A multi-disciplinary approach to predicting the mineral potential of major fault systems

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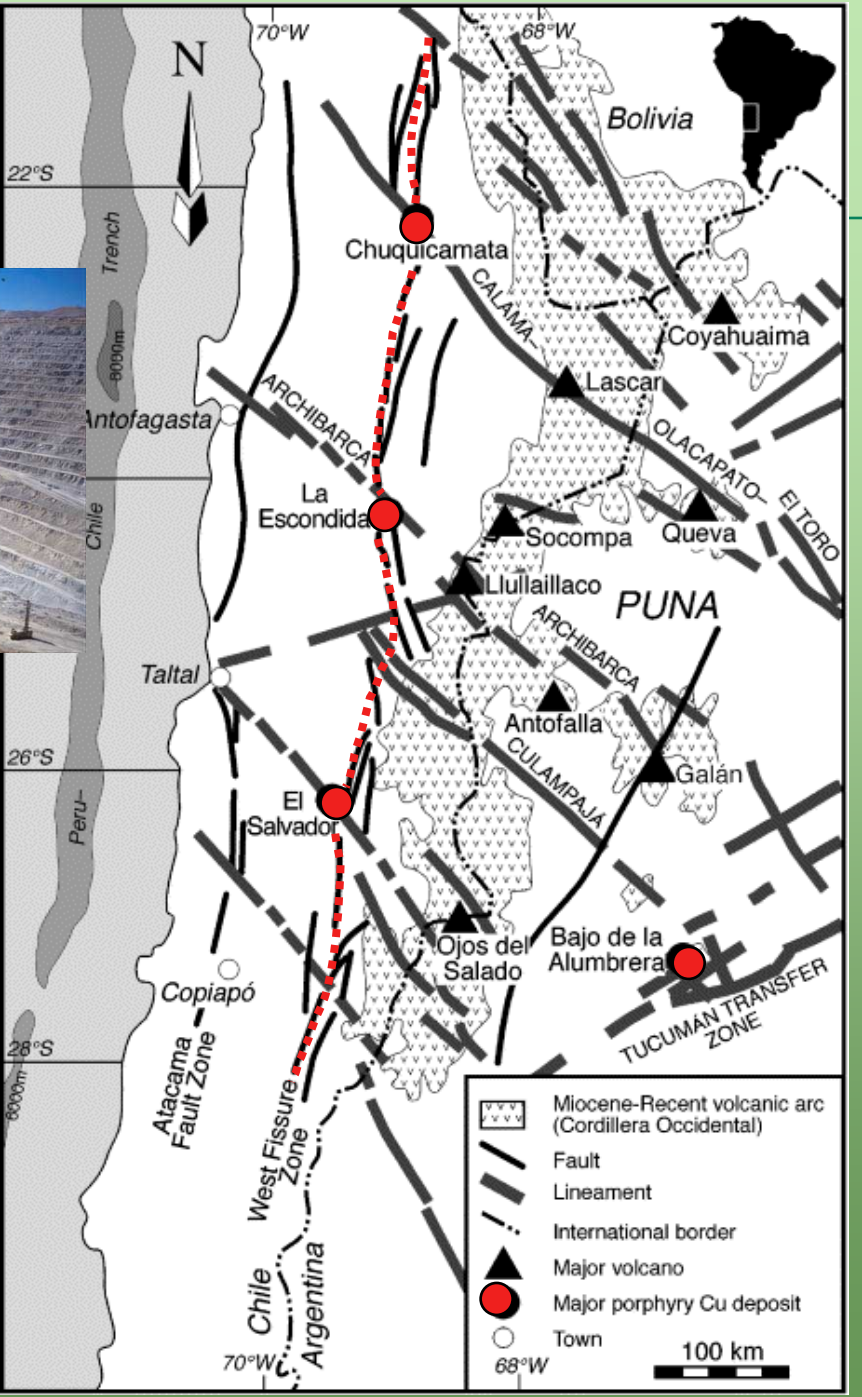
Mineralisation = Faults

Capacity to focus fluid/melt flux

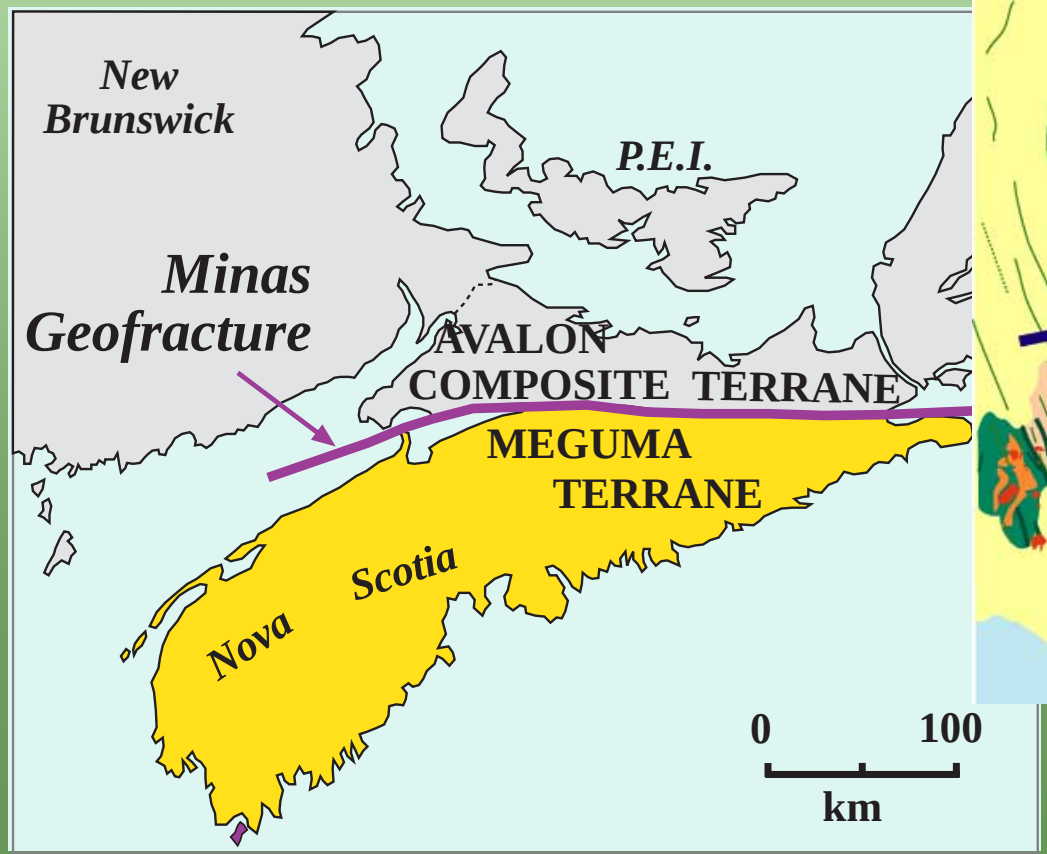
(Long-lived) columns of low-strength/high-permeability

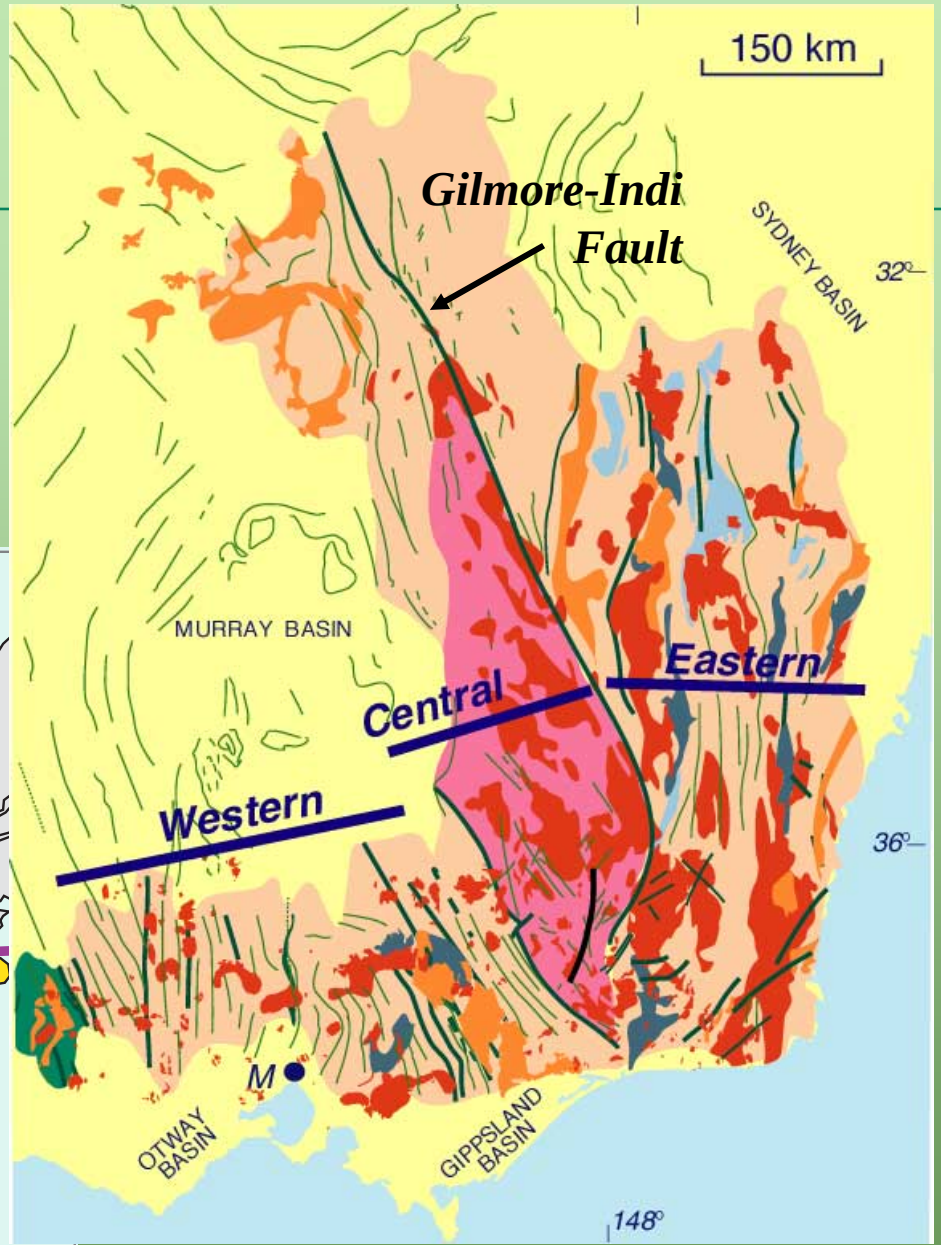
from Chernicoff et al. (2002)



Yet….

Faults ≠ Mineralisation!





What if…

…. we could predict *which* faults are mineralised?

significant aid to *predictive* mineral exploration

drill here!

