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# 3D Geology of the Tanami and overview of the seismic proposal

Tony Meixner & Leon Vandenberg



# The Tanami 3D model

Tony Meixner<sup>1</sup> Leon Vandenberg<sup>2</sup>  
(GA<sup>1</sup>- NTGS<sup>2</sup> collaborative)

## Acknowledgements

Richard Larson (GoCad), Malcolm Nicoll (GoCad),  
David Beard and team (VRML)



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# Building the 3D model

## Step 1 - Strip off the cover

- Geological mapping, drill hole information
- Interpretation of Magnetic and Gravity images

Solid geology interpretation maps

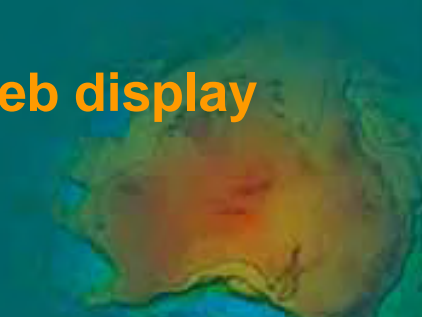
## Step 2 - Construct 2D modelled sections

- Generate a series of 2D geological sections
- Tested by potential field (Gravity and Magnetics) forward modelling incorporating rock property data (~250 samples)

## Integrating Geology and Geophysics

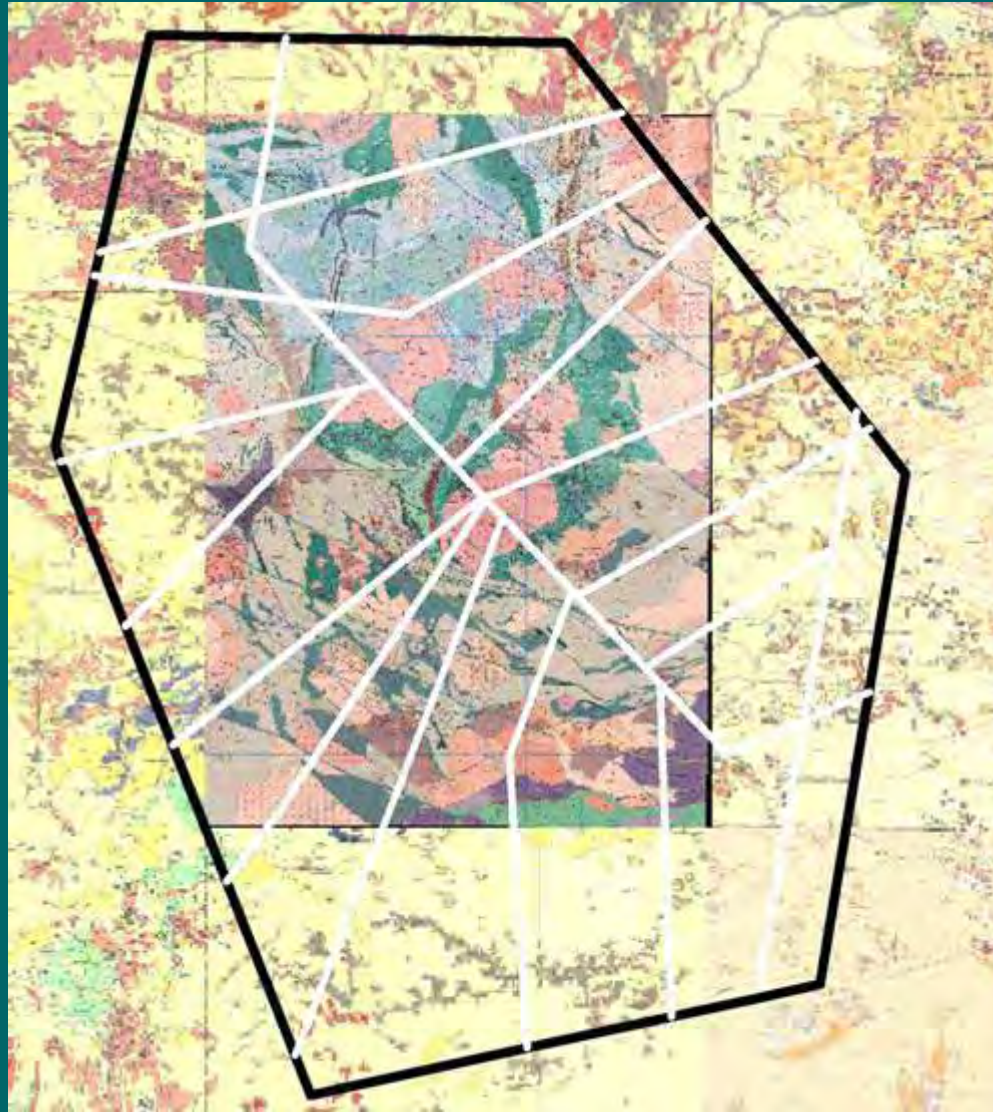
## Step 3 - Constructing 3D geometries

- Generate 3D surfaces in GoCad
- Importing the 3D surfaces into VRML language for web display



