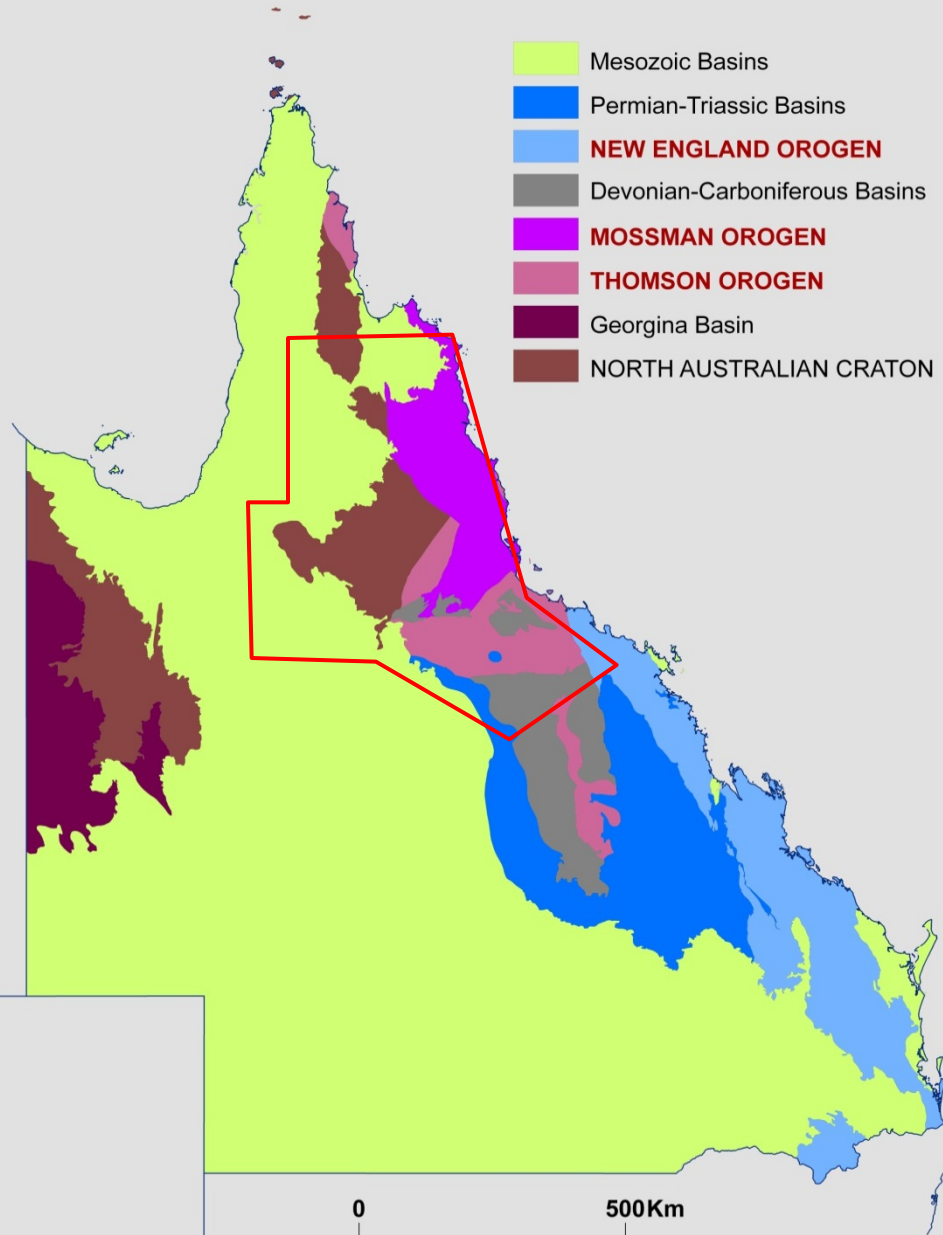


# *Undiscovered mineral resources of North Queensland*

Vladimir Lisitsin, Courteney Dhnaram  
Geological Survey of Queensland

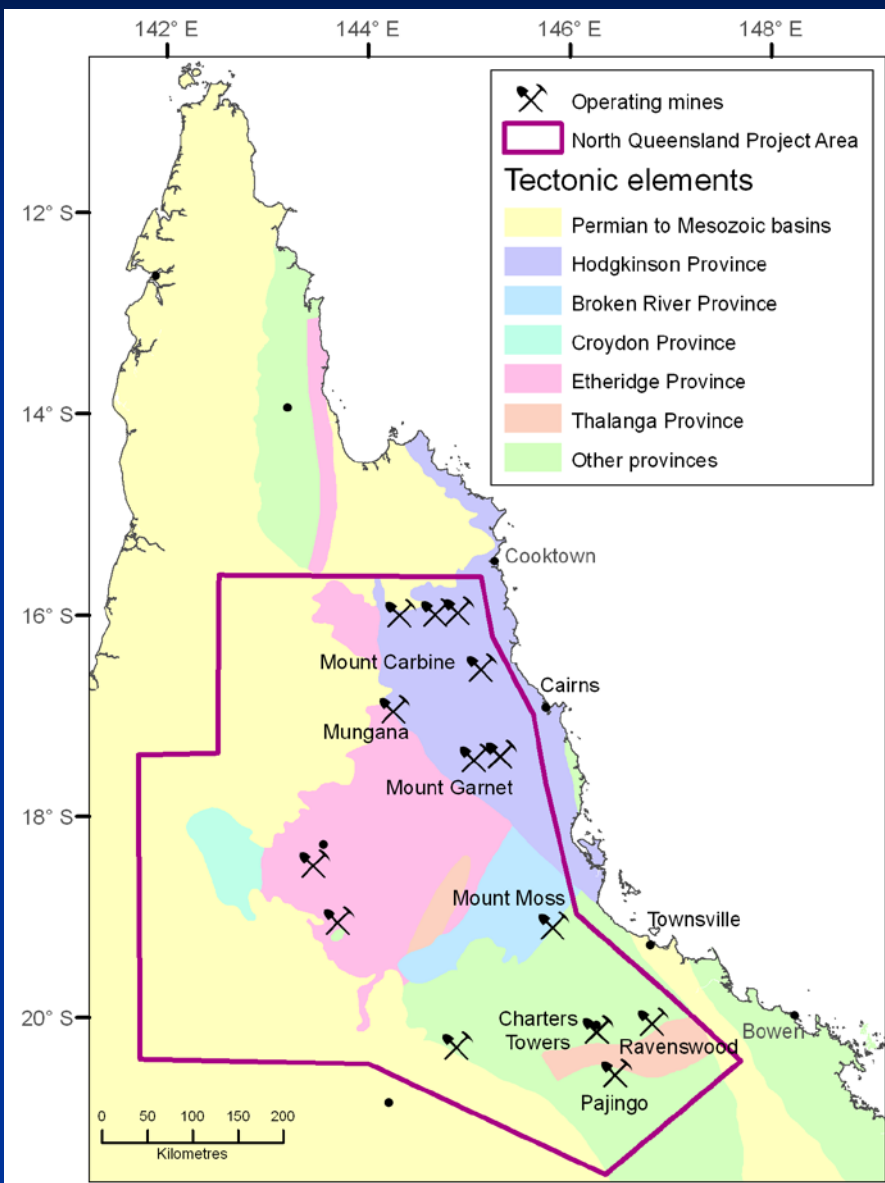
Digging Deeper 10  
5 December 2012

# Tectonic elements of North Queensland



- A series of Palaeozoic orogenic terranes, accreted to the Precambrian Australian Craton
- Extensive Palaeozoic magmatic provinces and Meso-Cainozoic sedimentary basins
- A wide variety of mineral deposits common for convergent continental margins