What we know (or think we know) - potentially critical factors:*

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Long-lived, complex damage zones (kinematic evolution); degree of non-linearity & gradients

Rheological contrast; strain partitioning

Steeply-dipping orientation at shallow levels

Proximity to (ancient) plate margins, sutures

Presence of mafic - intermediate igneous rocks

Extensive alteration

Length, relay zones, displacement

**** empirical/untested***

A coherent concept using a multi-disciplinary approach:

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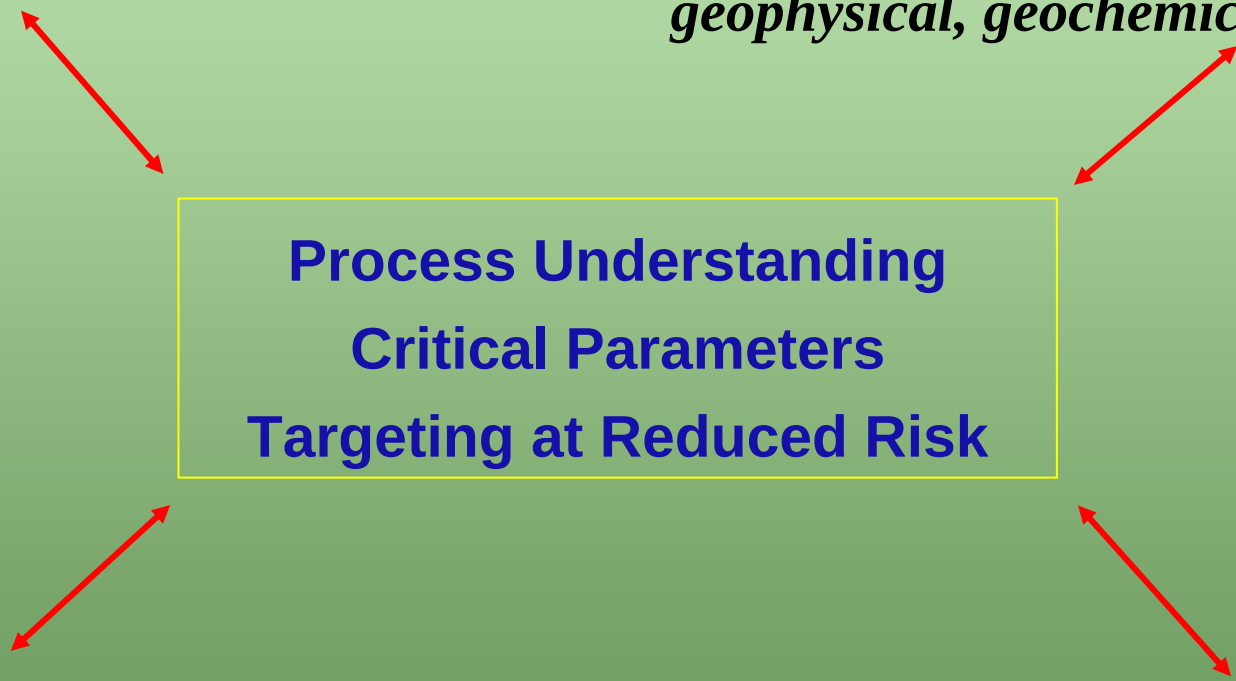
Tectonic Targets Database

Targeting Tools
geophysical, geochemical, isotopes



Key Area Studies
(input; validation)

Numerical Modelling
fractals; habitat

Data base illustrating commonalities between structures that host major ore deposits

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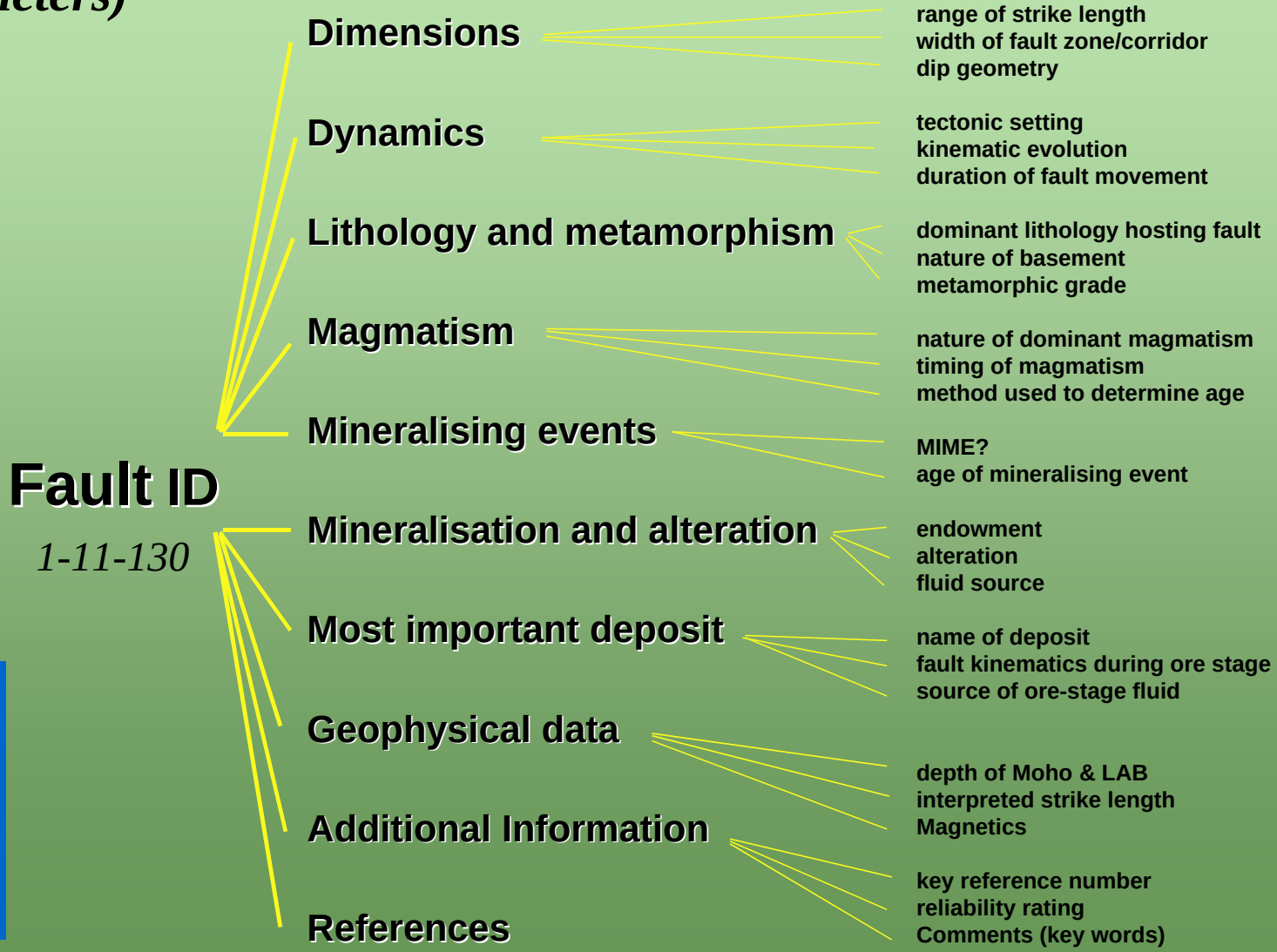
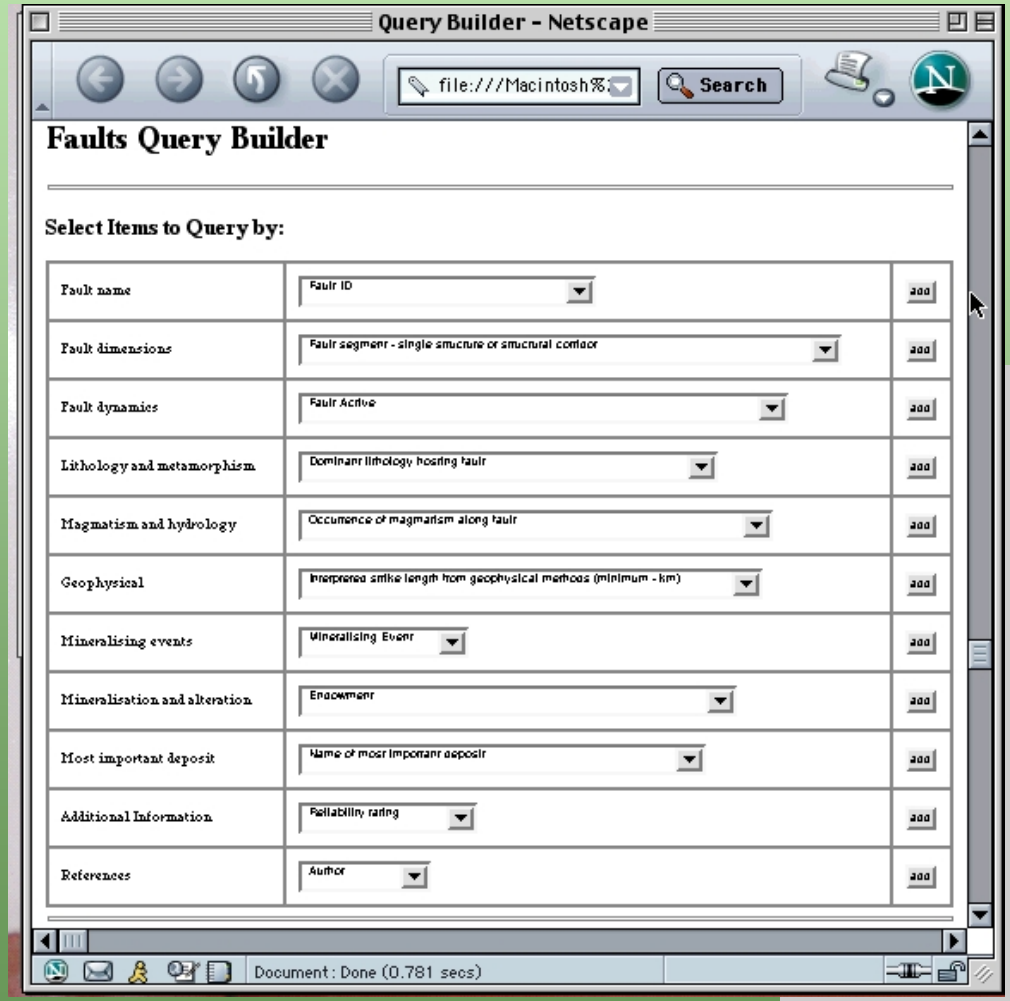
(critical parameters)