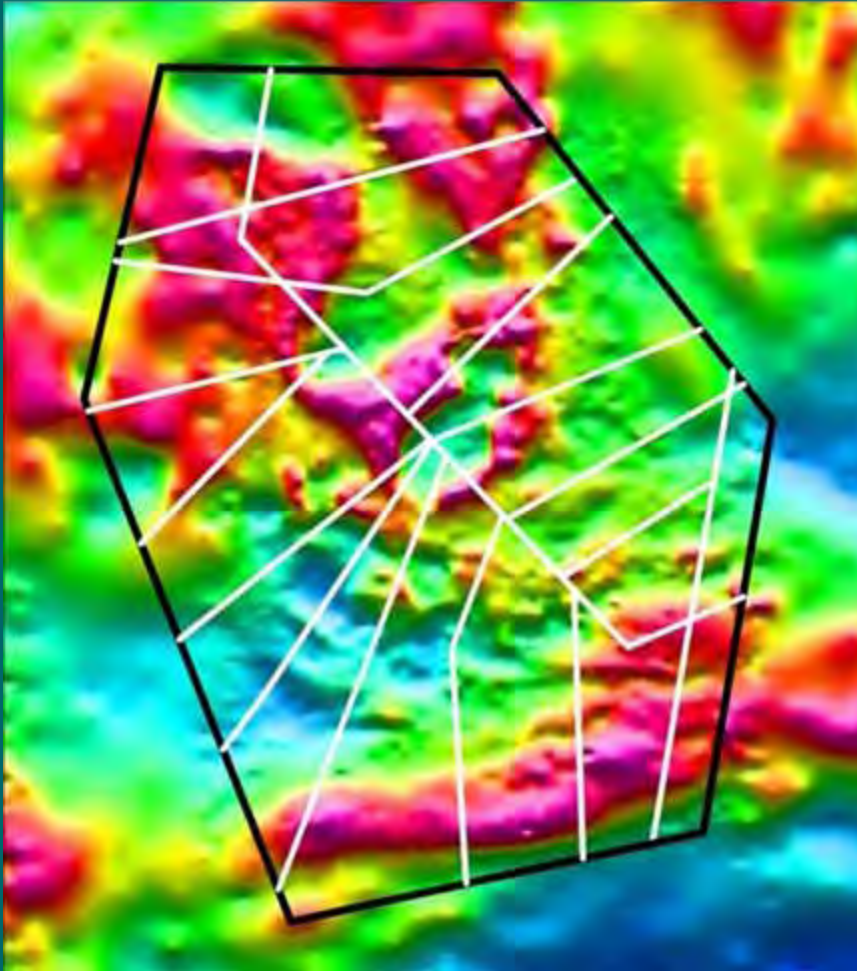


# Geological section location

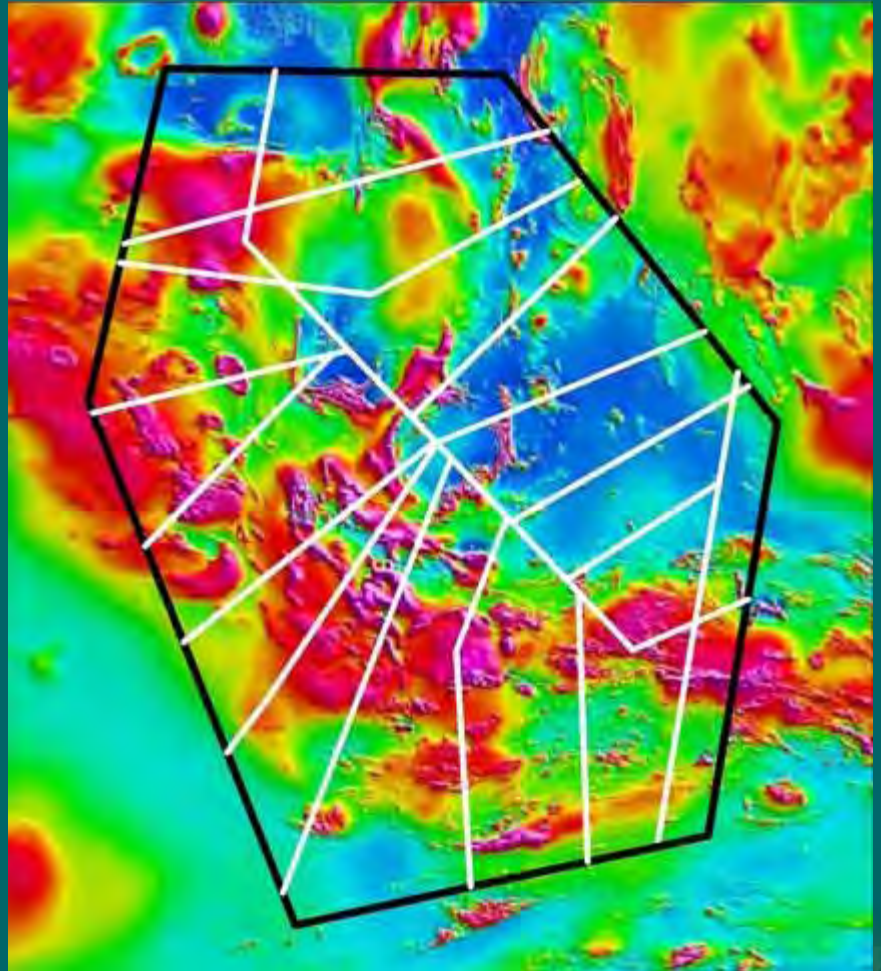




# Geological section location

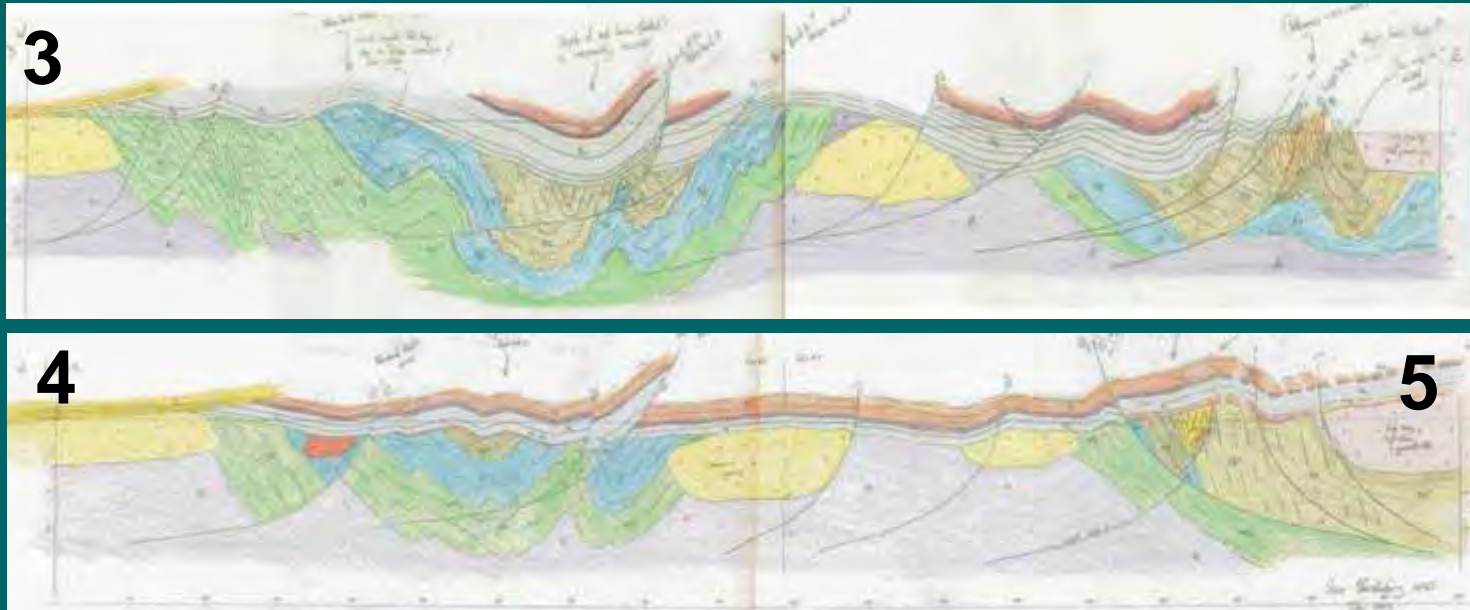


Gravity image



Magnetic image

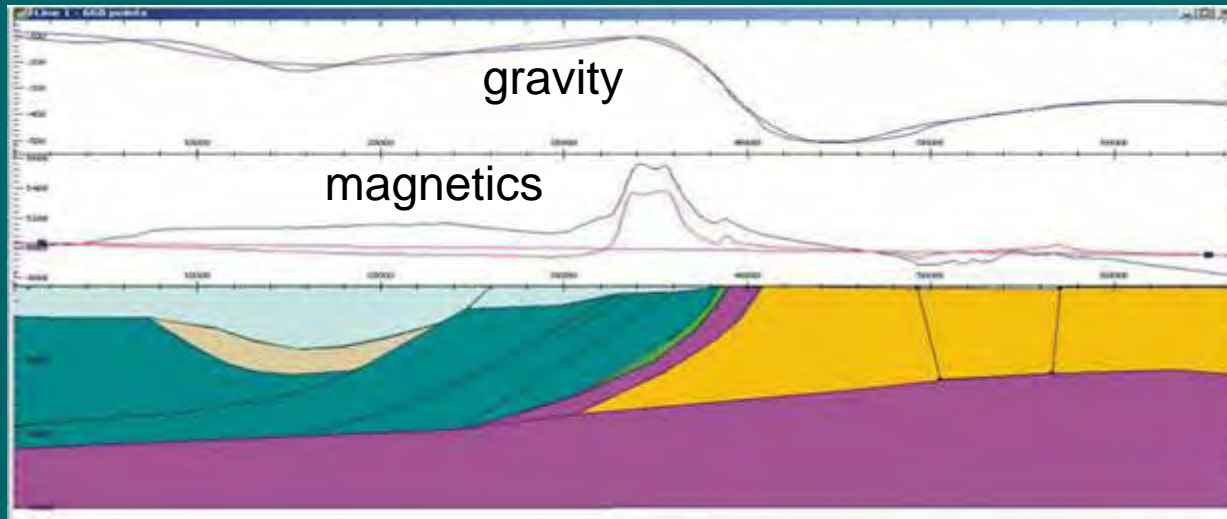
# Geological cross-section construction



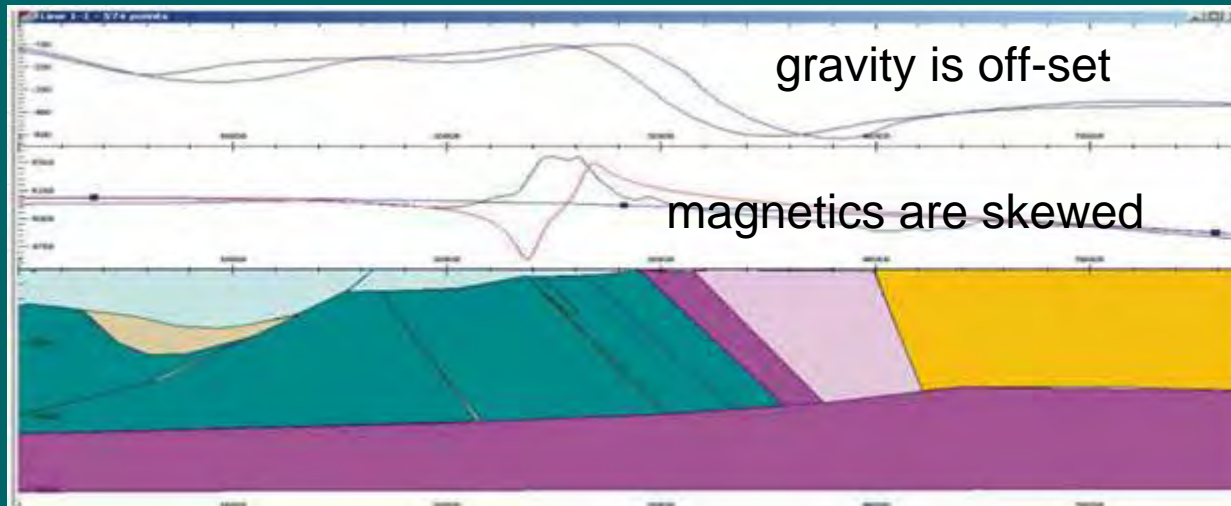
- Sections through the cover are relatively straight forward
- Sections through underlying Tanami basement are not so easy...
  - extrapolation of field data from off section
  - reliance on solid geology interpretation maps
- Consistency of major geometrical relationships through adjacent sections



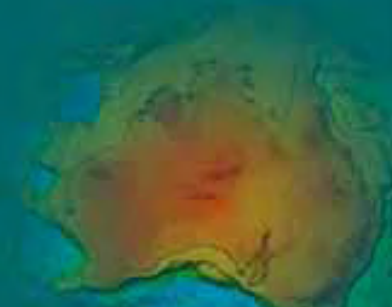
# Testing alternative geometries



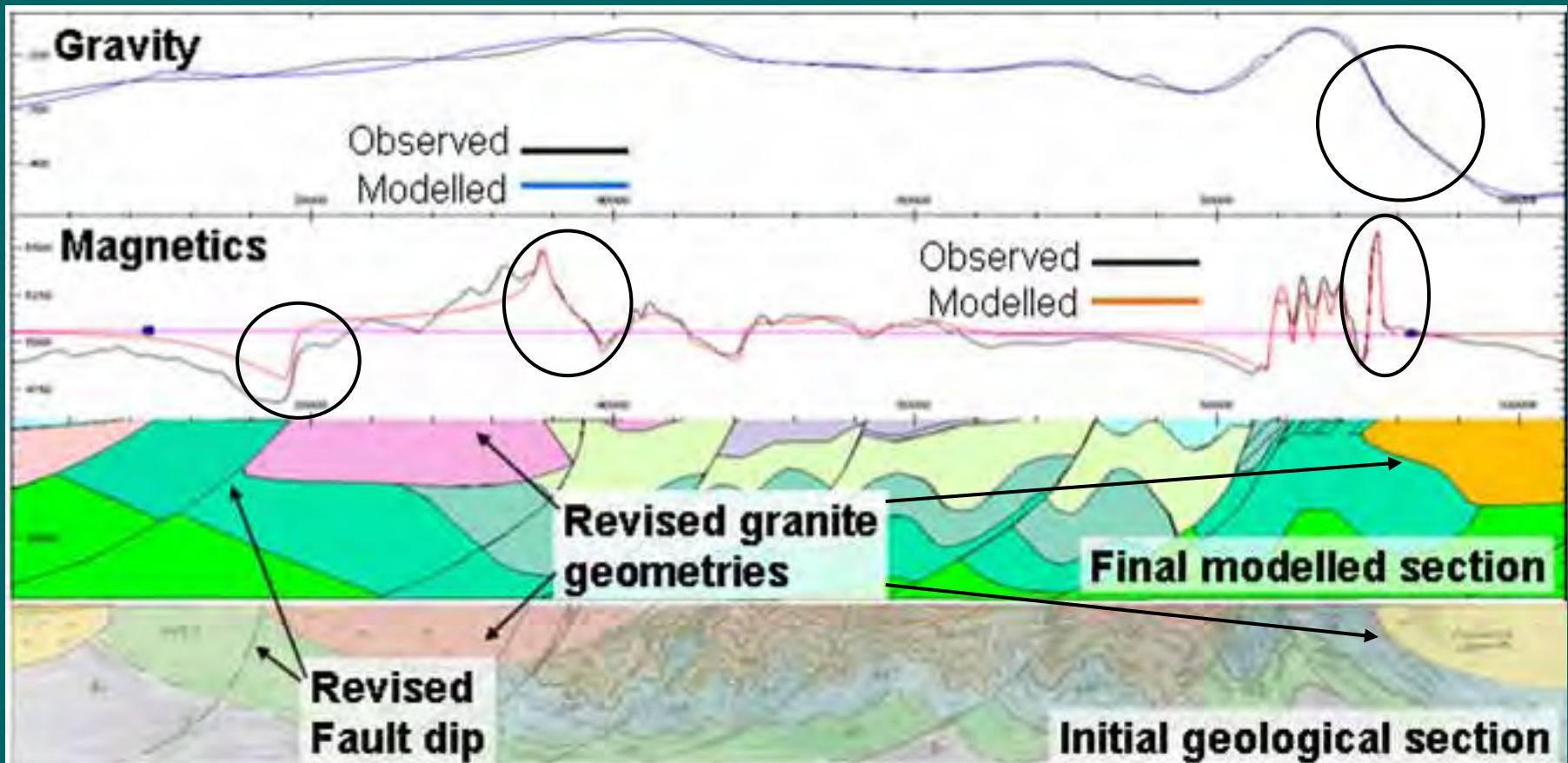
**Section 1  
model corresponding  
to cross-section**