# Major mineralisation types

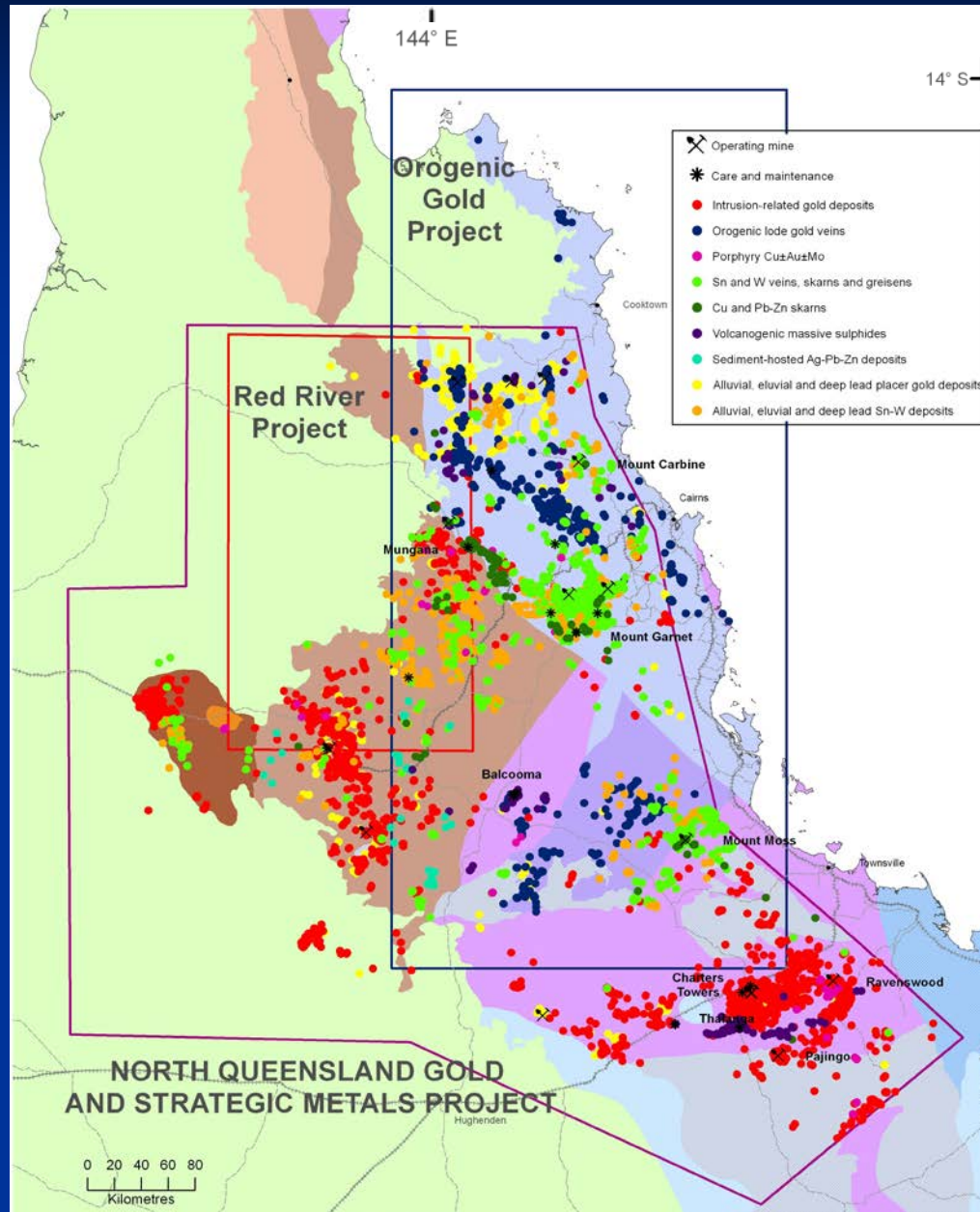


Major deposits of different types are associated with Palaeozoic orogenic and magmatic events:

- Intrusion-related and associated skarn gold
- Orogenic gold
- Epithermal Au-Ag
- VHMS Zn-Cu-Pb
- Vein and greisen Sn-W
- Skarn Fe

