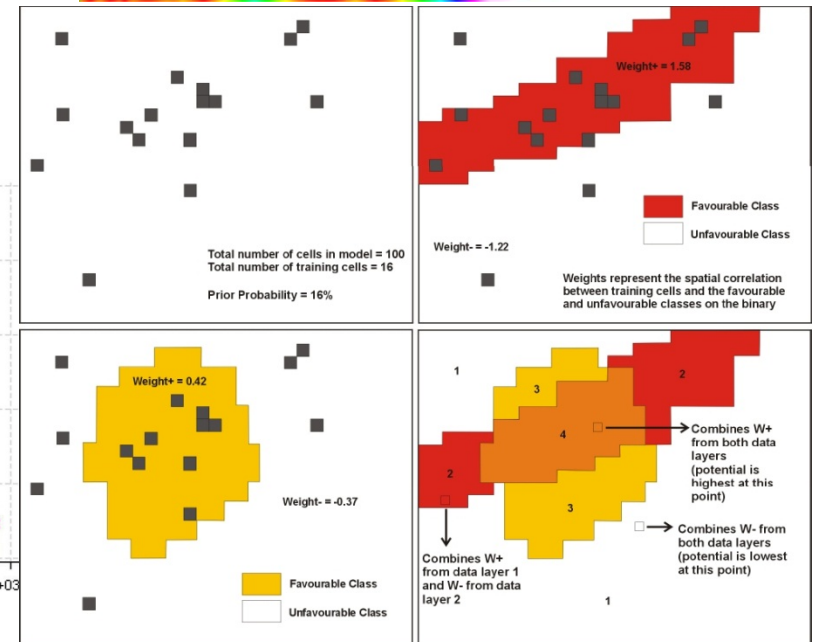


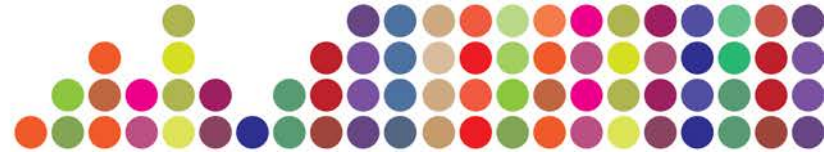
3D Weights of Evidence

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



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





3D Weights of Evidence (WoE) Targeting

- WoE modelling completed on top 2.5 km of model
- Different exploration criteria, contrast and cut-off values across the geological domains due to different mineralisation styles, expected targets and depth of cover.
- WoE models completed for two main domains, Canobie in centre of model and Mary Kathleen in west of model to find favourable mineral potential locations in each.
- Tested 23 evidential properties (including some combinations/variations:
 - Inverted density/Mag Susc, variation from mean/ median of unit, number of standard deviations from unit mean.
 - U/Th, U²/Th