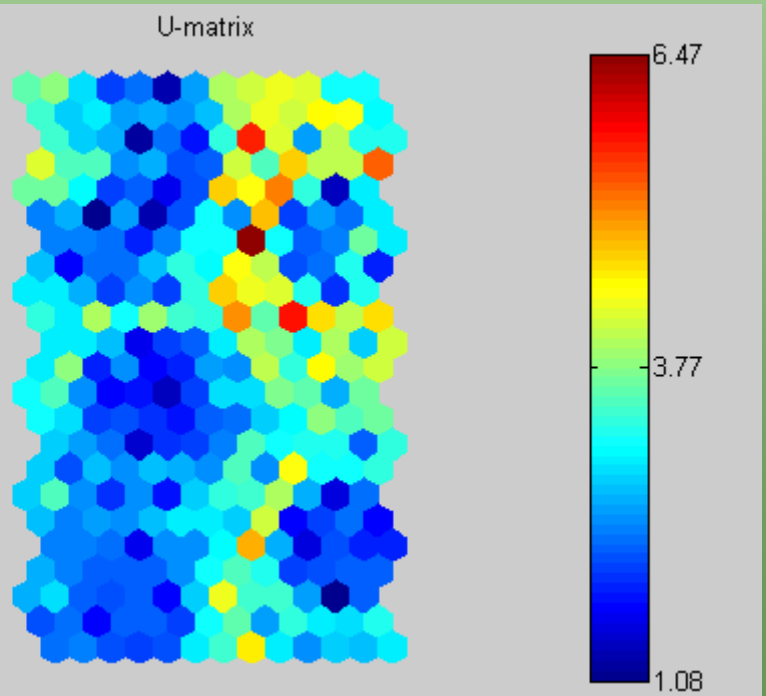
- Global
- Independent of commodity or time

Fault ID	Fault or Segment of Fault being documented	Fault segment - single structure or structural corridor	Single fault segments distinguished by	Linkage of single fault segments/relationship between structural elements within corridor	Range of strike length (minimum - km)	Range of strike length (maximum - km)	Width of corridor/ fault zone (minimum - km)	Width of corridor/ fault zone (maximum - km)	Dip geometry of fault
1	Turkestan Suture	single	offset by fault	discontinuous	1000		2	6	listric
2	Atbashi-Inylchek Suture	single	offset by fault	discontinuous	1000				
3	Talas-Ferghana Fault	single	not applicable	continuous	800	900			
4	Atacama Fault Zone	corridor	change in strike	continuous	200	500			
5	Sumatra Fault	corridor	jog separation	discontinuous	50	200	1	20	planar
6	New Guinea Suture	corridor	not applicable	continuous	1000				
7	Gowk Fault	single	not applicable	continuous	100	200	2	4	planar
8	Carlin Trend	corridor	not applicable	discontinuous	50	100	8	10	planar



work in progress…

(portable, searchable, expandable)

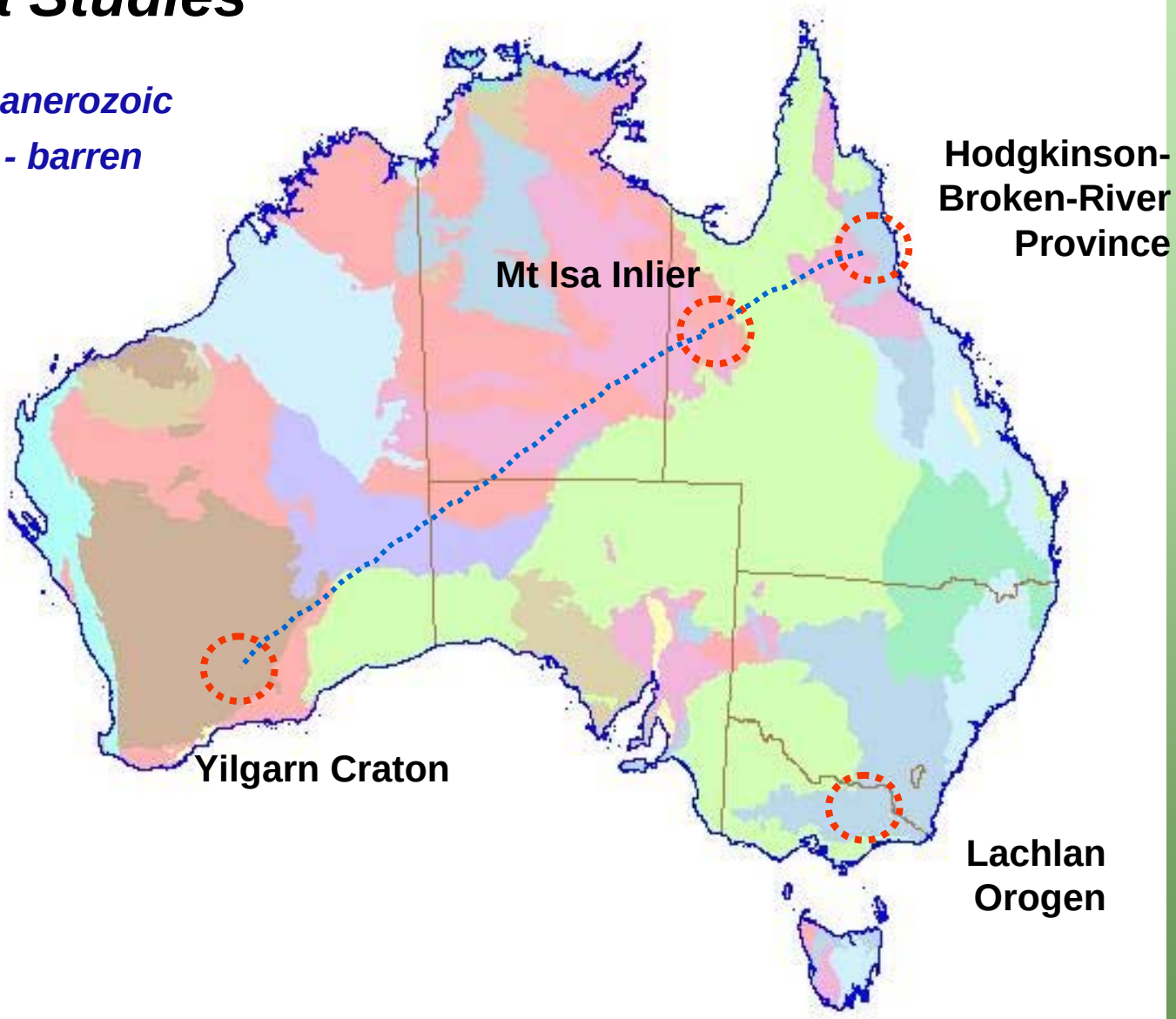


GEOSCIENCE AUSTRALIA

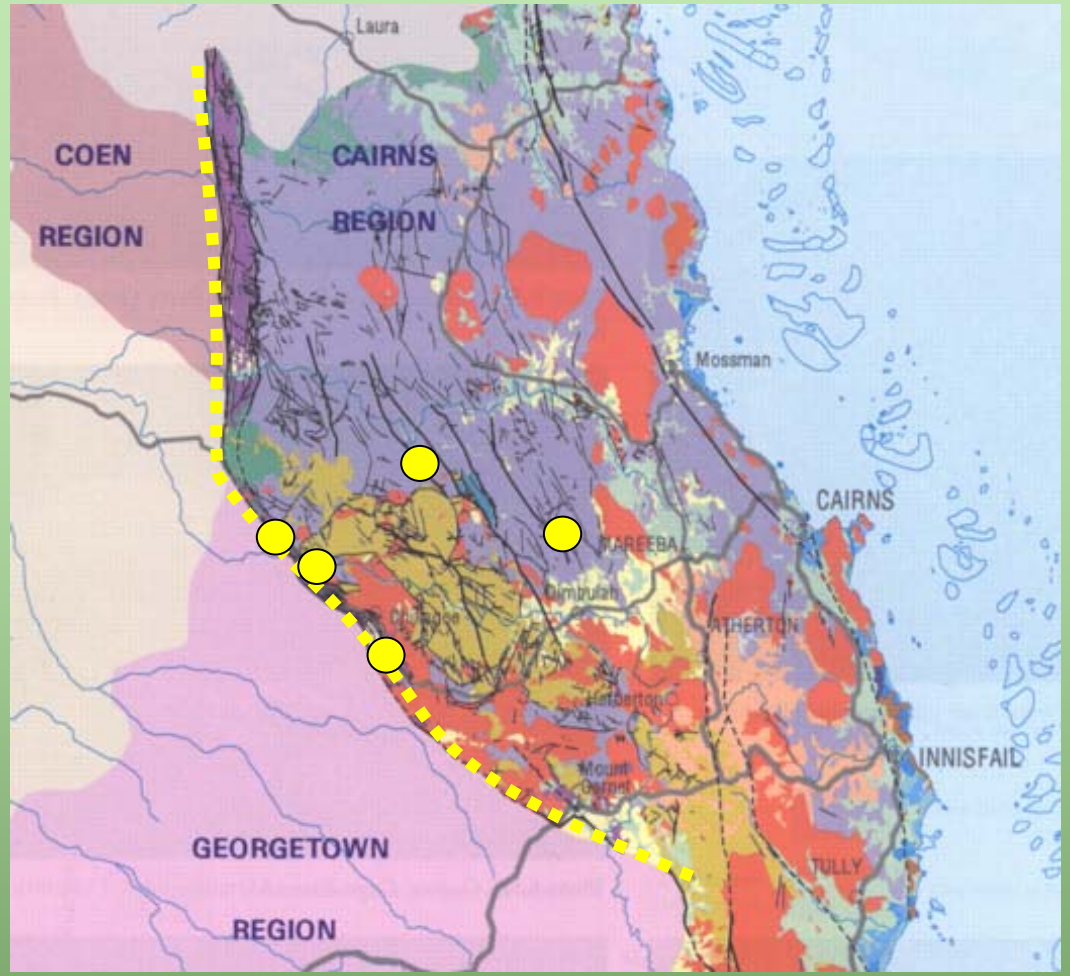
Key Area Studies

Archaean - Phanerozoic

well-endowed - barren



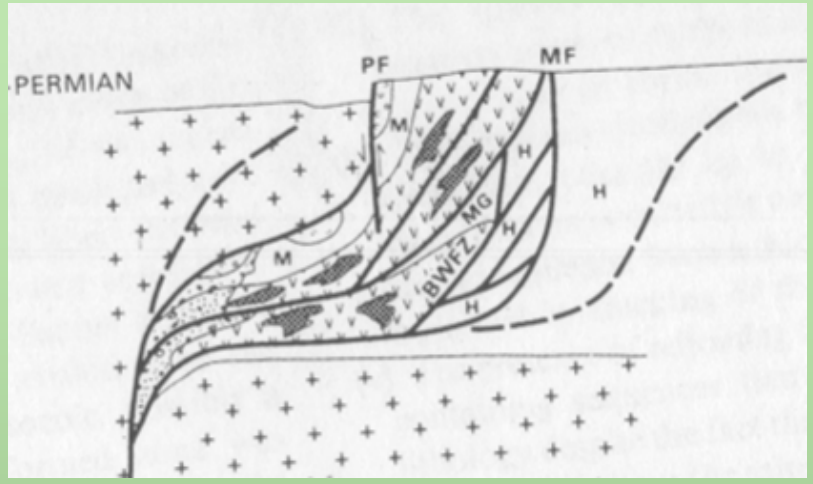
Tectonic evolution and mineral potential of the Palmerville Fault:



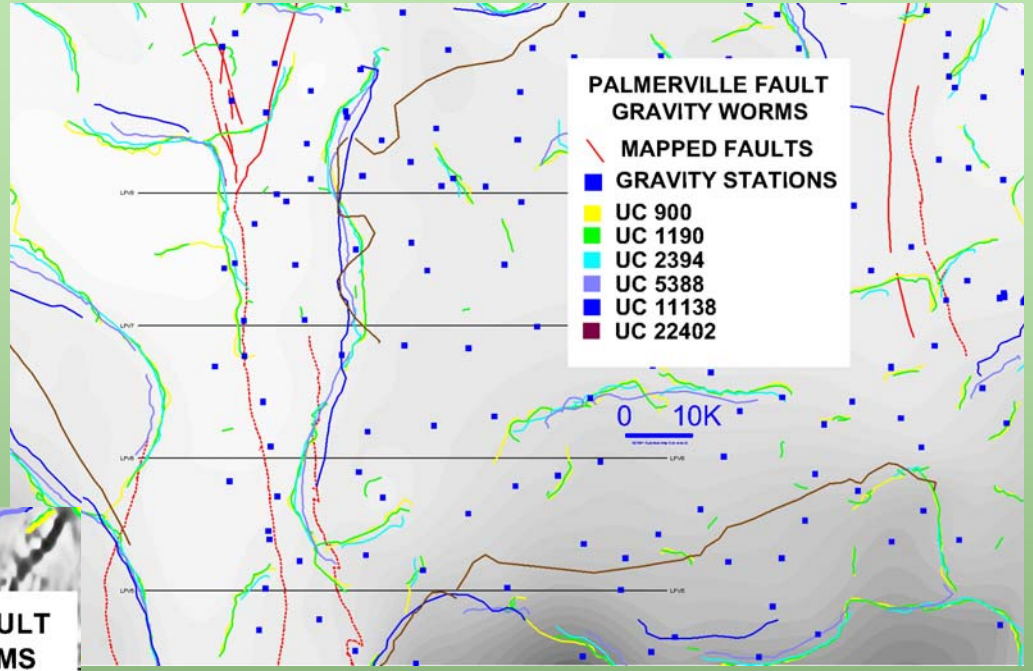
1st-order terrane-bounding fault *(LDD terrain)*

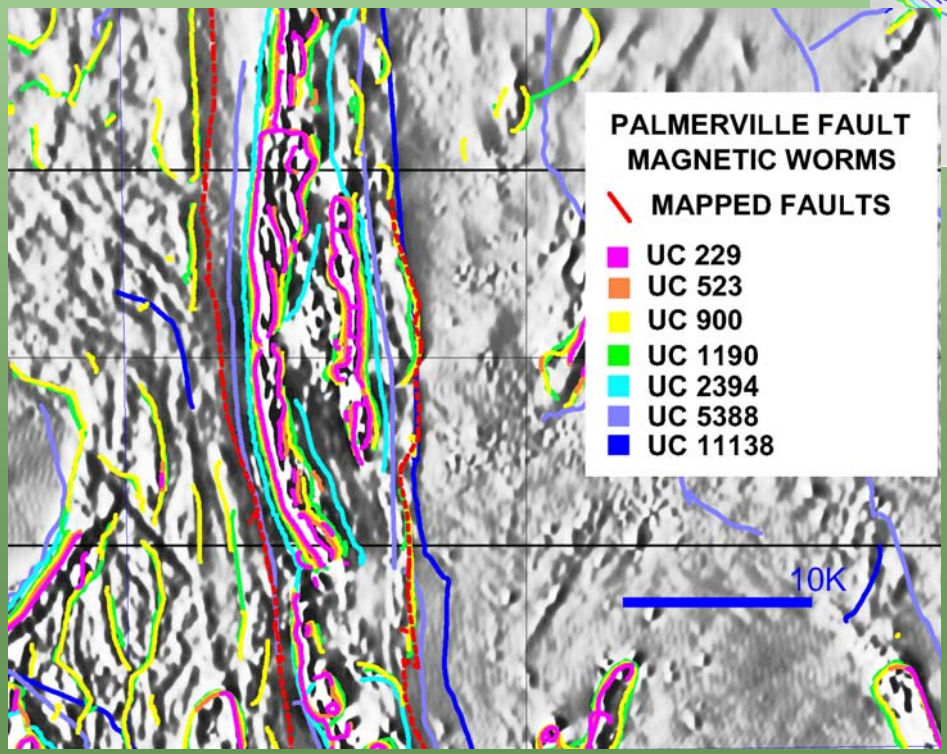
Dip angle & depth extent poorly constrained

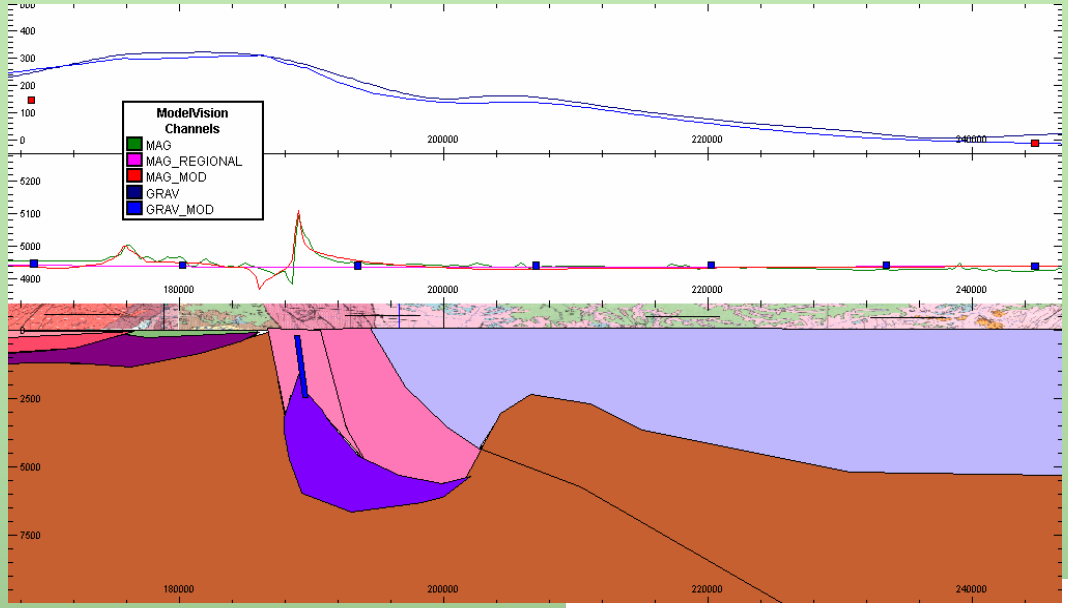
Some orogenic gold in NW-SE portion; N-S portion poorly endowed (*critical parameters*)?



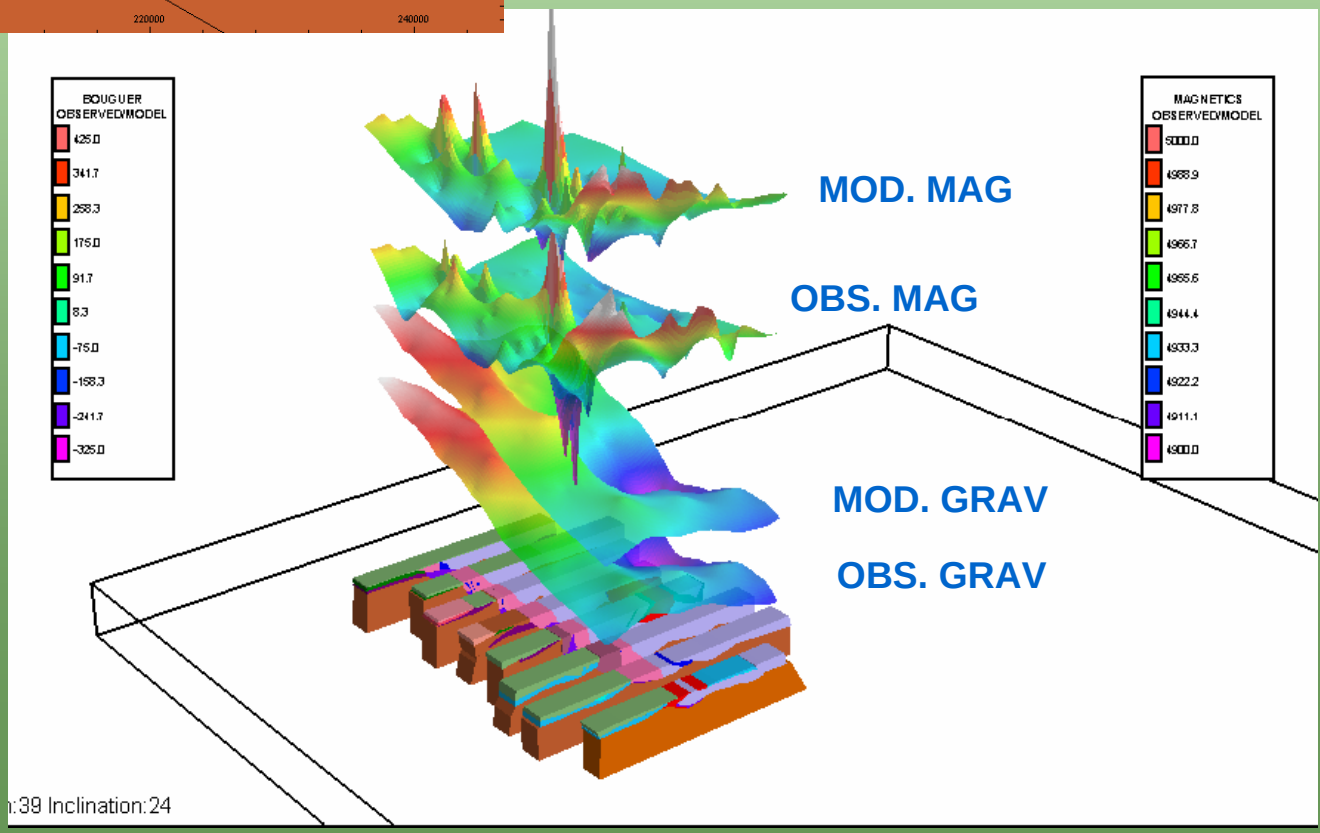
from Shaw et al. (1997)