Potential for porphyry Mo-Cu-Au and deposits of 'strategic' elements (Be, Bi, REE)

# Province-scale prospectivity assessments

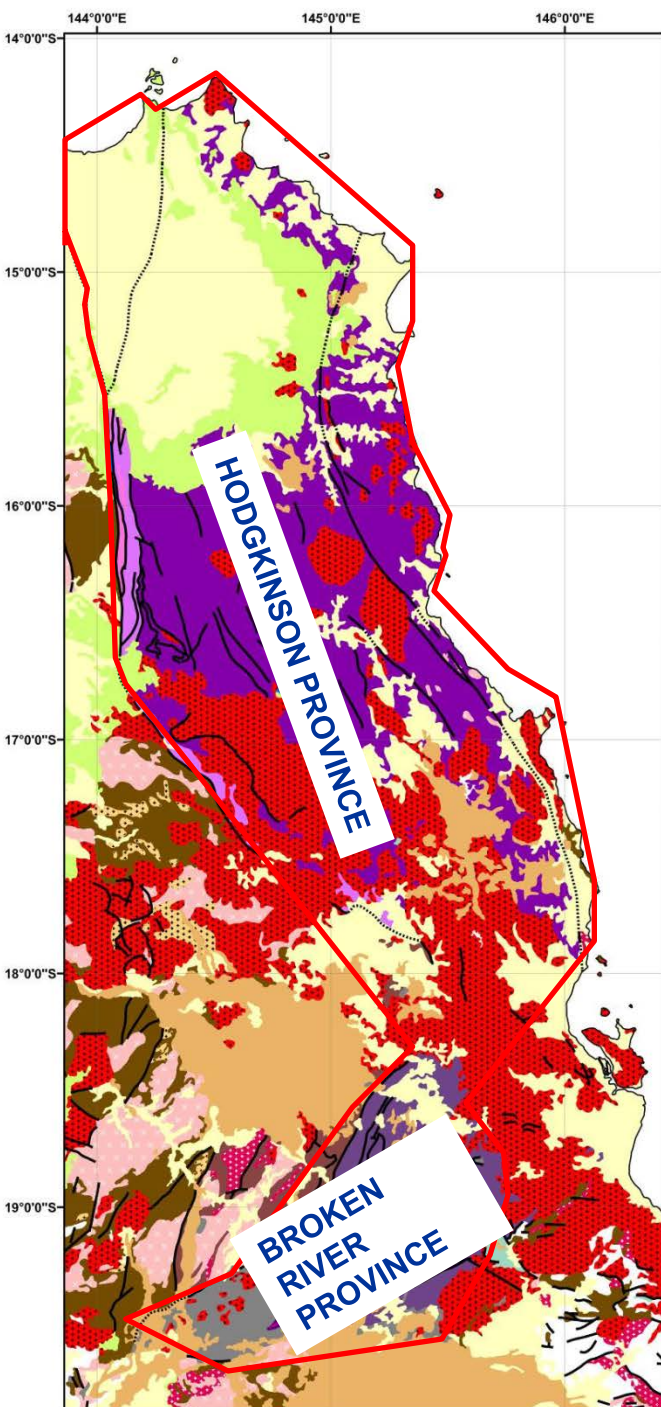


- Orogenic gold (Mossman Orogen, Charters Towers, Croydon)
- Intrusion-related gold, porphyry Mo-Cu-Au and associated deposits (Kennedy Igneous Province)
- Epithermal Au-Ag (Drummond Basin, parts of the Kennedy Province)
- Red River – a potential combination of several metallogenic provinces under cover