**Section 1  
reversed**



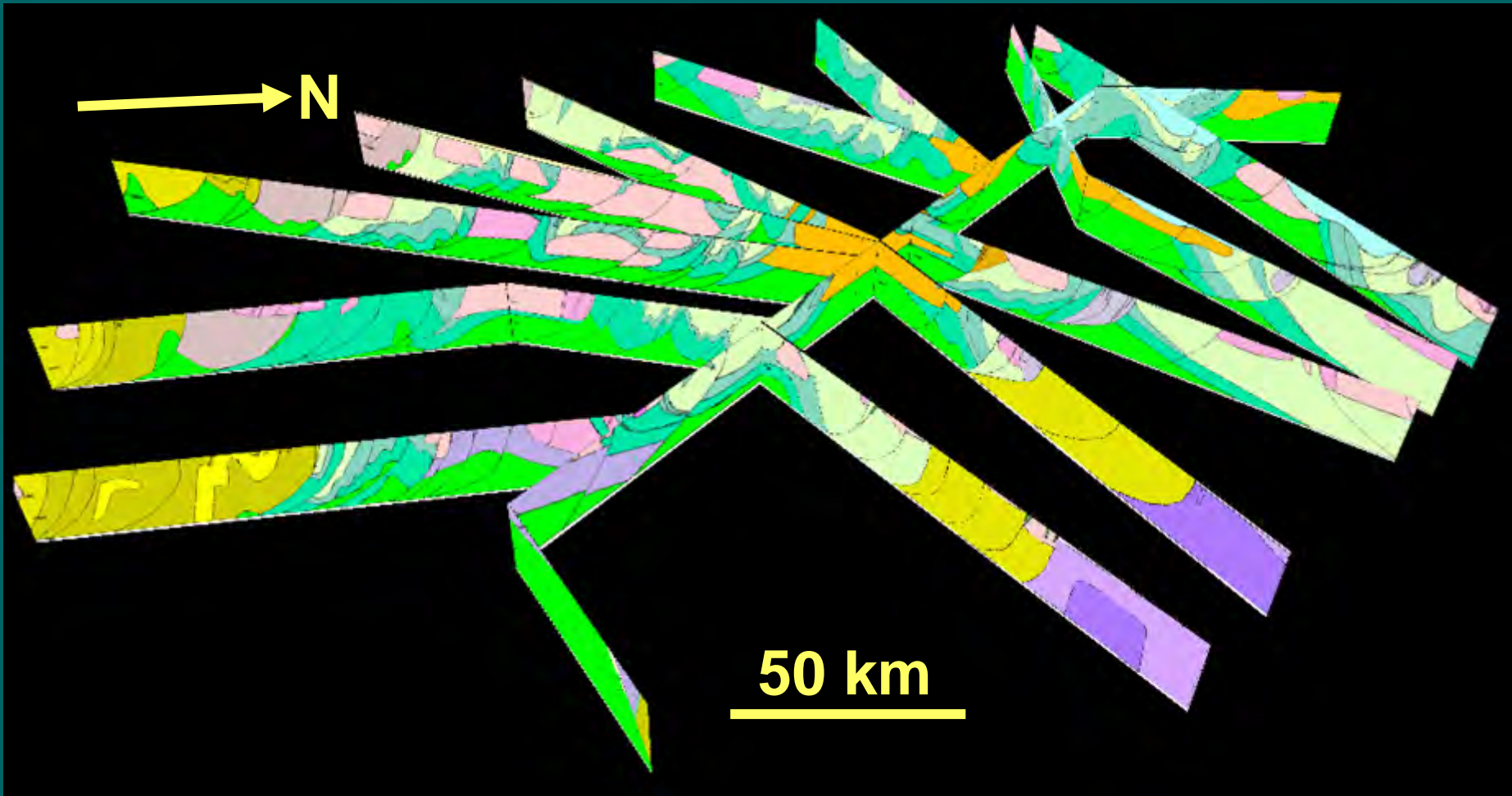
# Testing the geological sections



## Section 7



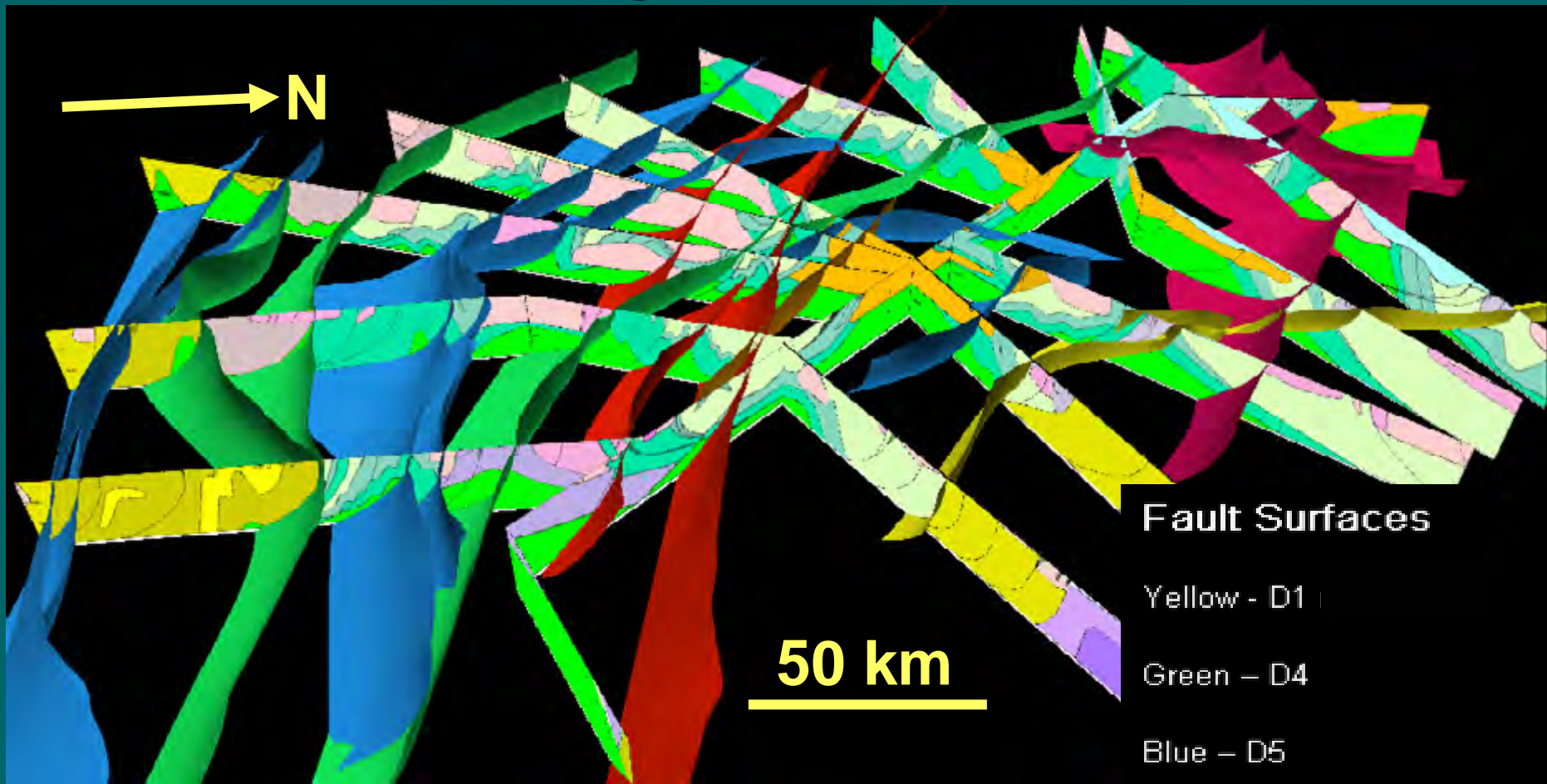
# 2D modelled sections



- Consistent with mapped geology
- Consistent with solid geology interpretations
- Consistent with magnetic and gravity data

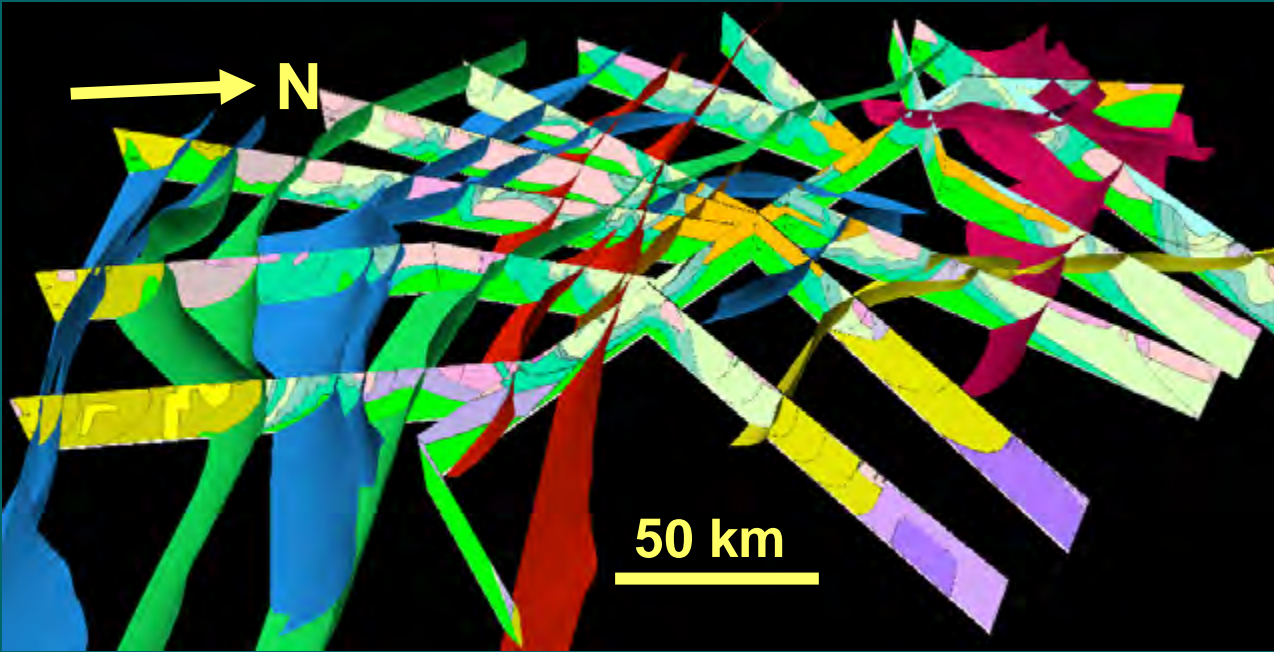


# 3D surface generation – GoCad





# Major findings derived from the modelling



- Large granite bodies (Coomarie, Frankenia and Browns Range) up to 8 km thick
- Birrindudu cover up to 5 km thick
- West of Coomarie granite stratigraphy and structures are dominantly west dipping

- East of Coomarie granite stratigraphy has easterly dips
- Main regional folds are approximately 10-25 km in wavelength
- Granite cored doubly-plunging antiformal structures occur in the south-west
- Tanami stratigraphy probably underlain by Archaean basement
- Willowra gravity ridge coincides with north dipping Archaean basement and Proterozoic basement of higher metamorphic grade – suggesting uplift of deeper crustal levels