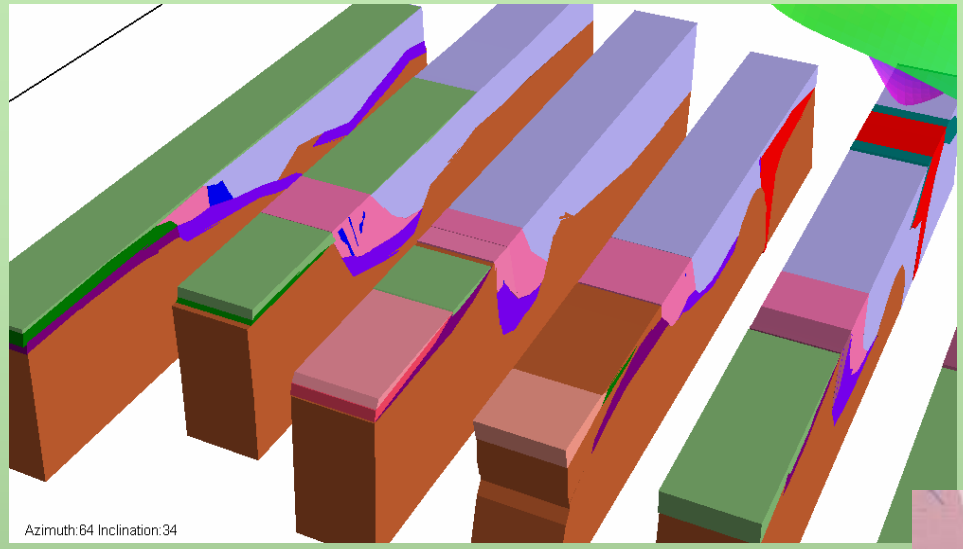






- **normal listric movement across Proterozoic basement;**
- **subsequent east-west compression with reverse thrusting**

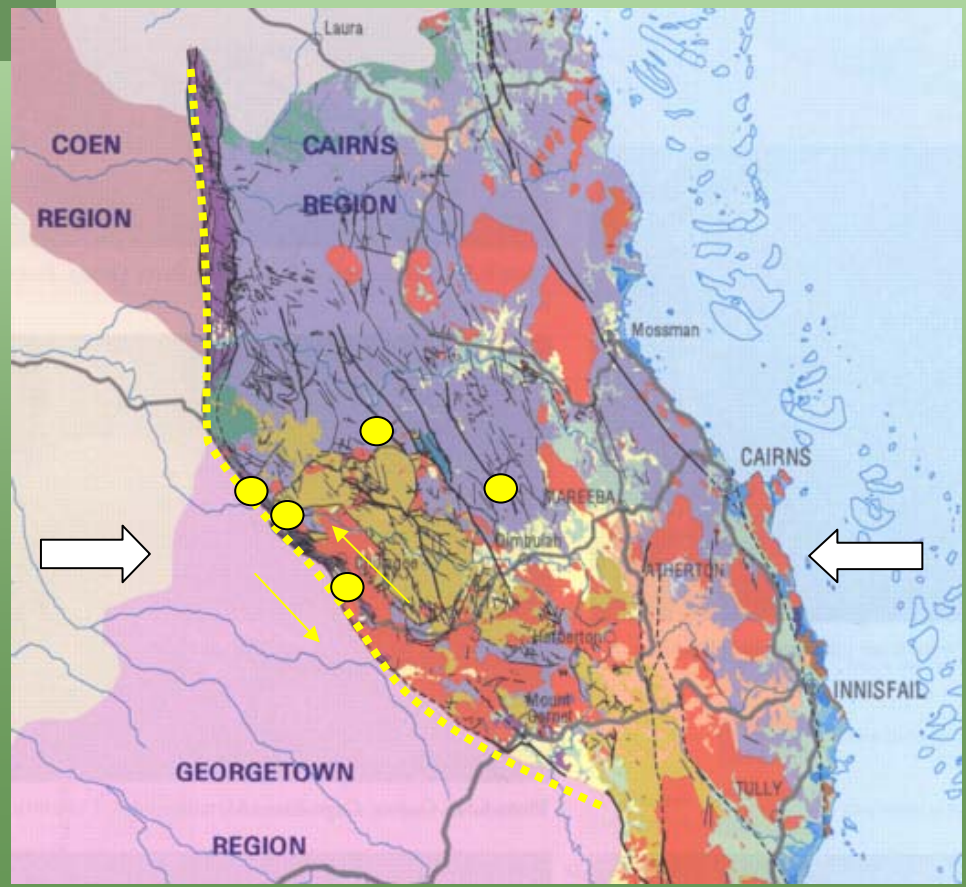




Why is N-S portion of Palmerville Fault poorly endowed?

1) Structuring too simple; no cross-cutting features

2) Not a deep-seated suture



3) E-W compression….

- NW-SE structures critical for mineralised fluids
- Best chance for gold mineralisation along S and N edges (increased complexity) & NW-SE portion

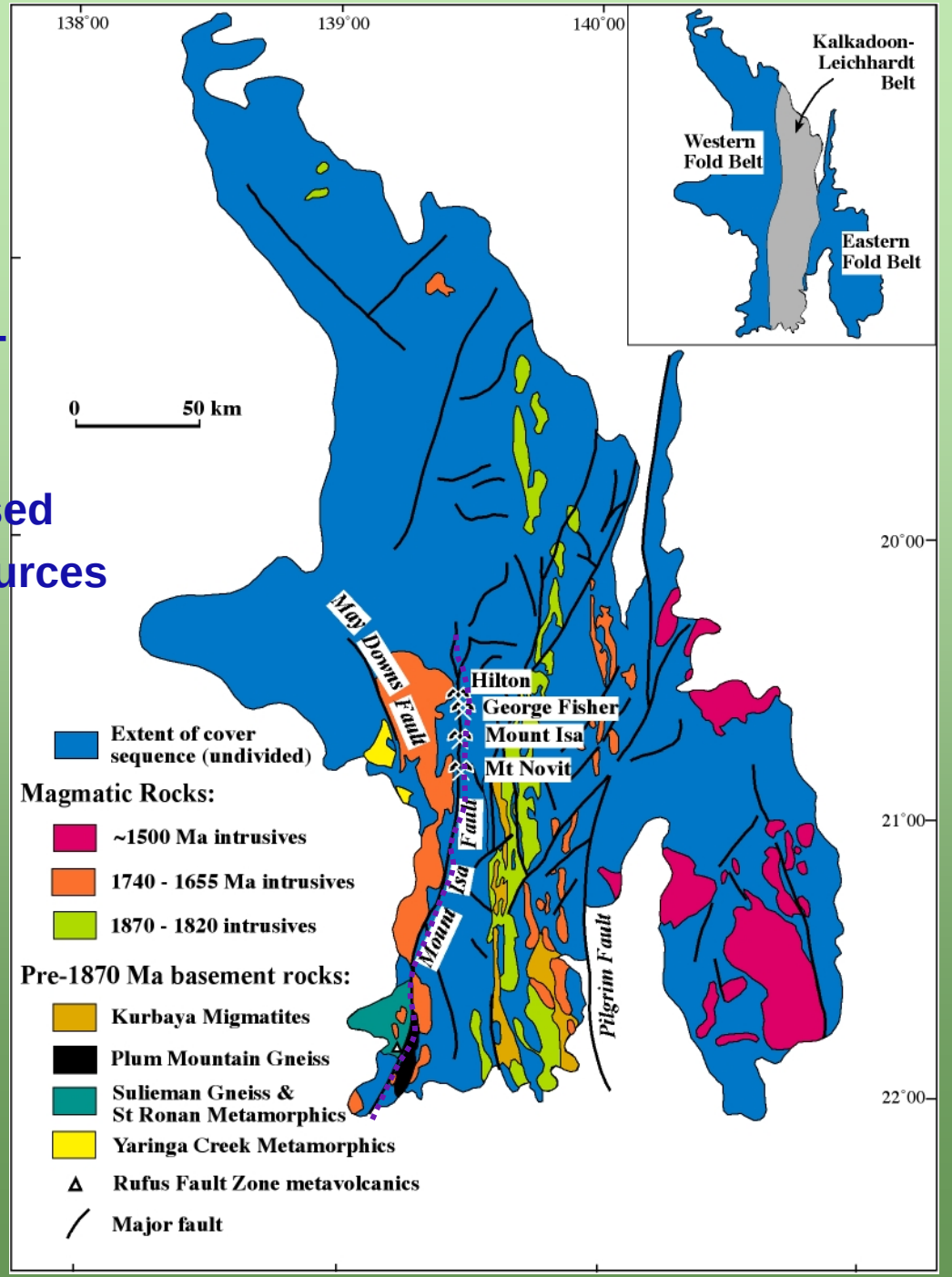
Mt Isa Fault Zone basement study:

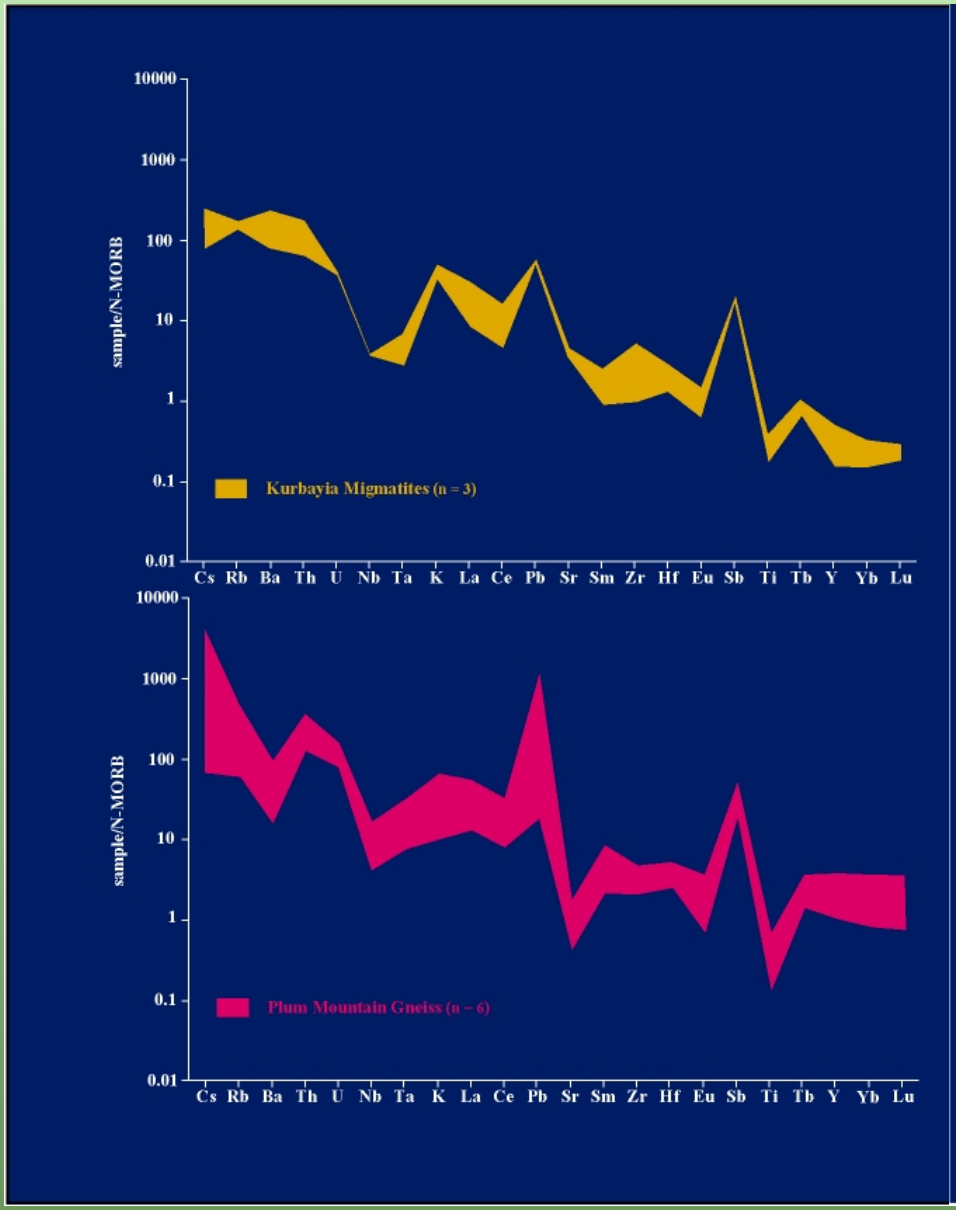
Associated with world-class Cu-Pb-Zn-Ag mineralisation