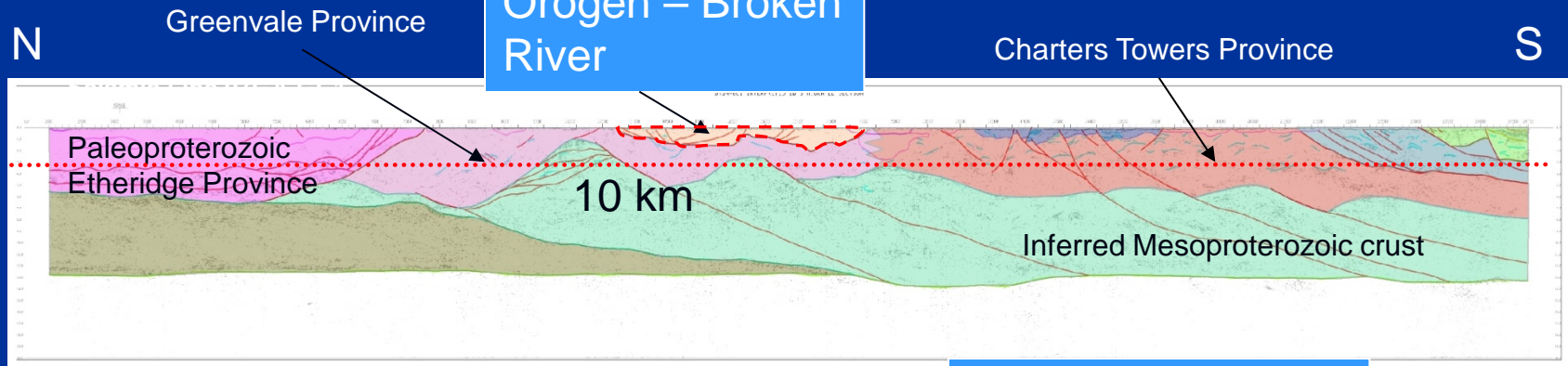
# Mossman Orogen

- Hodgkinson and Broken River provinces
- Generally considered as parts of a continuous Silurian-Devonian terrane, later separated by Permo-Carboniferous magmatic complexes
- Major orogeny at ~360 Ma, followed by several other tectonic events in the Carboniferous to Permian