# Web viewable – VRML

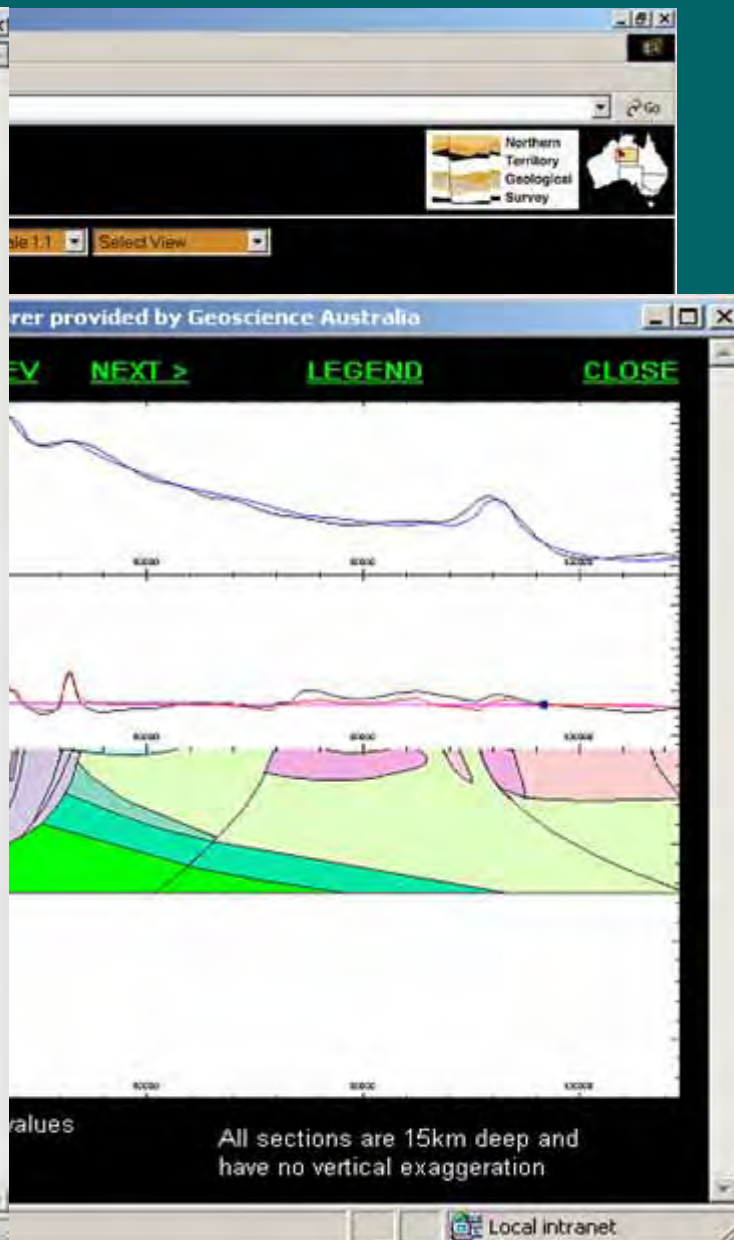
Geoscience Australia: Tanami 3D model - section legend - Microsoft Internet Explorer provided by Geoscience Australia

## Section Legend

[CLOSE](#)

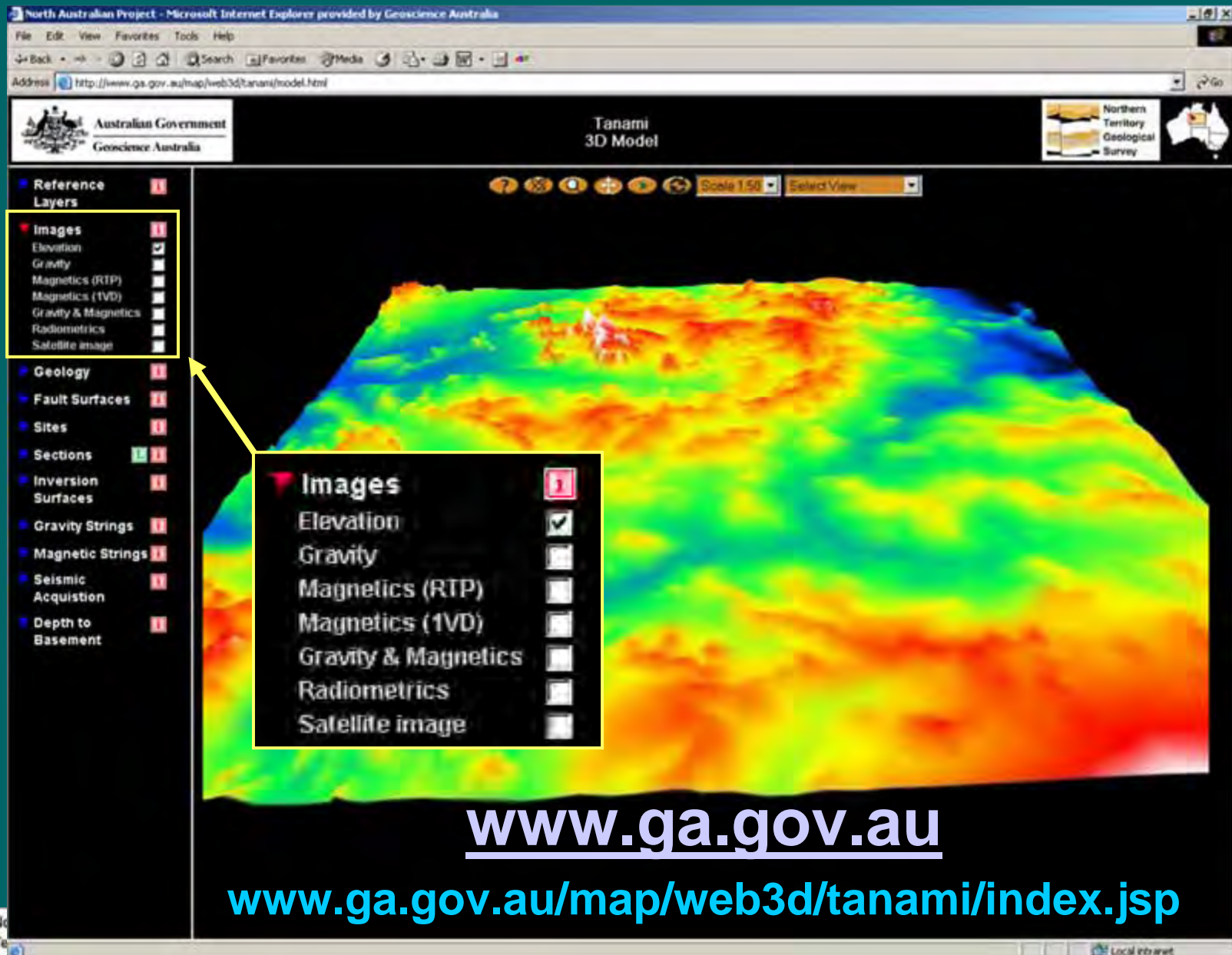
PALAEOZOIC	Lithology	Density (g/cc)	Magnetic
Wise Basin (cover)	Sandstone, siltstone	Low (2.5)	Non
<b>PROTEROZOIC</b>			
Elmudá Group (cover)	Sandstone, siltstone	Low (2.55)	Weakly
Mount Charles Formation	Basalt, sandstone, siltstone	High (2.78 - 2.87)	Moderately
Browns Range, Coomarie & Frankema Domes	Monzogranite, quartz monzogranite, granodiorite	Low (2.57)	Mostly non
Undifferentiated intrusive rocks		Low (2.58 - 2.64)	Non
Undifferentiated intrusive rocks		Low to moderate (2.62 - 2.73)	Moderately
Ware Group	Sandstone, siltstone, volcanics	Moderate to high (2.78 - 2.82)	Variably
<b>Tanami Group (tentatively time equivalent to Lander Group)</b>			
Killi killi Formation	Sandstone, siltstone	Low (2.64 - 2.69)	Non- to weakly
Dead Bullock Formation			
Metadolerite sills		High (2.9)	Highly
Callie Member	Mafic sills, siltstone, carbonaceous siltstone, chert, BIF	Moderate to high (2.67 - 2.85)	Variably weak to high
Ferdies Member	Sandstone, siltstone, numerous mafic sills	Moderate to high (2.7 - 2.84)	Variably weak to high
<b>Lander Group (tentatively time equivalent to Tanami Group)</b>			
	Migmatite, intrusive granitic dykes/sills	High (2.78 - 2.82)	Highly
	Metasediment	Low to moderate (2.64 - 2.74 g/cc)	Weakly
	Schist/gneiss, minor granite	Moderate (2.74 - 2.78)	Weakly
	Amphibolite, dolerite, mafic schist/gneiss, metasediments	Moderate (2.7 - 2.76)	Highly
	Undifferentiated	Low (2.64 - 2.67)	Non
<b>ARCHAEAN</b>			
	Undifferentiated	Felsic & mafic gneiss, granite, migmatite	High (2.8)
			Variably

Done Local intranet





# Web viewable – VRML



# Web viewable – VRML

North Australian Project - Microsoft Internet Explorer provided by Geoscience Australia

File Edit View Favorites Tools Help

Address <http://www.ga.gov.au/map/web3d/tanami/model.html>

Australian Government  
Geoscience Australia

Tanami  
3D Model

Northern Territory Geological Survey

Reference Layers  
Images  
Geology  
Outcrops  
Major faults  
Arunta  
Tanami  
West Tanami  
Regolith  
Fault Surfaces  
Sites  
Sections  
Inversion Surfaces  
Gravity Strings  
Magnetic Strings  
Seismic Acquisition  
Depth to Basement

Scale 1:50 Select View

Geology  
Outcrops  
Major faults  
Arunta  
Tanami  
West Tanami  
Regolith

[www.ga.gov.au](http://www.ga.gov.au)

[www.ga.gov.au/map/web3d/tanami/index.jsp](http://www.ga.gov.au/map/web3d/tanami/index.jsp)

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# Web viewable – VRMI

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Tanami 3D Model

- Reference Layers
- Images
- Geology
- Fault Surfaces
- Sites**
  - Deposits
  - Geochronology
- Sections
- Inversion Surfaces
  - Low Density
  - Highly Magnetic
- Gravity Strings
- Magnetic Strings
- Seismic Acquisition
- Depth to Basement

**Sites**  
Deposits  
Geochronology

Geochron Database, SHRIMP Query Results - Microsoft Internet Explorer provided by Geoscience Australia

File Edit View Favorites Tools Help

Address [http://www.ga.gov.au/map/web3d/shrimp\\_results.php?rockid=133921](http://www.ga.gov.au/map/web3d/shrimp_results.php?rockid=133921)

SHRIMP results for rock sample: 2000082026

Sample Originator	Cross, A.	State	NT
1:250K Map	HIGHLAND ROCKS	1:100K Map	HIGHLAND
Easting (m)	654188.2	Northing (m)	7673023.7
Longitude	130.483838	Latitude	21.037153
Location Accuracy	100		
Location Description			
Qualifier		Lithology	granite
Rock unit			
Informal	Fiddlers Lake Granite (south)		
Geochronologist	Cross, A.	Interp.Date	15-JUL-2002
Comment			
Age(ma)	1731	Error	4
MSWD	37	No. analyses	29
Events		Event Classification	
emplacement		geological inference	
<a href="#">Concordia Diagram (Java Required)</a>			
Error			
MSWD		No. analyses	37
Events		Event Classification	
inherited individuals		geological inference	
<a href="#">Concordia Diagram (Java Required)</a>			
Error			
MSWD		No. analyses	24
Events		Event Classification	
Pb loss		isotopic interpretation	
Pb loss		geological inference	
<a href="#">Concordia Diagram (Java Required)</a>			

Age: 1731 Ma / Lithology: granite / SampleID: 2000082026 / Click for more information

[www.ga.gov.au](http://www.ga.gov.au)

[www.ga.gov.au/map/web3d/tanami/index.jsp](http://www.ga.gov.au/map/web3d/tanami/index.jsp)

# Web viewable – VRML

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Address <http://www.ga.gov.au/map/web3d/tanami/model.html>

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Reference Layers  
Images  
Geology  
Fault Surfaces  
Sites  
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Geochronology  
Sections  
Inversion Surfaces  
Low Density  
Highly Magnetic  
Gravity Strings  
Magnetic Strings  
Seismic Acquisition  
Depth to Basement

Geoscience Australia: Tanami 3D model - information - Microsoft Internet Explorer provided by Geoscience Australia

## Inversion Surfaces

[Help](#) [Reference layers](#) [Geology](#) [Sites](#) [Inversion surfaces](#) [Seismic](#)  
[Coordinates](#) [Images](#) [Faults](#) [Sections](#) [Strings](#) [Depth to basement](#)

### 3D inversion surfaces

The low density (red) and highly magnetic (green) inversion surfaces were generated using recently developed 3D inversion modelling software. This software, which utilises gravity and magnetic data, was developed by the University of British Columbia - Geophysical Inversion Facility (Li & Oldenburg, 1996; 1998) and is an advance over the more traditional 2D forward modelling method, allowing the generation of full 3D models in an automated environment.