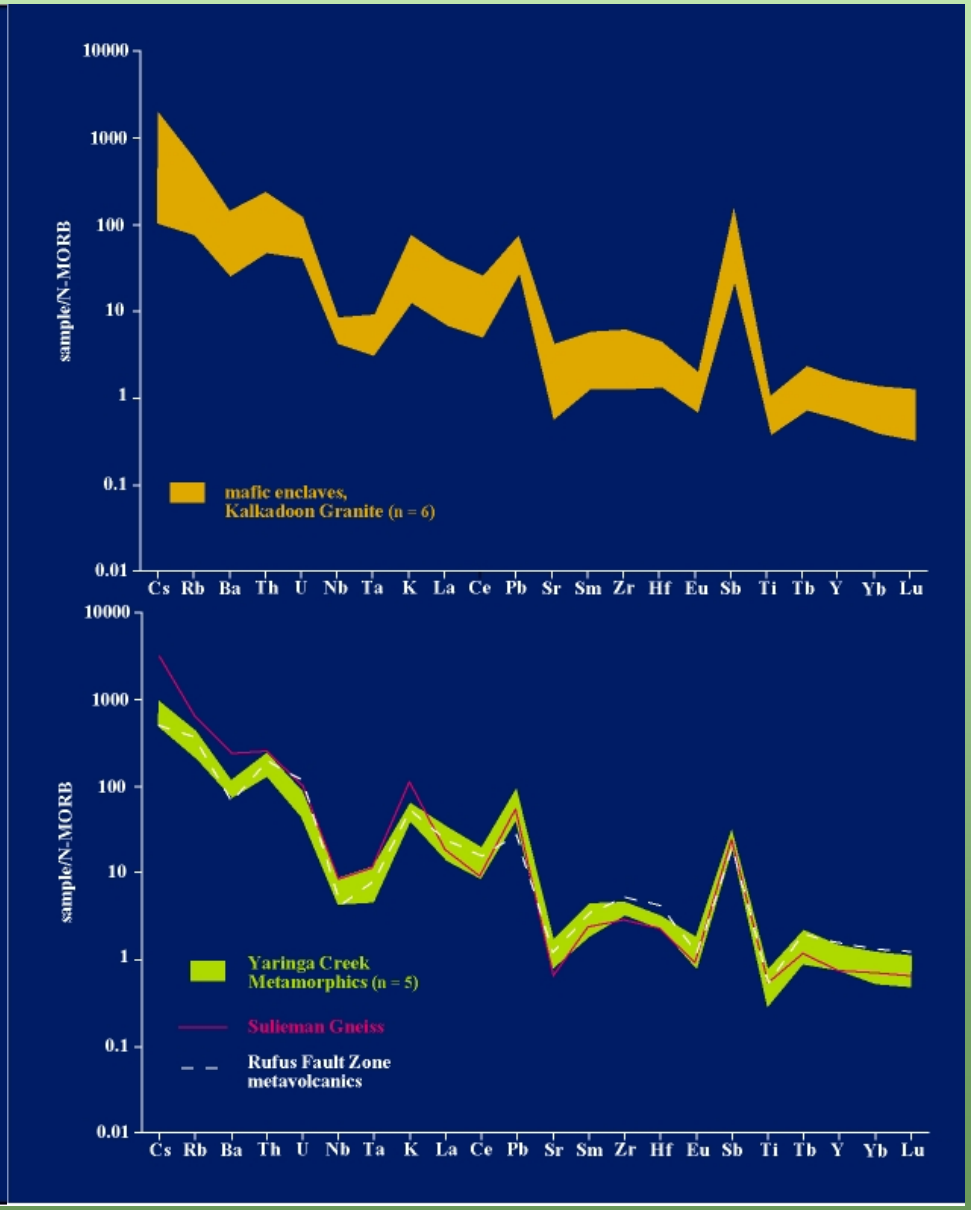
Profound role in focusing mineralised fluids from lower crustal/mantle sources

Does MIFZ demarcate ~ 1.8 Ga boundary between two distinct lithospheric blocks?

Fingerprint pre-Barramundi Orogeny basement rocks from E and W of MIF

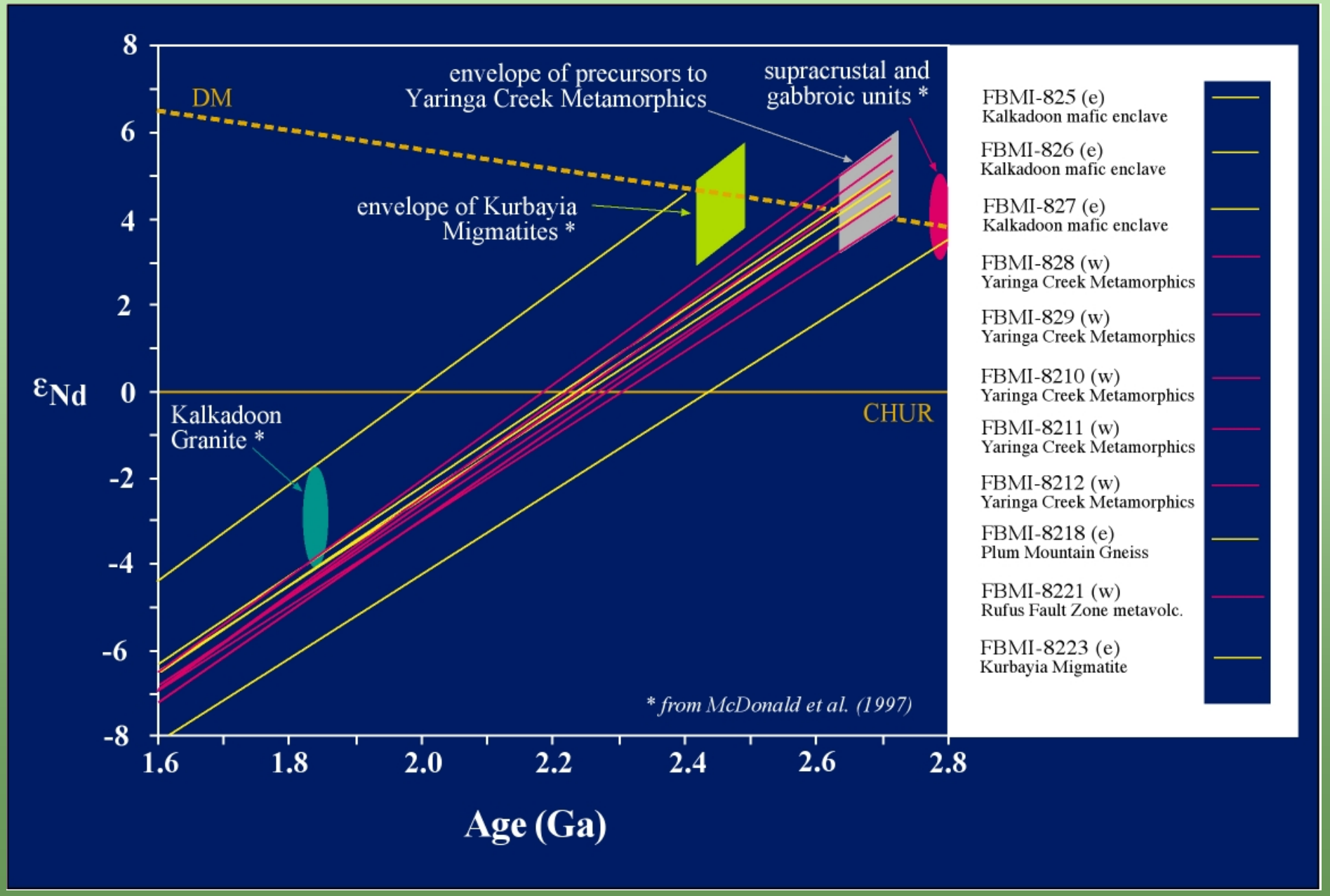






East of Mt Isa Fault

West of Mt Isa Fault


8
6
4
2
0
-2
-4
-6
-8
εNd
1.6
1.8
2.0
2.2
2.4
2.6
2.8
Age (Ga)
DM
envelope of precursors to Yaringa Creek Metamorphics
supracrustal and gabbroic units *
envelope of Kurbayia Migmatites *
Kalkadoon Granite *
CHUR
* from McDonald et al. (1997)
FBMI-825 (e) Kalkadoon mafic enclave
FBMI-826 (e) Kalkadoon mafic enclave
FBMI-827 (e) Kalkadoon mafic enclave
FBMI-828 (w) Yaringa Creek Metamorphics
FBMI-829 (w) Yaringa Creek Metamorphics
FBMI-8210 (w) Yaringa Creek Metamorphics
FBMI-8211 (w) Yaringa Creek Metamorphics
FBMI-8212 (w) Yaringa Creek Metamorphics
FBMI-8218 (e) Plum Mountain Gneiss
FBMI-8221 (w) Rufus Fault Zone metavolc.
FBMI-8223 (e) Kurbayia Migmatite

MIFZ basement study - major findings:

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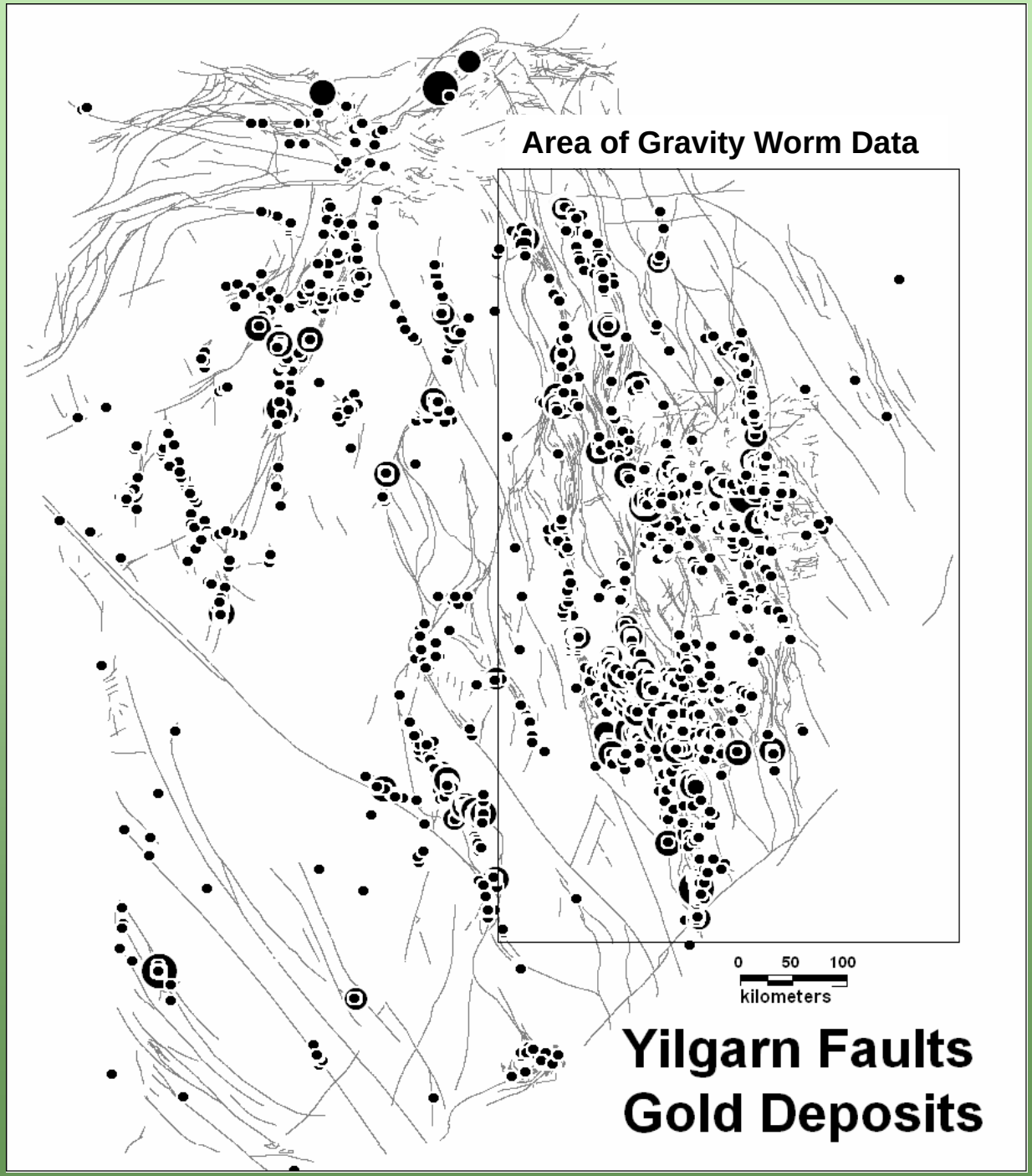
Chemical resemblance across basement lithologies

Crustal blocks must have been within close proximity of each other

Mt Isa Fault - inverted extensional fault or late-orogenic thrust?

No terrane-bounding suture - unlikely to cut the lower crust
(supported by forward modelling of gravity data across MIFZ)

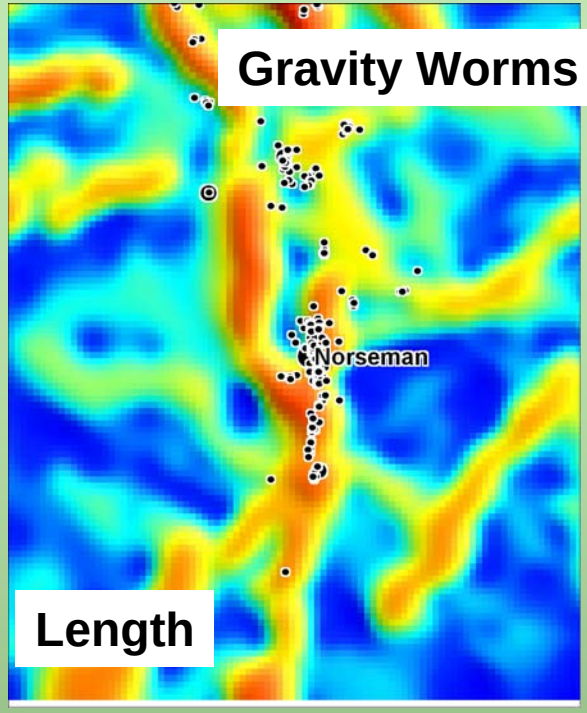
Has implications for crustal-scale exploration models for Mt Isa-style mineralisation

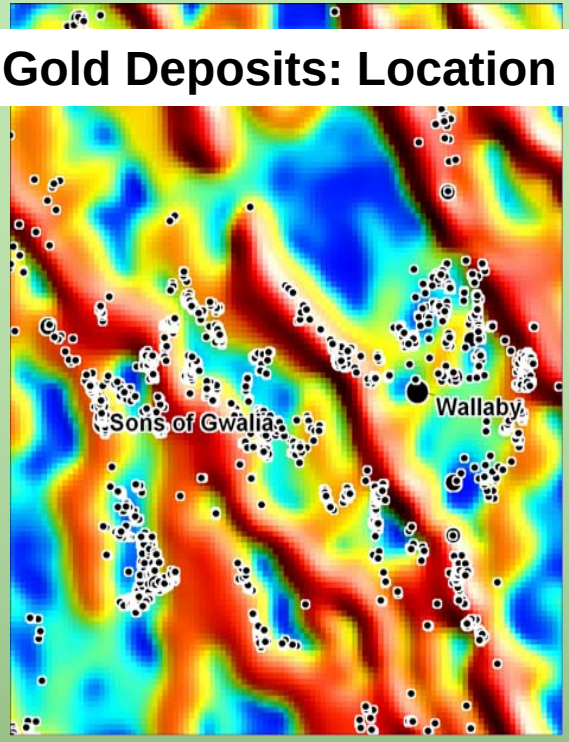


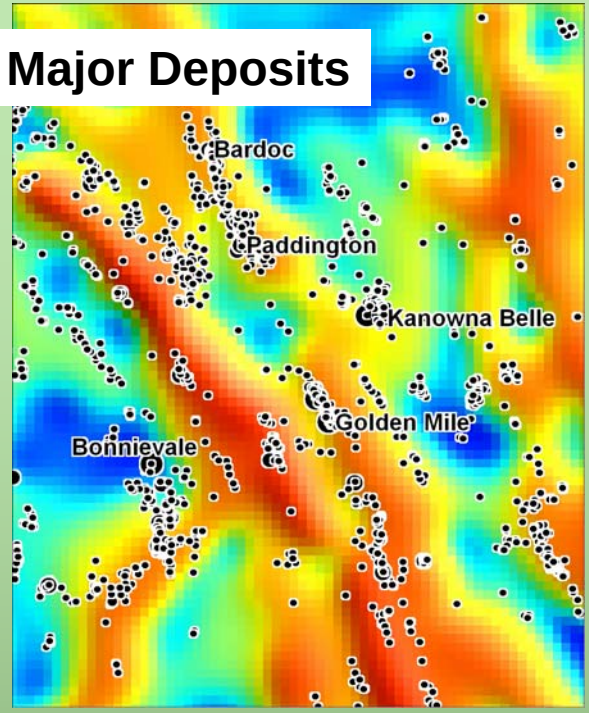
Gravity Worms - application of a geophysical targeting tool:

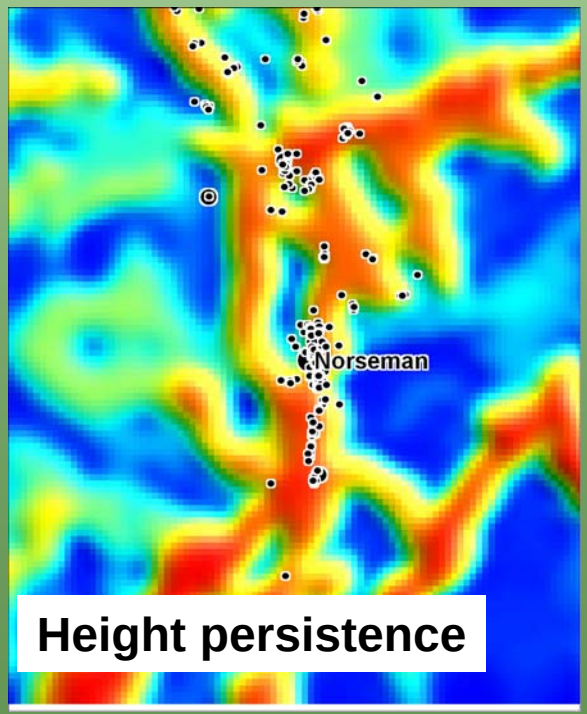
- Points of maximum gradient in 3D space
- Edges with a measurable density contrast or amplitude
- Upward continued to 66km (FracWormer™)
- Vector Edge Dimensions:
  – height persistence (proxy for depth)
  – length

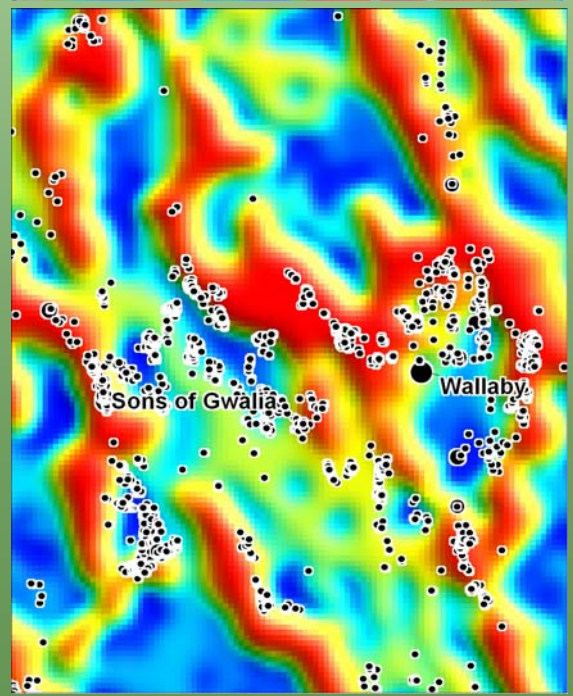
Gravity Worms & Gold Deposits: Location of Major Deposits