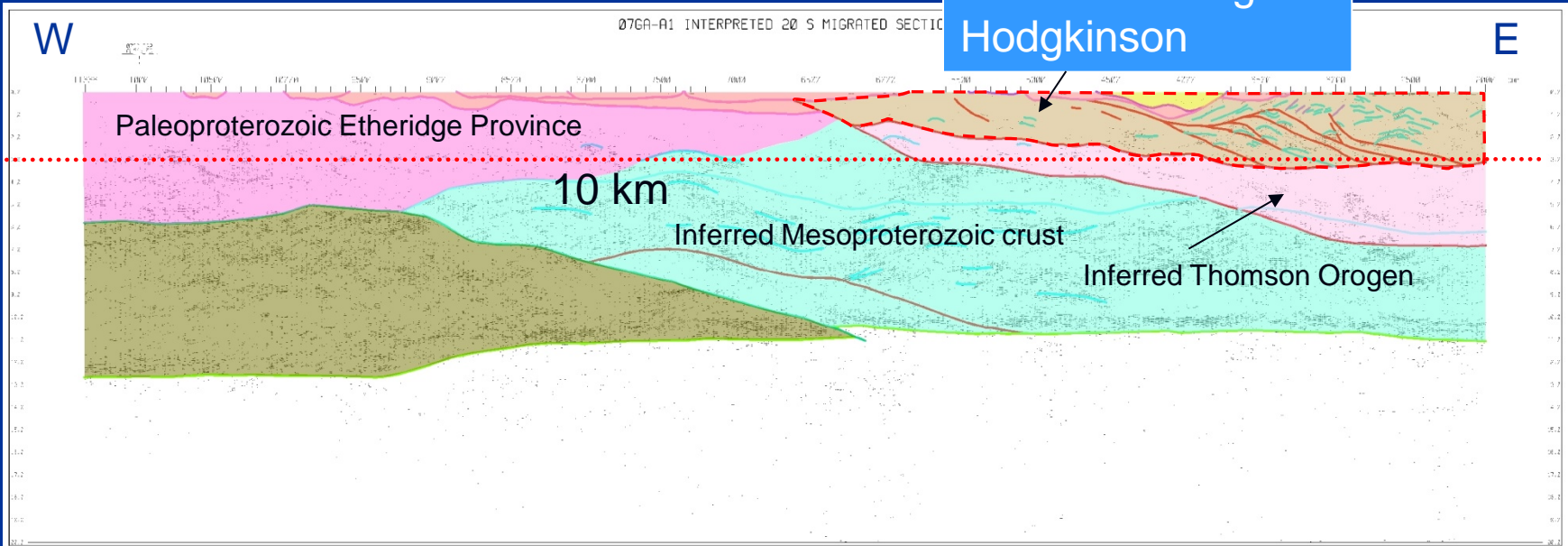


# Mossman Orogen – crustal architecture

## Mossman Orogen – Broken River



## Mossman Orogen - Hodgkinson

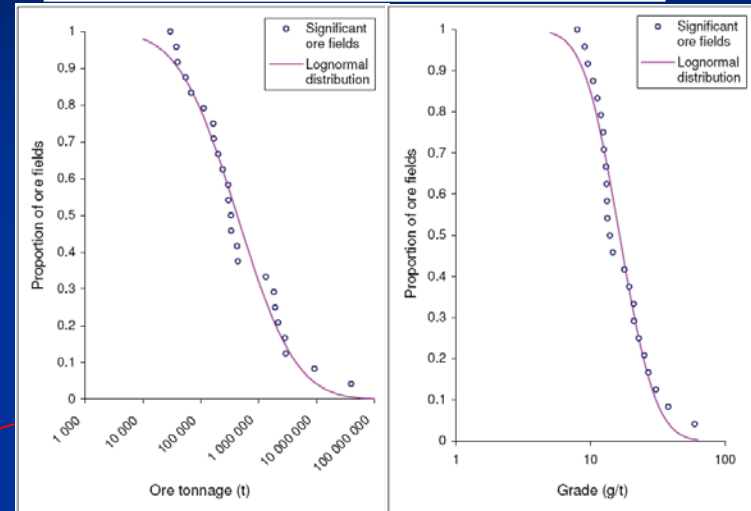
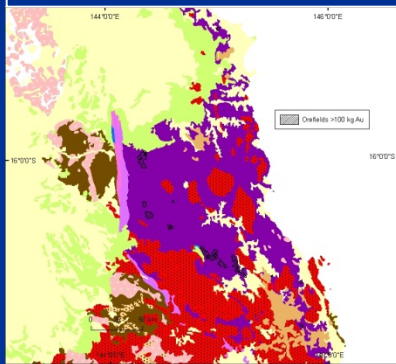


# Quantifying undiscovered endowment

Deposit type

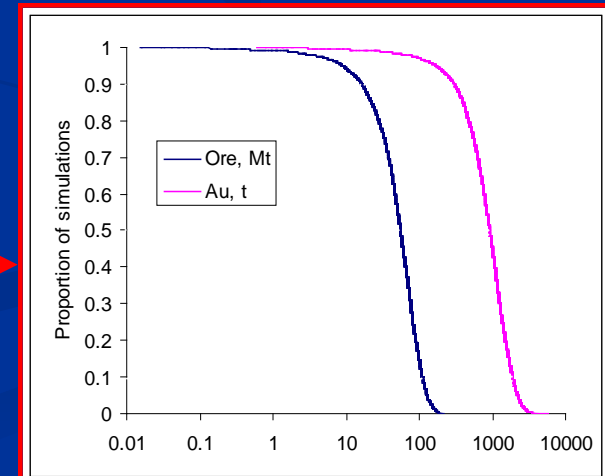
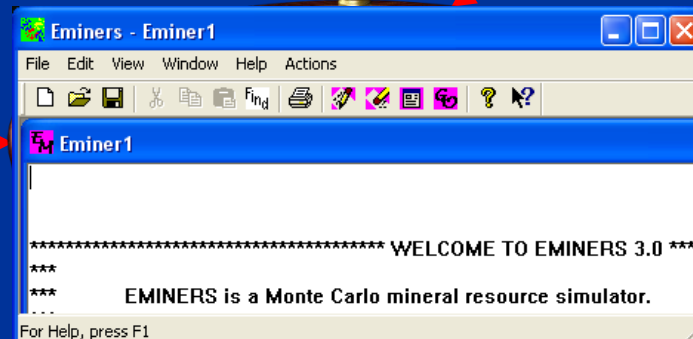
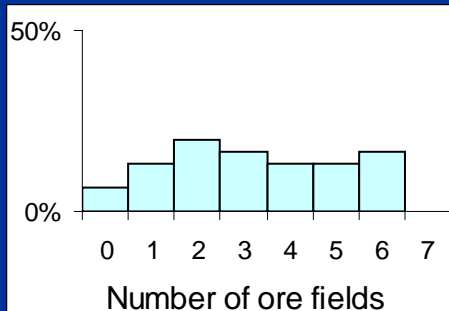
Grade and tonnage model