This study is the first application of 3D inversion modelling to the central Australian region (Meixner & Lane, 2005). 3D inversion is a means of transforming observed gravity or magnetic data into a 3D model, populated by a mesh of cells consisting of density or magnetic susceptibility values. The process is iterative, whereby adjustments are made to a starting model in order to minimise the misfit between the observed and the computed data. The final models, containing the density and magnetic susceptibility values, reproduce the observed gravity or magnetic field to within a small degree of error.

3D inversion surfaces were generated to enclose regions within the models of anomalous physical property values. The red surfaces enclose regions of low density within the gravity model of less than 2.655 g/cm<sup>3</sup>, or 0.015 g/cm<sup>3</sup> below the mean density for the model of 2.67 g/cm<sup>3</sup>. These surfaces correspond mostly to mapped and interpreted granites and are interpreted to simulate the 3D distributions of the granites. The green surfaces enclose regions of high magnetic susceptibilities within the magnetic inversion model with susceptibility values of greater than 0.01 SI. These surfaces correspond mostly to the magnetic stratigraphy (BIFs and mafic units) within the Tanami group sediments and are also interpreted to simulate the 3D distribution of these units. The inversion models, therefore, may be used as a regional-scale guide for determining where the magnetic units, which are considered to be potential traps for gold mineralisation, may appear at depth, as well as where these units might occur close to the surface, beneath younger cover.

#### References

Li, Y. & Oldenburg, D.W., 1996. 3-D inversion of magnetic data. *Geophysics*, VOL 61(2), 394-408.

Li, Y. & Oldenburg, D.W., 1998. 3-D inversion of gravity data. *Geophysics*, VOL 63(1), 109-119.

Meixner, A.J. & Lane, R., 2005. 3D inversion of gravity and magnetic data for the Tanami Region. Annual Geoscience Exploration Seminar (AGES) 2005. Record of Abstracts. Northern Territory Geological Survey. Record 2005-001.

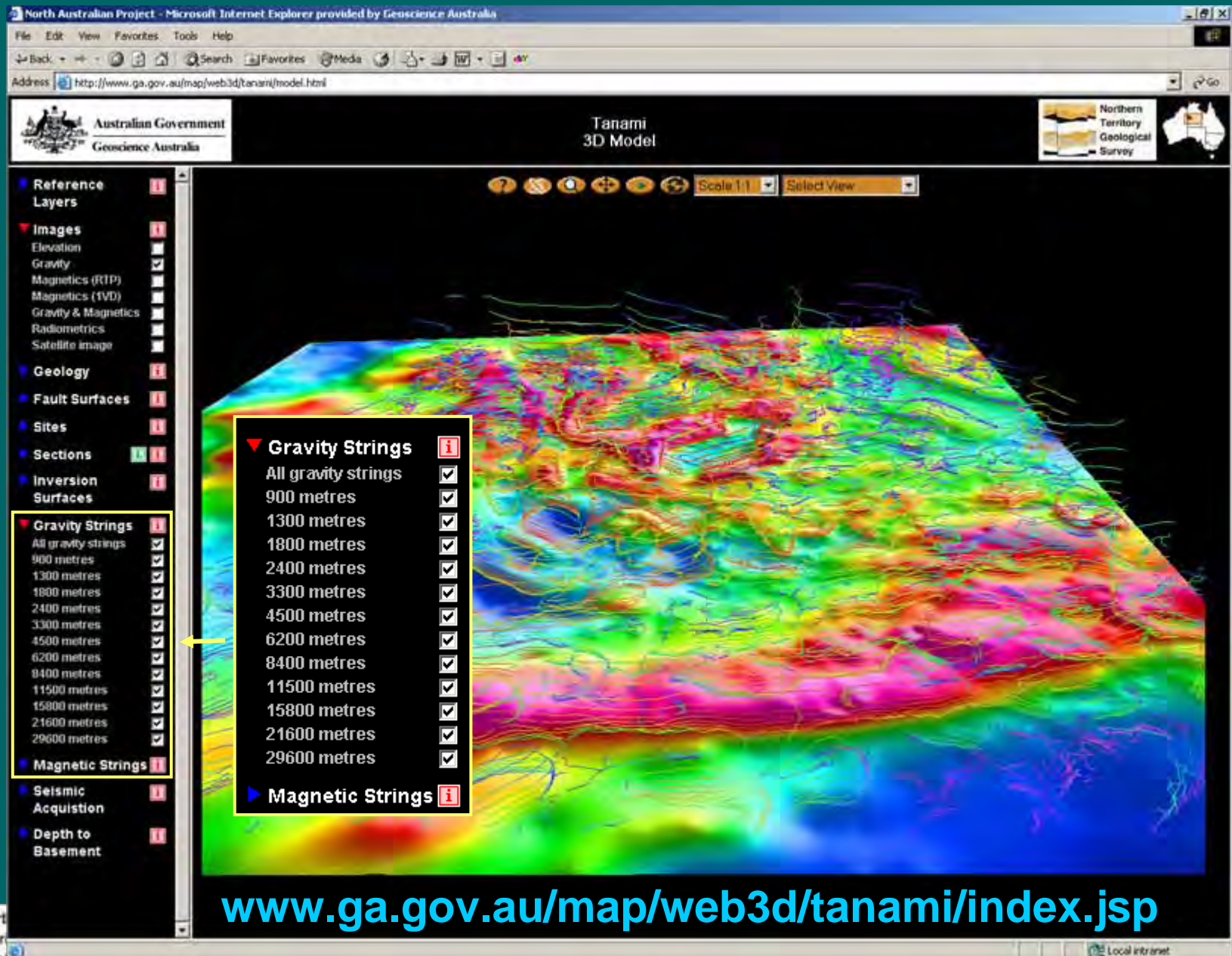
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[www.ga.gov.au/map/web3d/tanami/index.jsp](http://www.ga.gov.au/map/web3d/tanami/index.jsp)

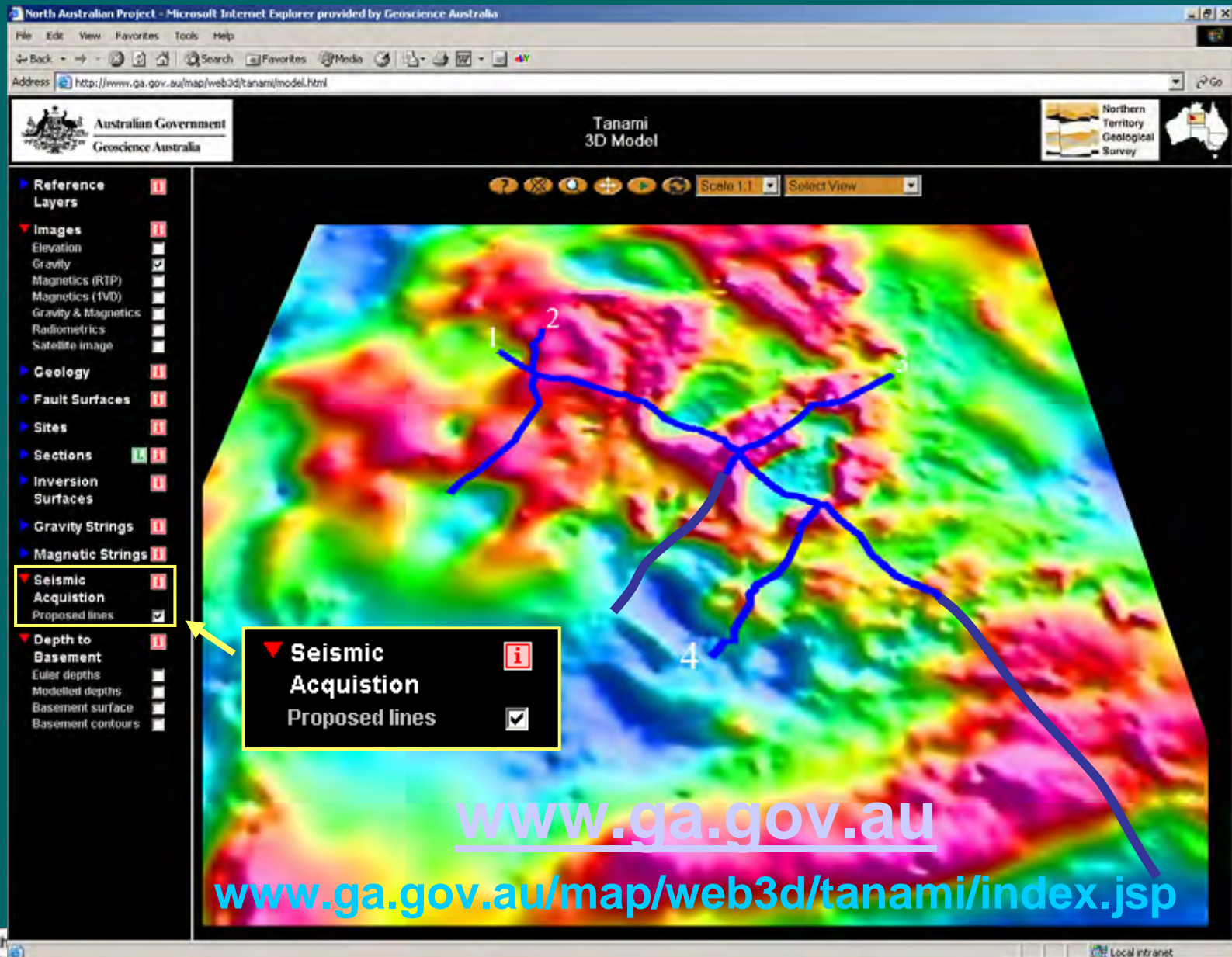
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# Web viewable – VRML



# Web viewable – VRML





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Tanami  
3D Model

Northern Territory Geological Survey

Reference Layers

Images

- Elevation
- Gravity
- Magnetics (RTP)
- Magnetics (TVD)
- Gravity & Magnetics
- Radiometrics
- Satellite image

Geology

Fault Surfaces

Sites

Sections

Inversion Surfaces

Gravity Strings

Magnetic Strings

Seismic Acquisition

Depth to Basement

- Euler depths
- Modelled depths
- Basement surface
- Basement contours

Scale 1:5 Select View

[www.ga.gov.au](http://www.ga.gov.au)

[www.ga.gov.au/map/web3d/tanami/index.jsp](http://www.ga.gov.au/map/web3d/tanami/index.jsp)

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# Future directions

- **Incorporate the results of the Tanami seismic survey**
  - relocate a number of sections to match the seismic lines
  - remodelling, where necessary, the 2D sections
- **Use the modified sections as the constraints to build a new 3D model using GeoModeller**

Constructs 3D surfaces from geological information as opposed to GoCad which is a 3D drafting package

- Define geological pile (conformable, onlap or erosional contacts)
- Define structural events and their relationships to each other and the geological pile
- Input geological information (contacts between units and dip information) from geological maps and 2D sections

## Advantages

- 3D surface generation takes little time
- The model is easily modified by changing the input geology