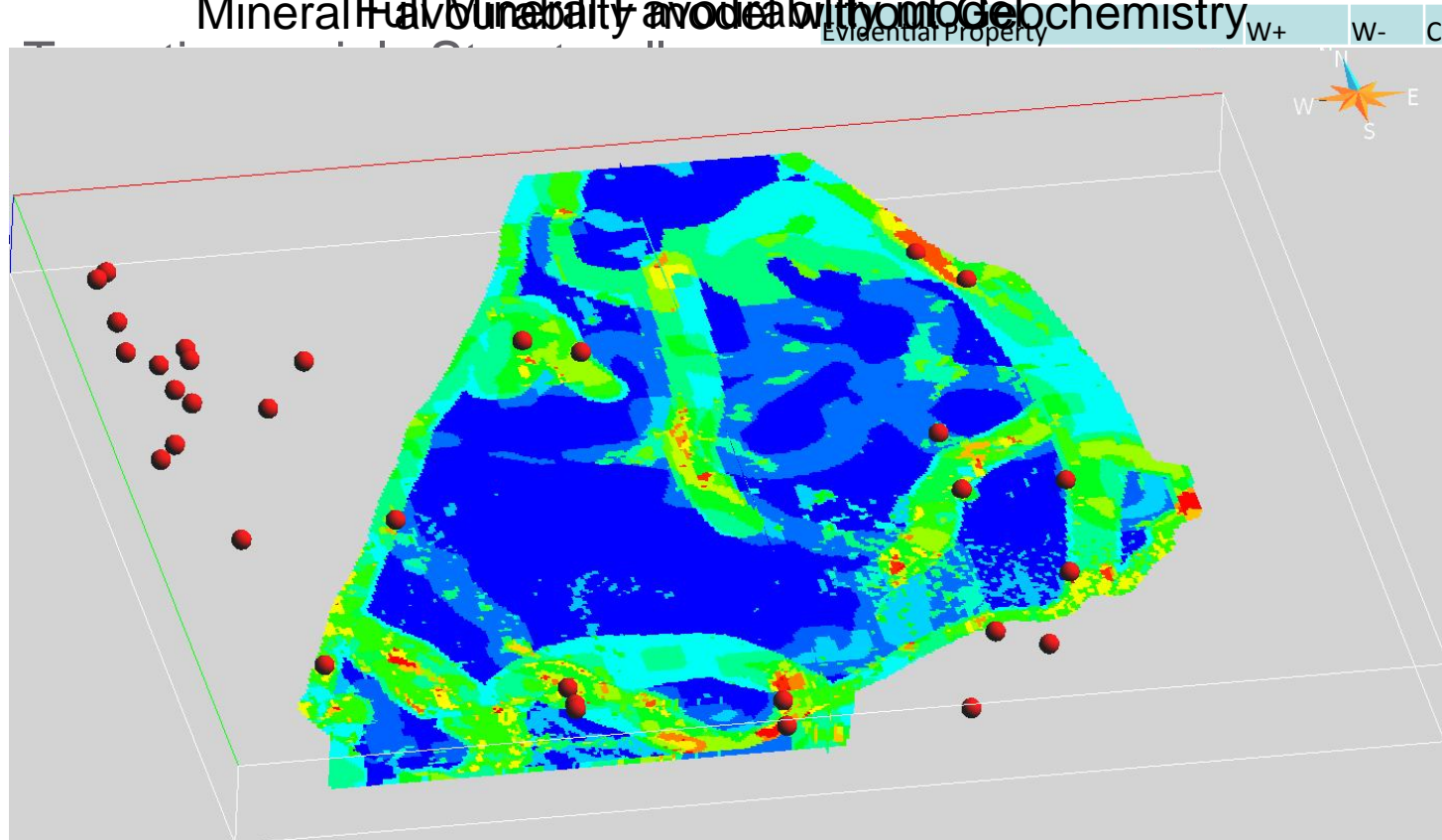
Mineral Potential Index – Canobie Domain