Permissive tract



Number of undiscovered deposits

$$N_{90} - N_{50} - N_{10}$$





# Gold mineralisation

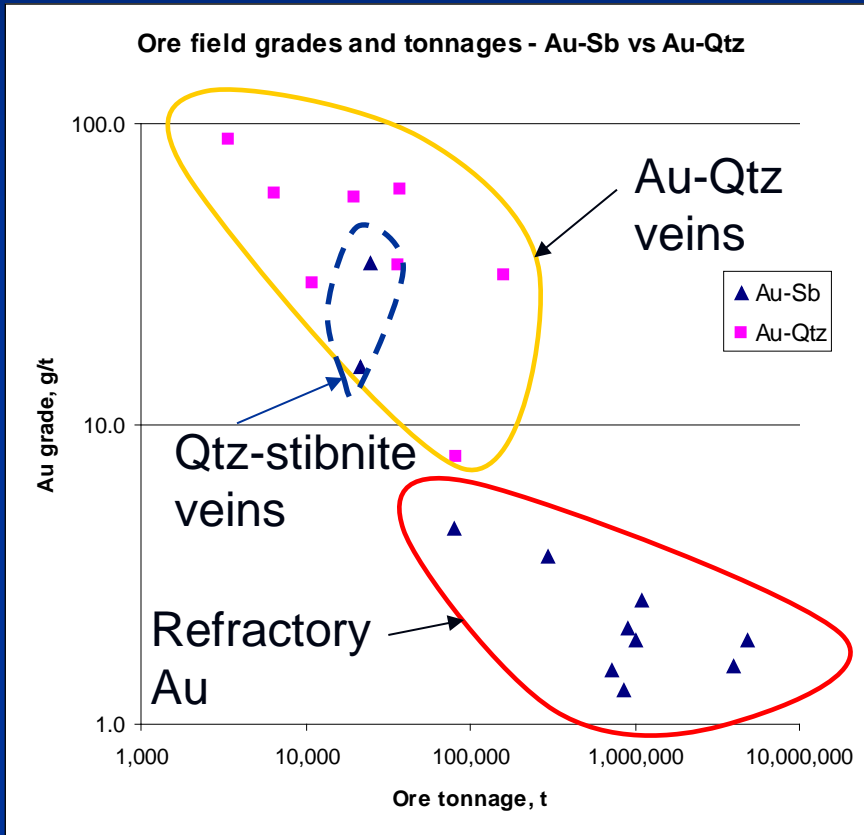
## Primary deposit 'styles':

- Au-Qtz veins with free gold
- 'Au-Sb' deposits, including:
  - Refractory Au in Pyr-Asp
  - Qtz-stibnite veins