**New version out early 2007**





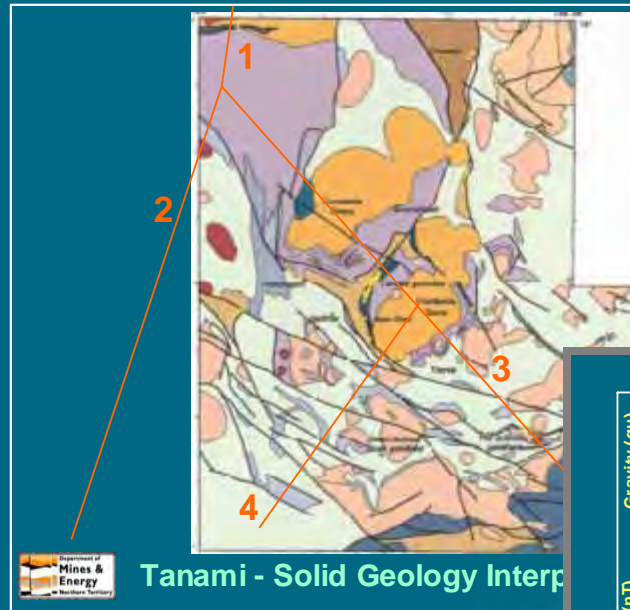
# Potential Field Modelling of Proposed Land Seismic Transects in the NT

# AGES 2002

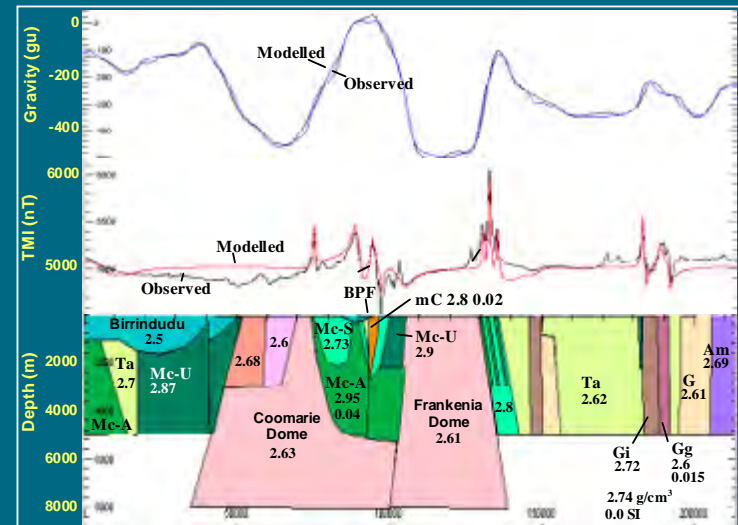
(Australian Geoscience Exploration Seminar)

Tony Meixner, David Maidment, Jim Jackson

Geoscience Australia  
www.ga.gov.au



Tanami - Solid Geology Interpretation

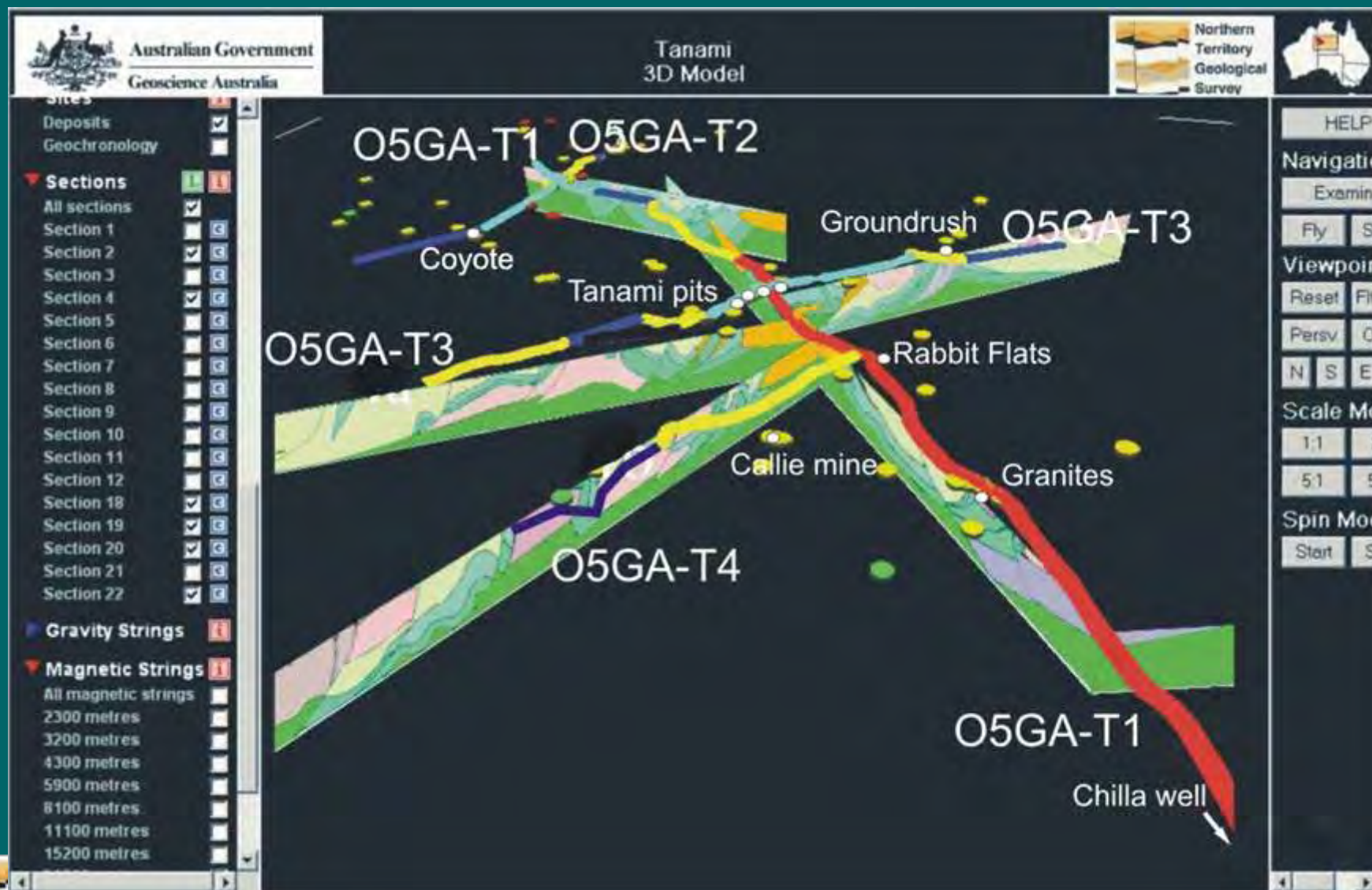


Tanami - Section 3



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# Tanami Seismic Reflection Proposal 2004/05