Mineral Potential Index – Canobie Domain

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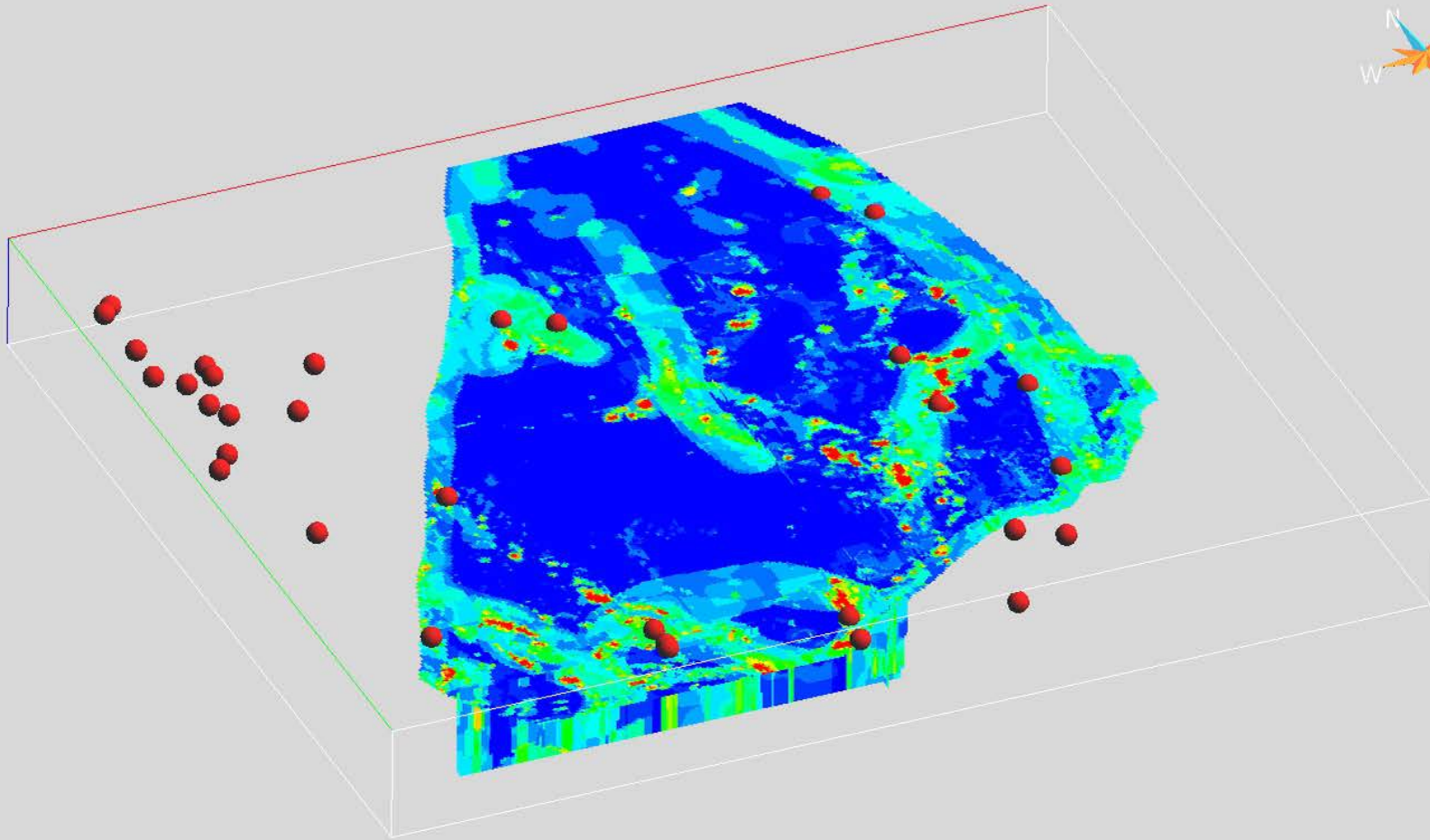