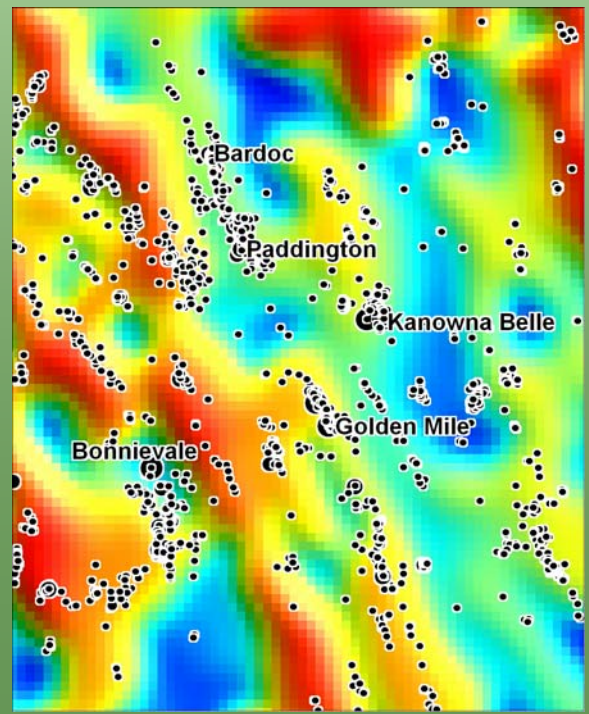


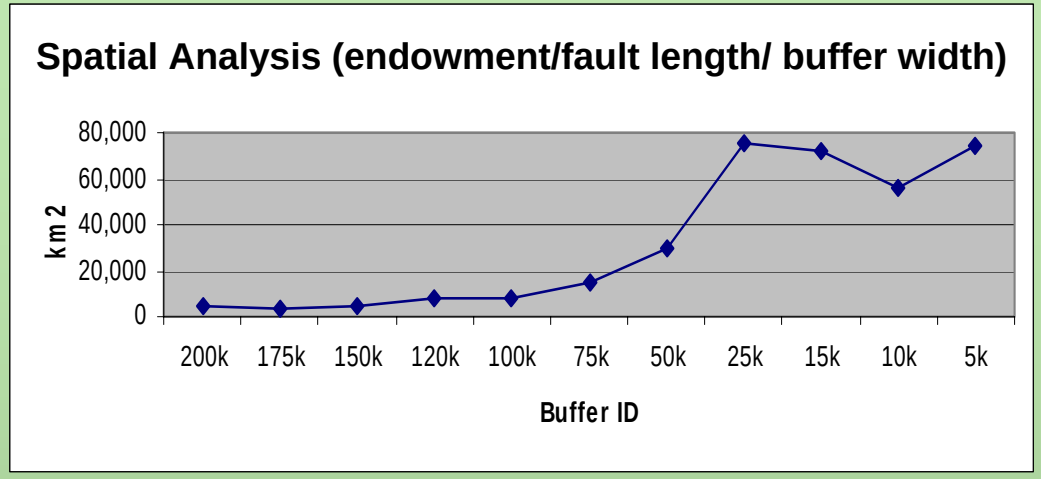


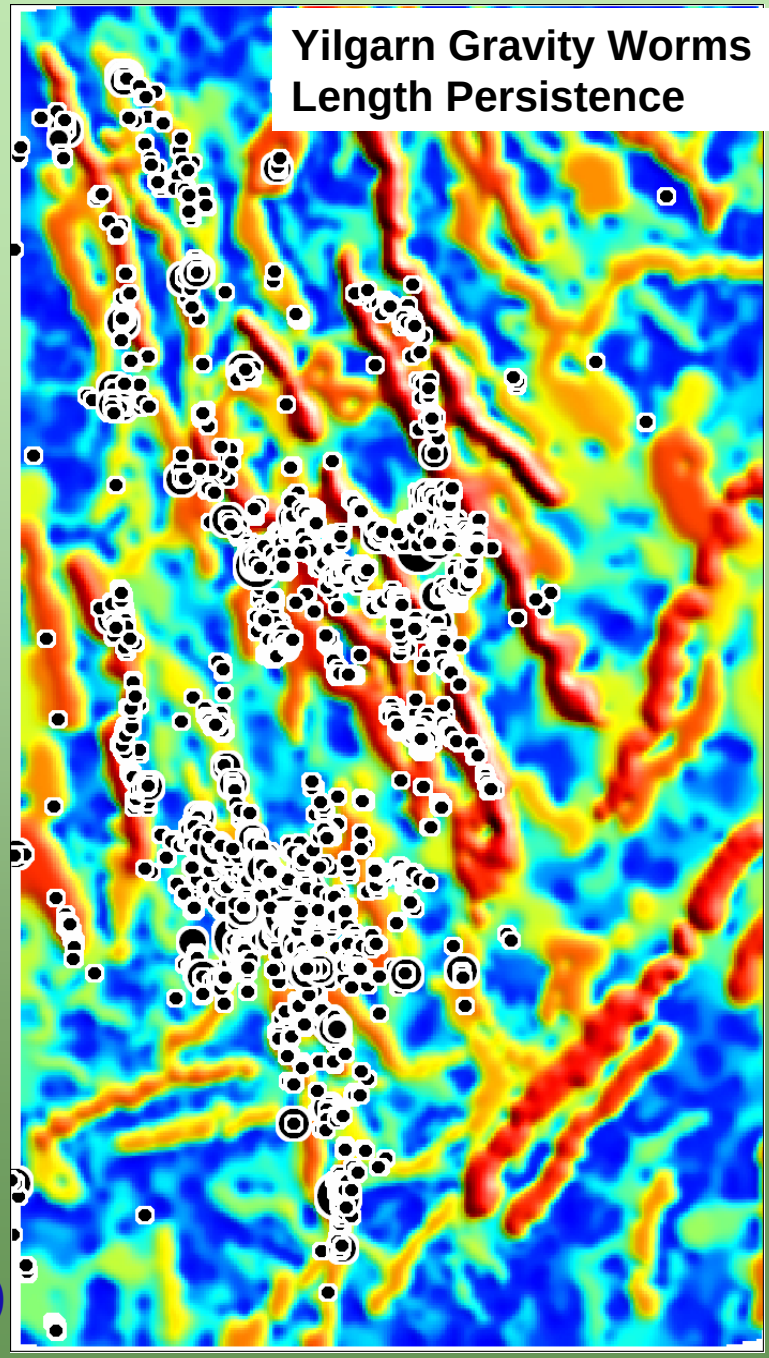












- **Size is important, after all….!**
- **Strong fault control on Au distribution**
- **Endowment correlates with fault length (Au in small faults, close to long faults)**
- **Long faults: first order area selection filter**
- **Au distribution ± correlates with long strike-length, penetrative gravity worms**
- **Consider long, deep worms (esp. under cover)**

(Preliminary) Overall Conclusions:

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Testing of parameters +/- confirms empirical relationships ….no real surprises?

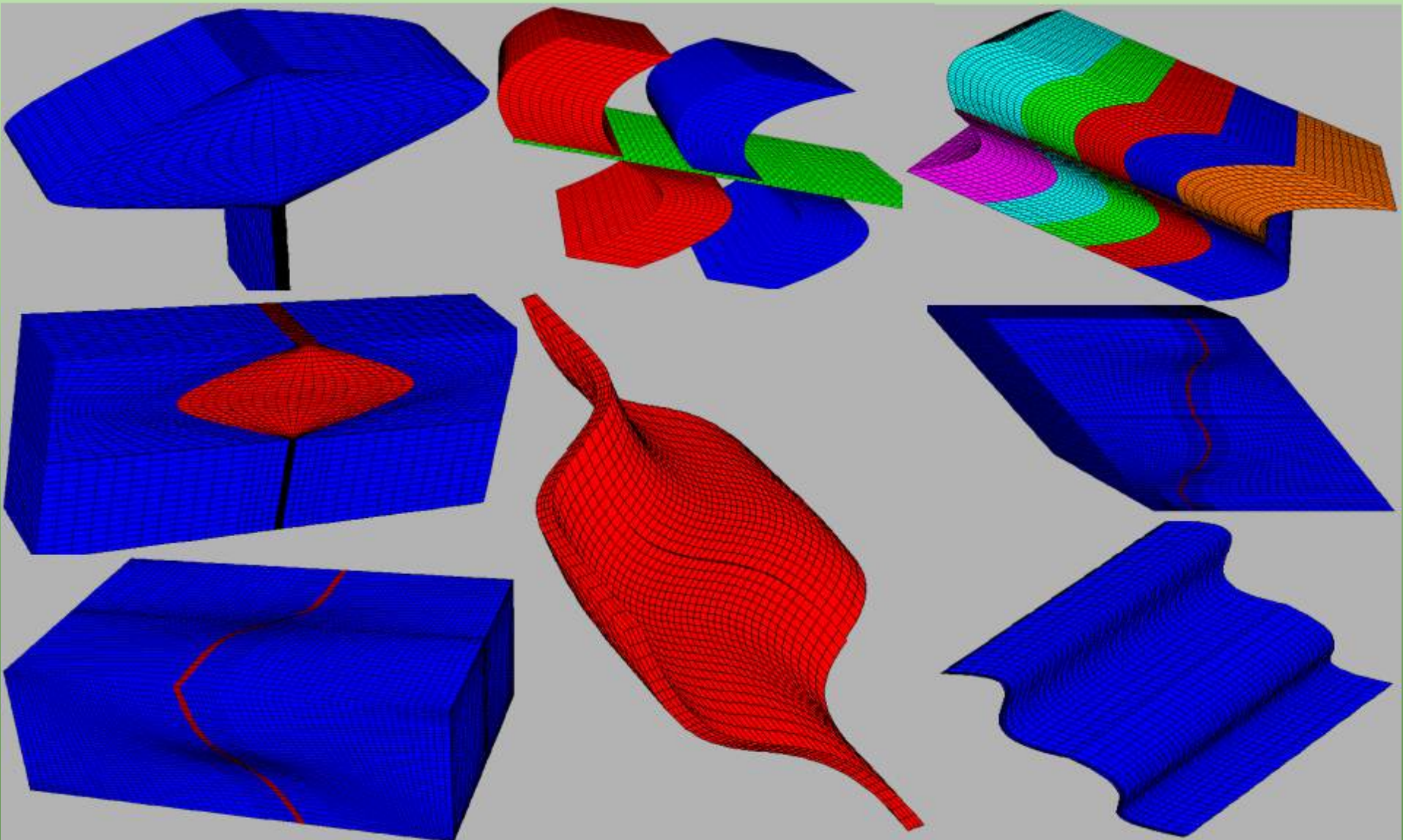
Classification, quantification, prioritisation of fundamental parameters?

Application of geophysical/geochemical targeting tools demonstrates power of prospectivity drivers being tested

Demonstrates value of multi-disciplinary investigation (especially where LDD); novel ways of testing/using existing geophysical technology at a variety of scales

Input parameters for development of realistic modelling scenarios…

The variety of geometries that can be derived from a single template *(courtesy of W. Potma; CSIRO Modelling Project)*



Related poster presentations:

Anthony Morey: ***Why is the Menzies-Boorara Shear Zone not as well endowed as the Boulder-Lefroy Shear Zone?***

Ivo Vos: ***The mineral potential of major fault systems: a case study from NE QLD, Australia***