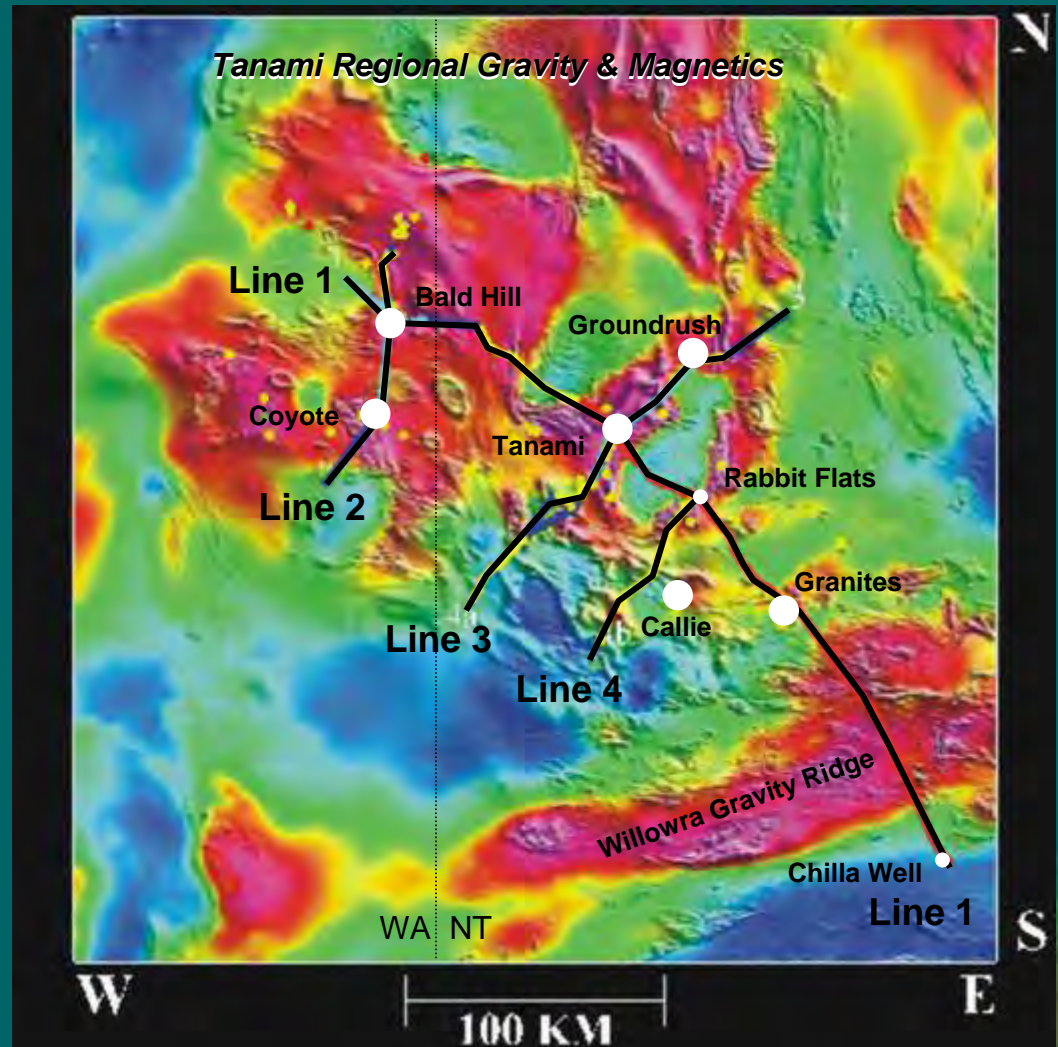




# Location of Seismic Lines

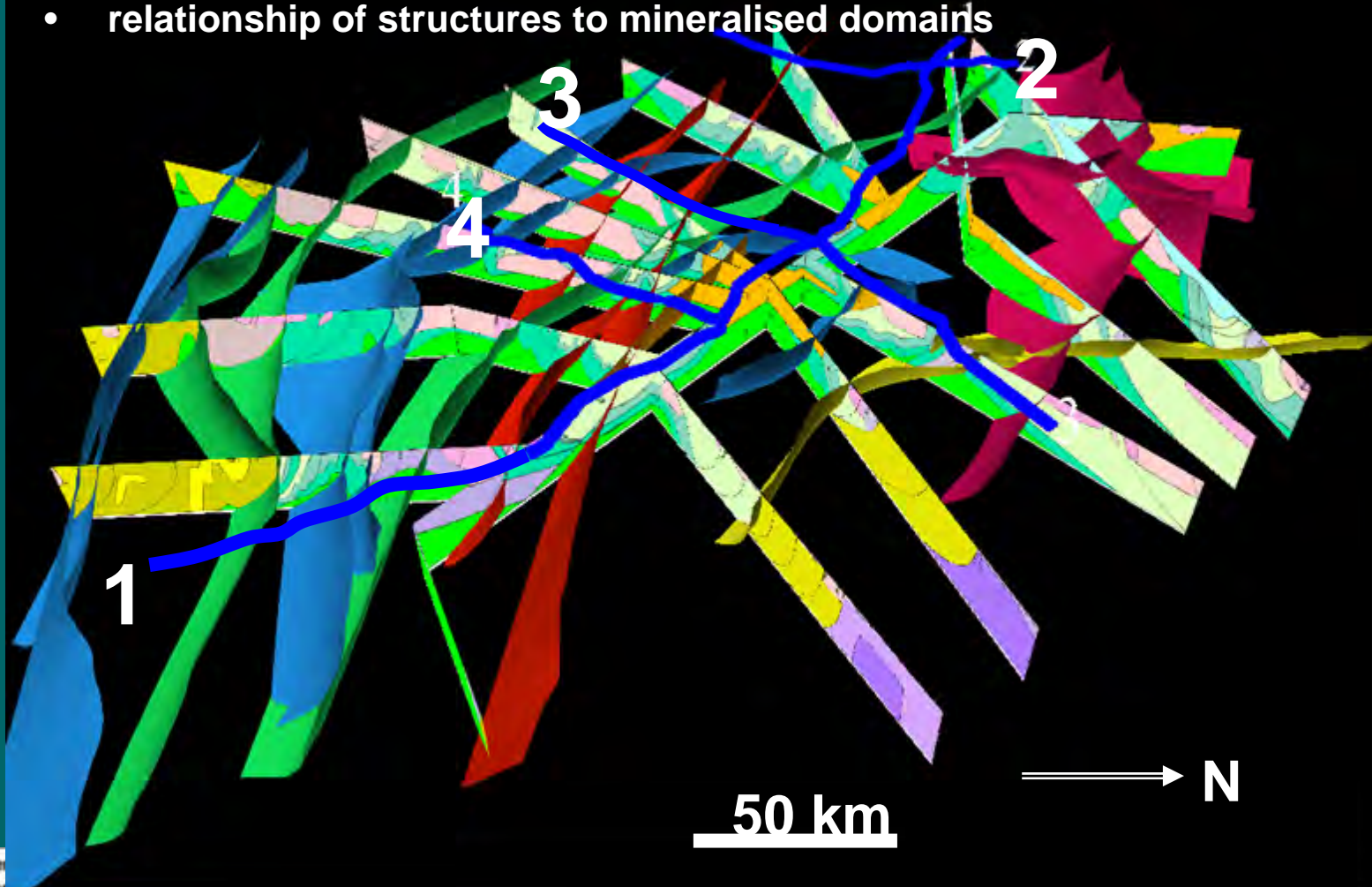


720 line km of seismic reflection data



# Structural & stratigraphic architecture

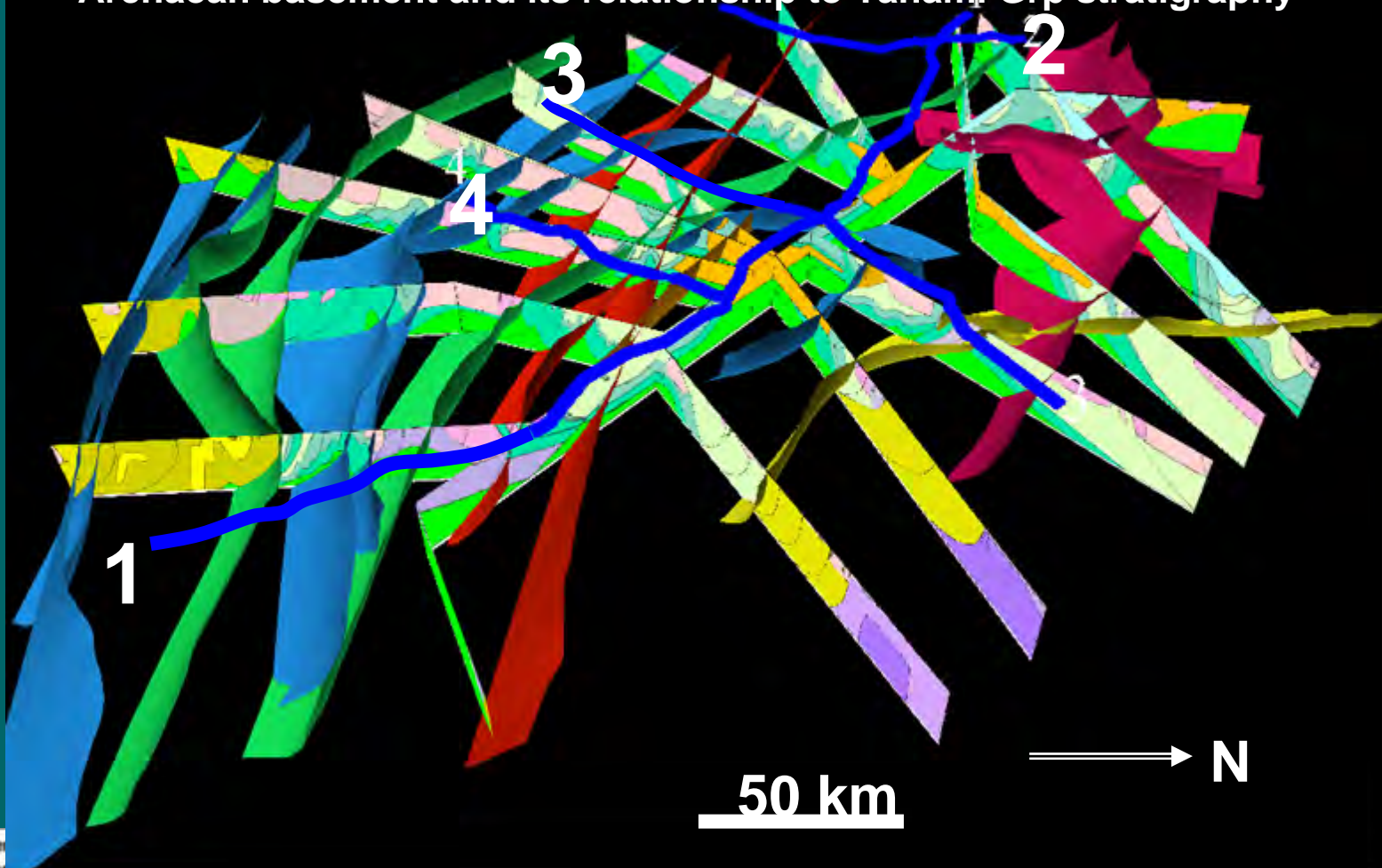
- the geometry and scale of the main faults & other features
- a deformation sequence for these features
- relationship of structures to mineralised domains



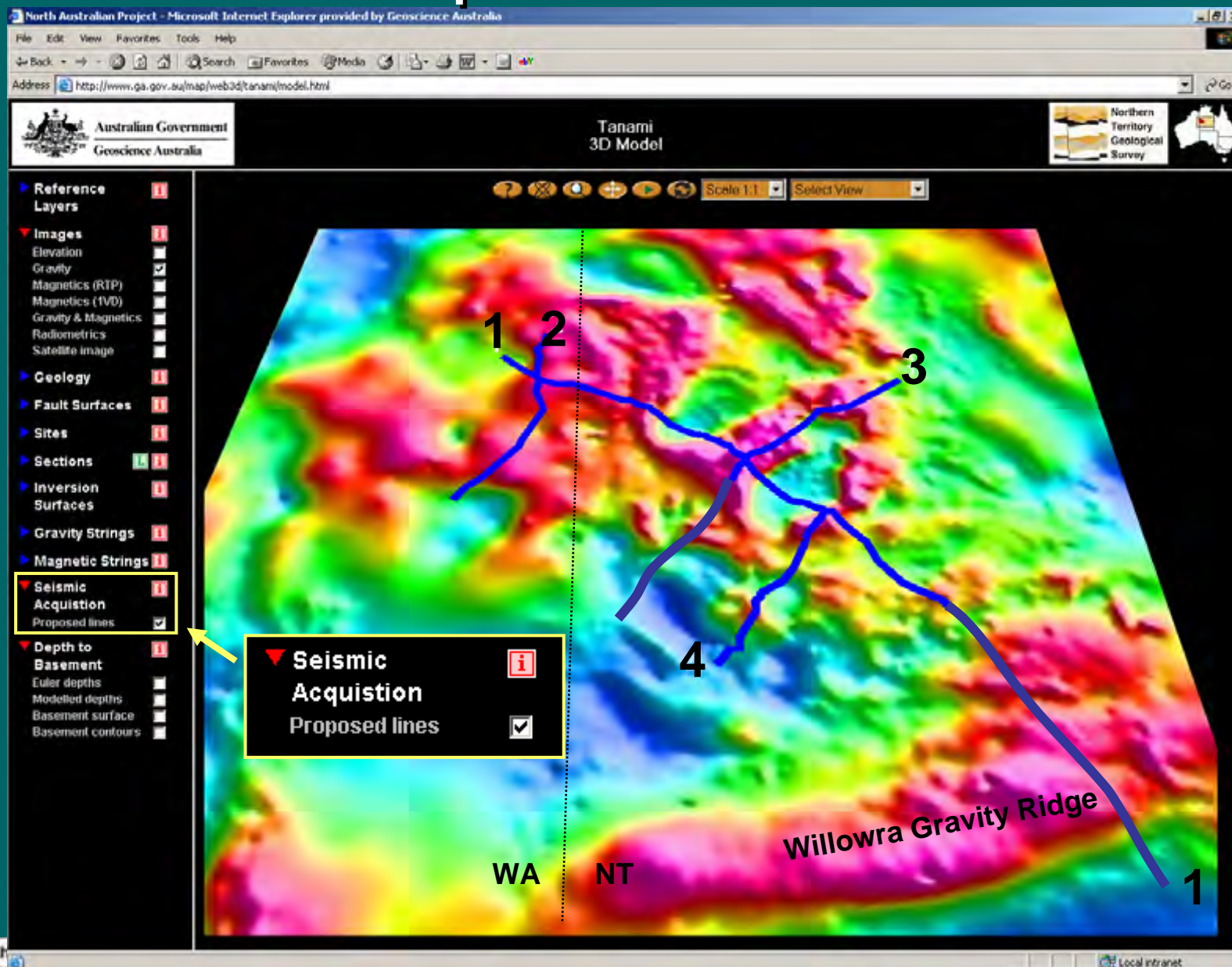


# Structural & stratigraphic architecture

- thicknesses of the stratigraphic packages, sequence stratigraphy
- relationships btw stratigraphic packages to controlling structures
- Archaean basement and its relationship to Tanami Grp stratigraphy