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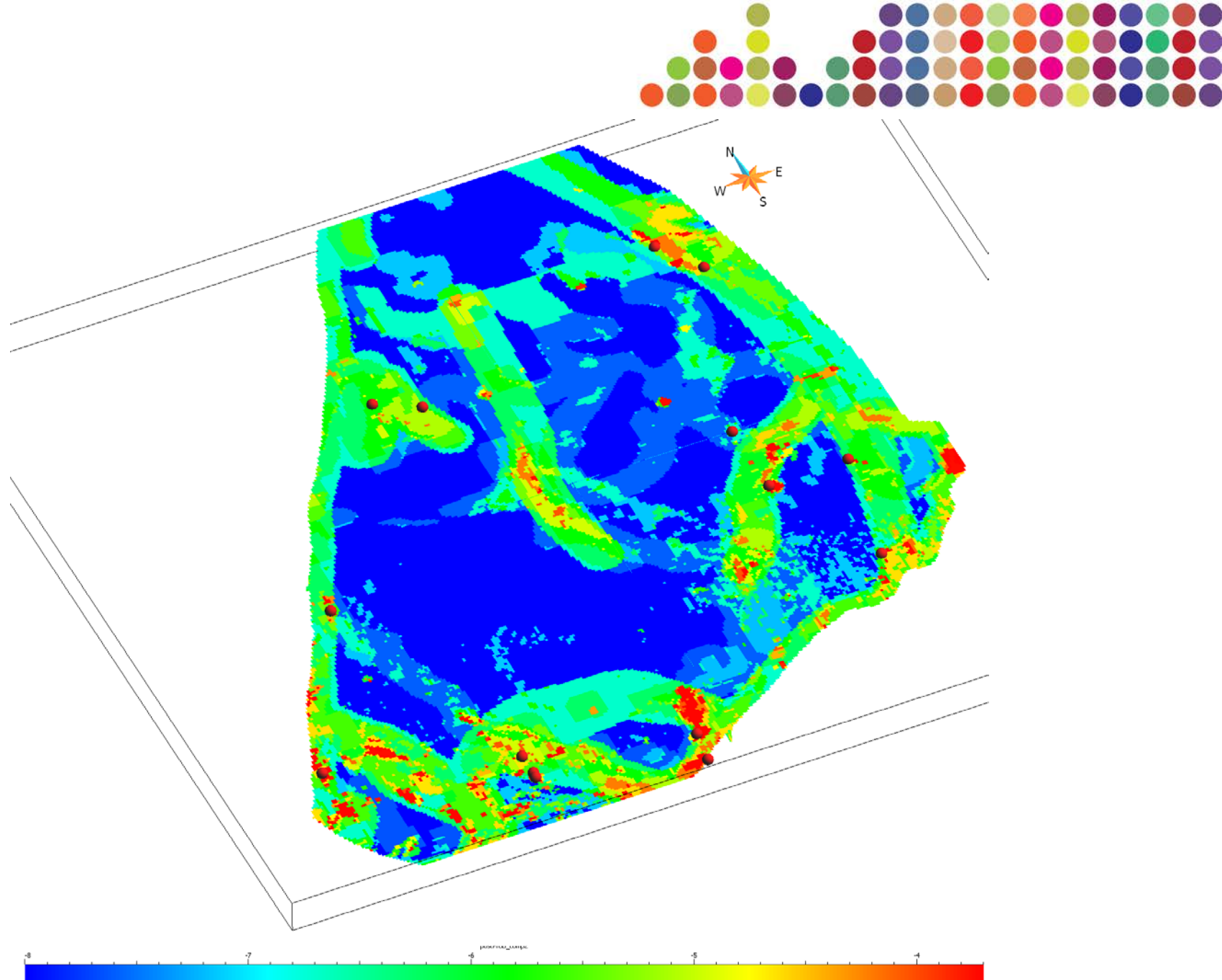