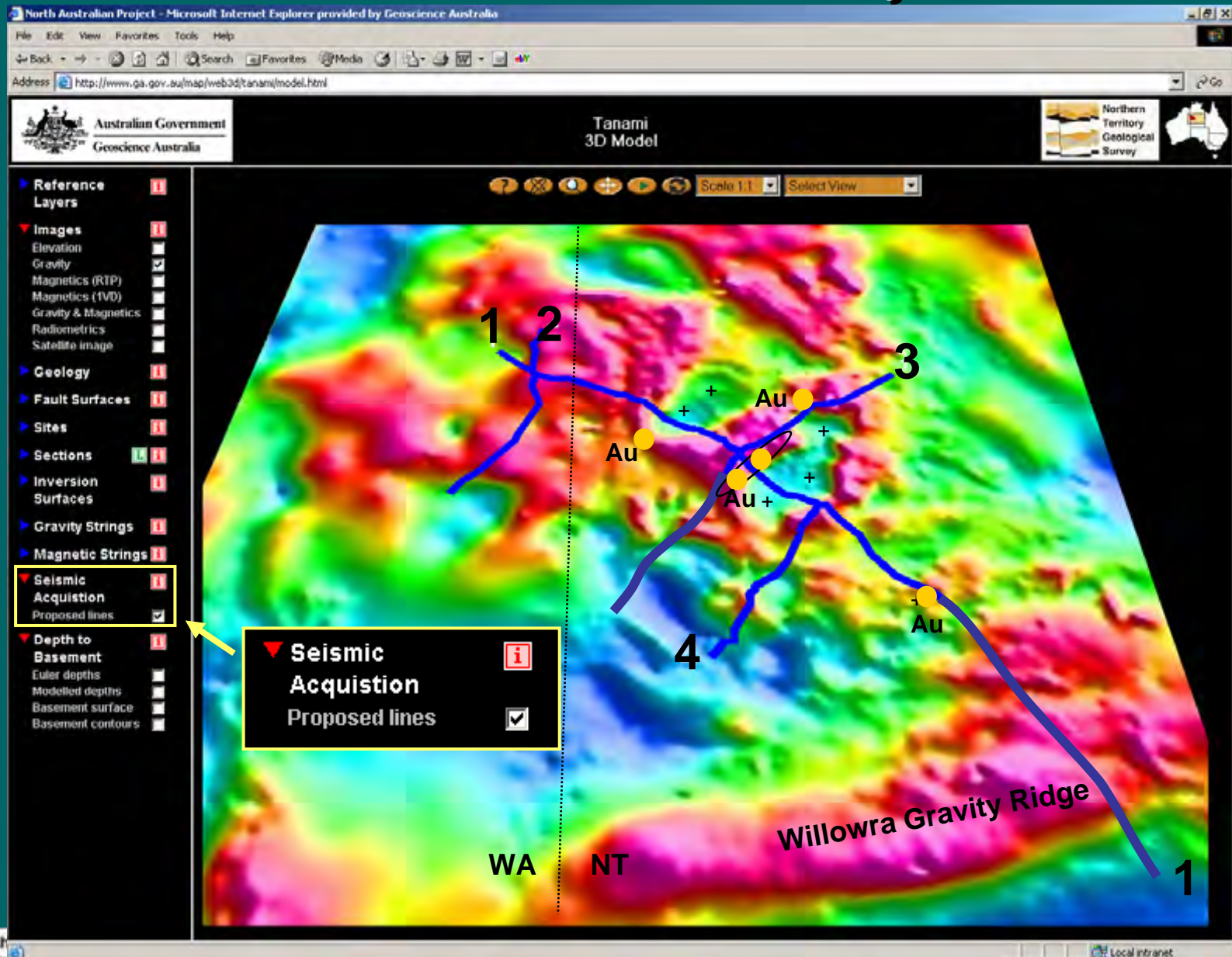


# Deep Crustal Features

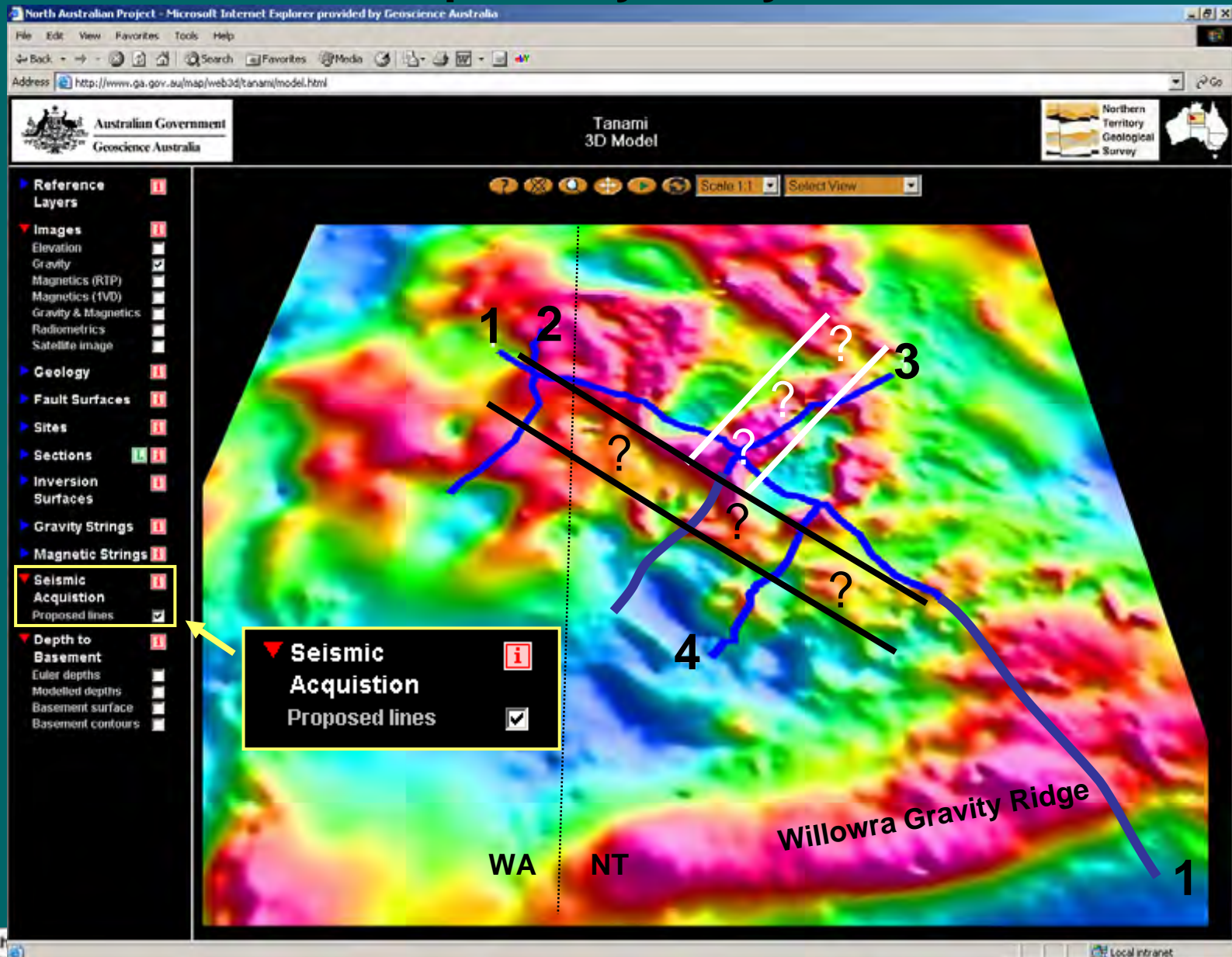




# Pluton related mineralised systems

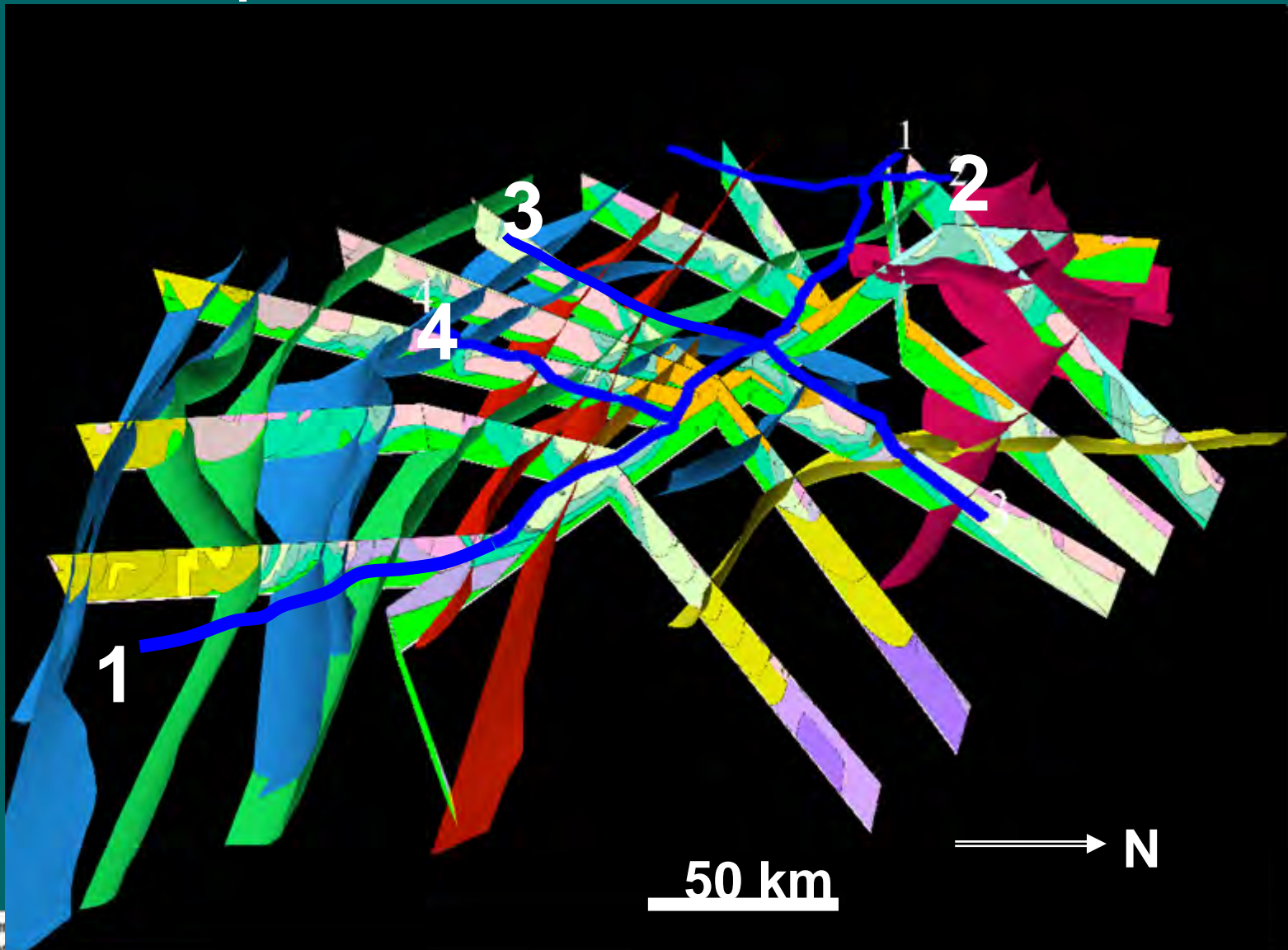


# Fluid pathways & systems





# Leading to..... predictive mineralisation models



## In General....

- Broad correlation between the geological relationships in the current seismic interpretations to those modelled in the Tanami 3D web-model, with improvement to the 3D web-model following incorporation of the new seismic data
- Predictive capability- anticipated significant impact on current and future exploration strategies in the Tanami Region



# Websites



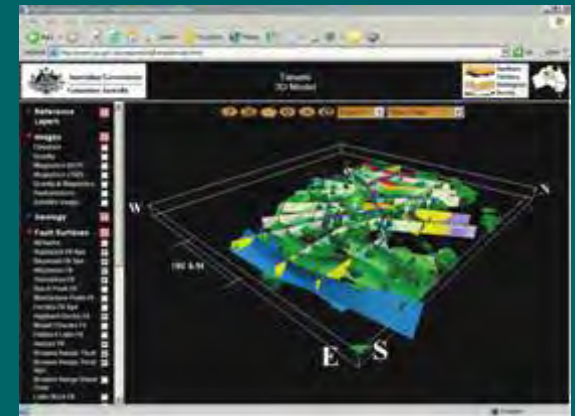
•GA website  
<http://www.ga.gov.au/>



•NTGS website  
<http://www.minerals.nt.gov.au/ntgs/>



•GSA website  
<http://www.doir.wa.gov.au/gswa>



•GA website  
<http://www.ga.gov.au/map/web3d>



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