W+	W-	Contrast	Stud. Contrast
		4.48	8.65
		4.40	8.51
		1.70	3.10
		2.05	3.95
		1.03	1.87
		3.11	3.01
		2.08	3.95
		0.94	1.81
		2.09	3.81

exploration.

Horizontal slice at 1200m (up to ~4500m cover)

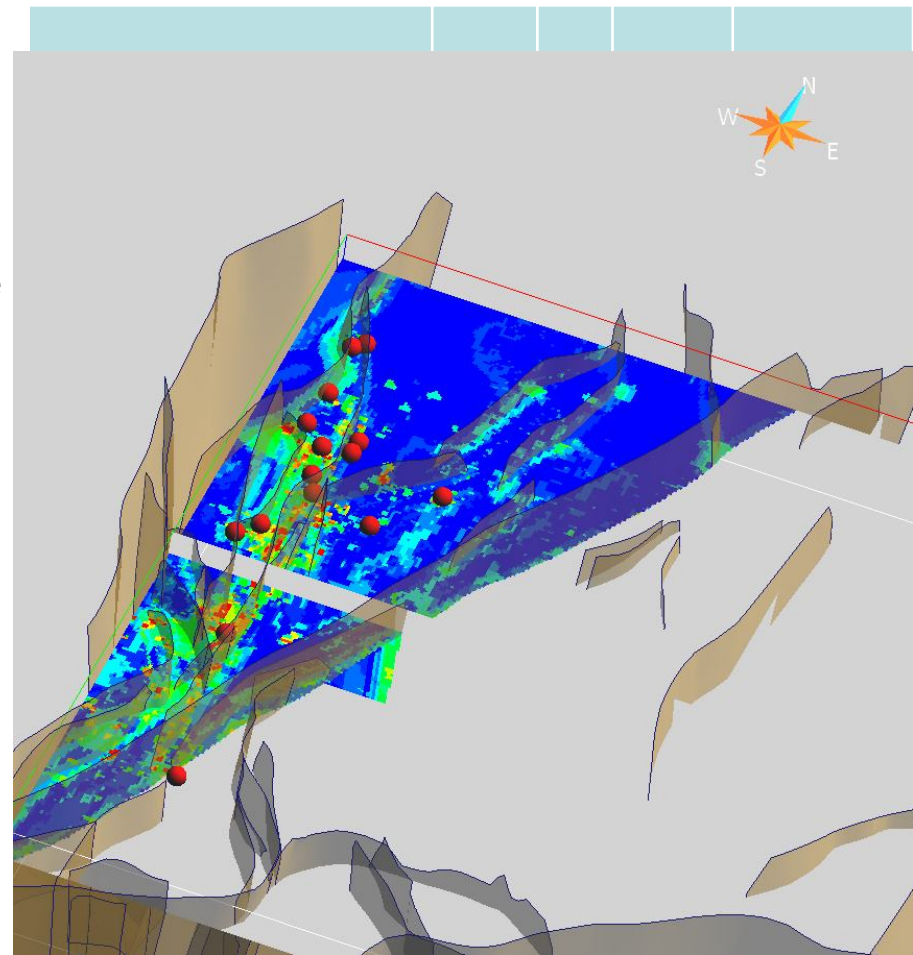


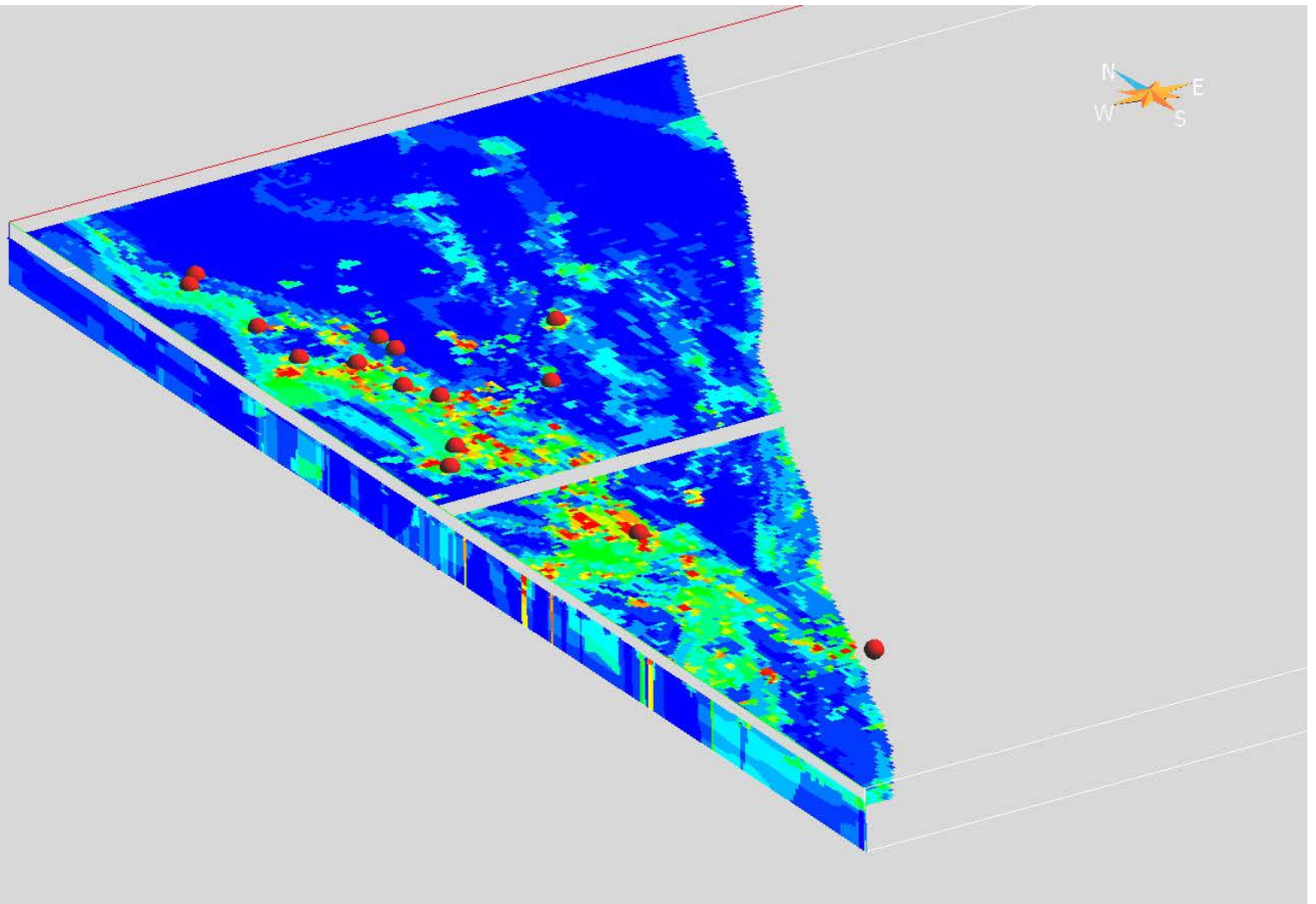


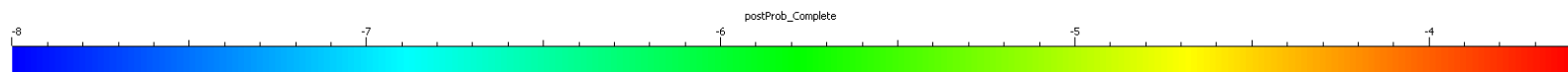
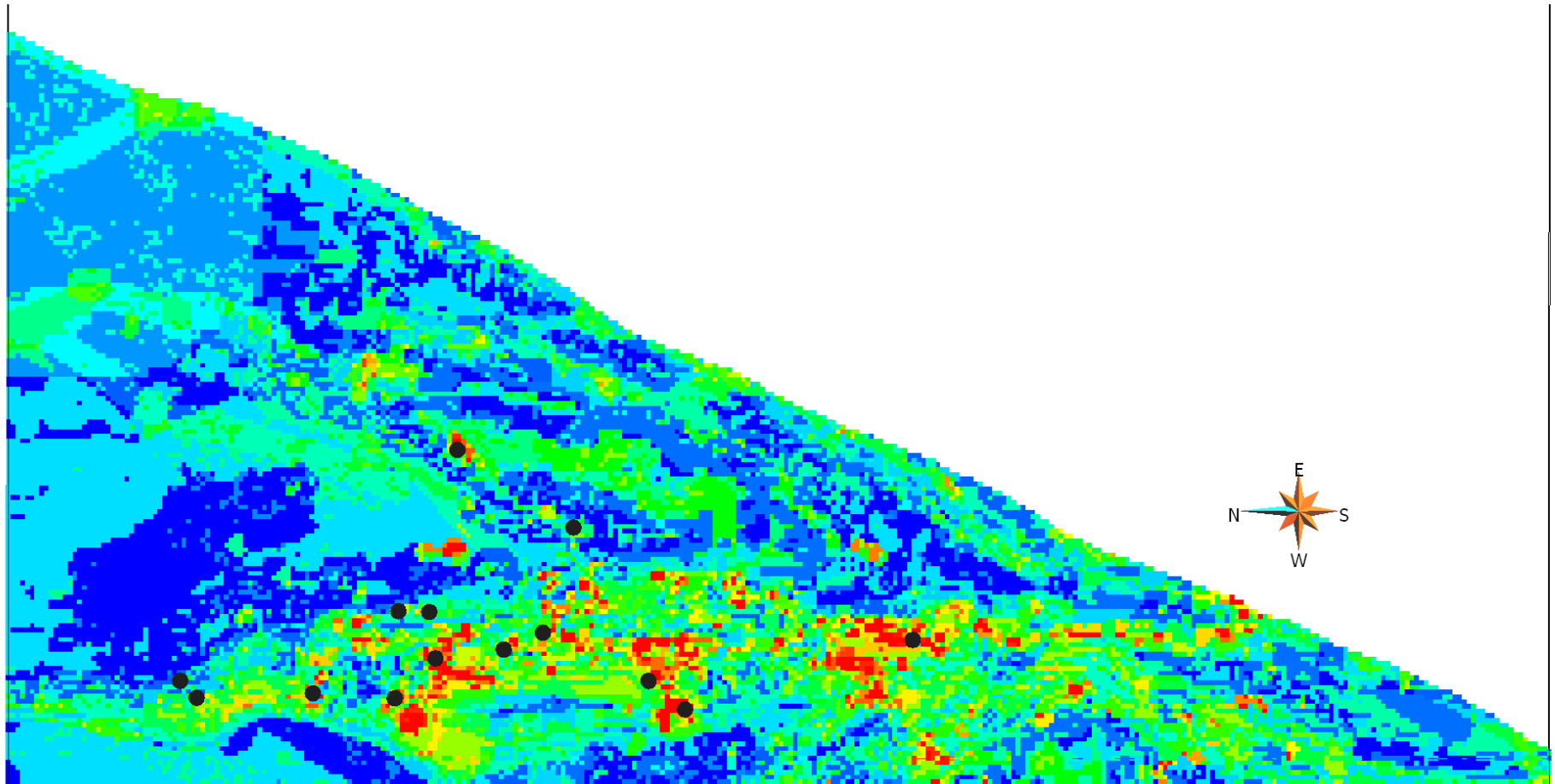


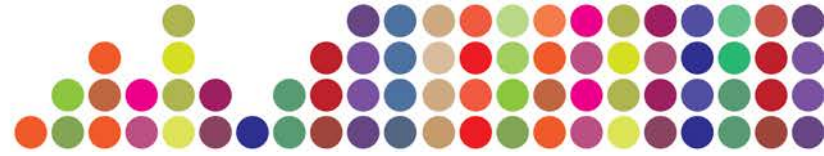
Mineral Potential Index – Mary Kathleen Domain

- Targets include
 - Structurally-controlled epigenetic Cu±Au±iron
 - Sediment hosted copper (shale hosted or supergene enriched) in oxide zone
- Geochemistry, magnetic inversion deviations from unit mean, fault curvature, distance from faults and K radiometric channel ratio best evidential properties/ mineral probability discriminators.
- Different strengths of association
- Less variation in 3D than Canobie









Conclusions

- The Quamby region still contains high mineral potential under cover both in the Mary Kathleen and Canobie domains
- Exploration criteria and weights are different between domains and not same as Mount Dore study area
- 3D WoE modelling can help to
 - Better define exploration criteria
 - Develop new ideas about exploration in area
 - Define areas of interest AND low-interest
- Models are not static, can add data later and re-run WoE as new data and/or ideas are available



Questions?