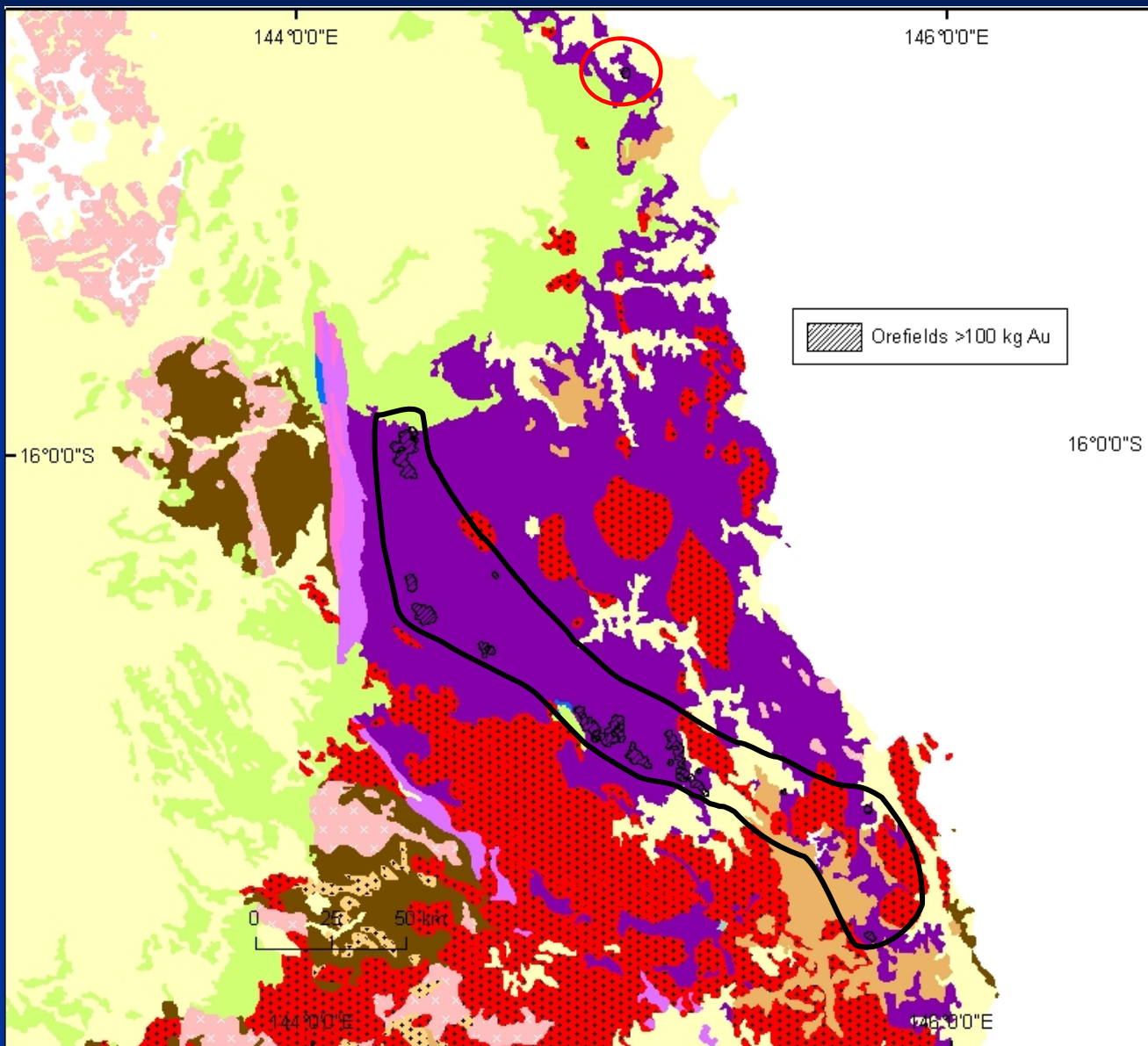


# Grade and tonnage models



- Au-Qtz veins and 'Au-Sb' deposits have significantly different grades and tonnages
- Qtz-stibnite veins have grades and tonnages closer to Au-Qtz veins than the refractory Au sub-type of 'Au-Sb' deposits

# Hodgkinson Province – primary ore fields



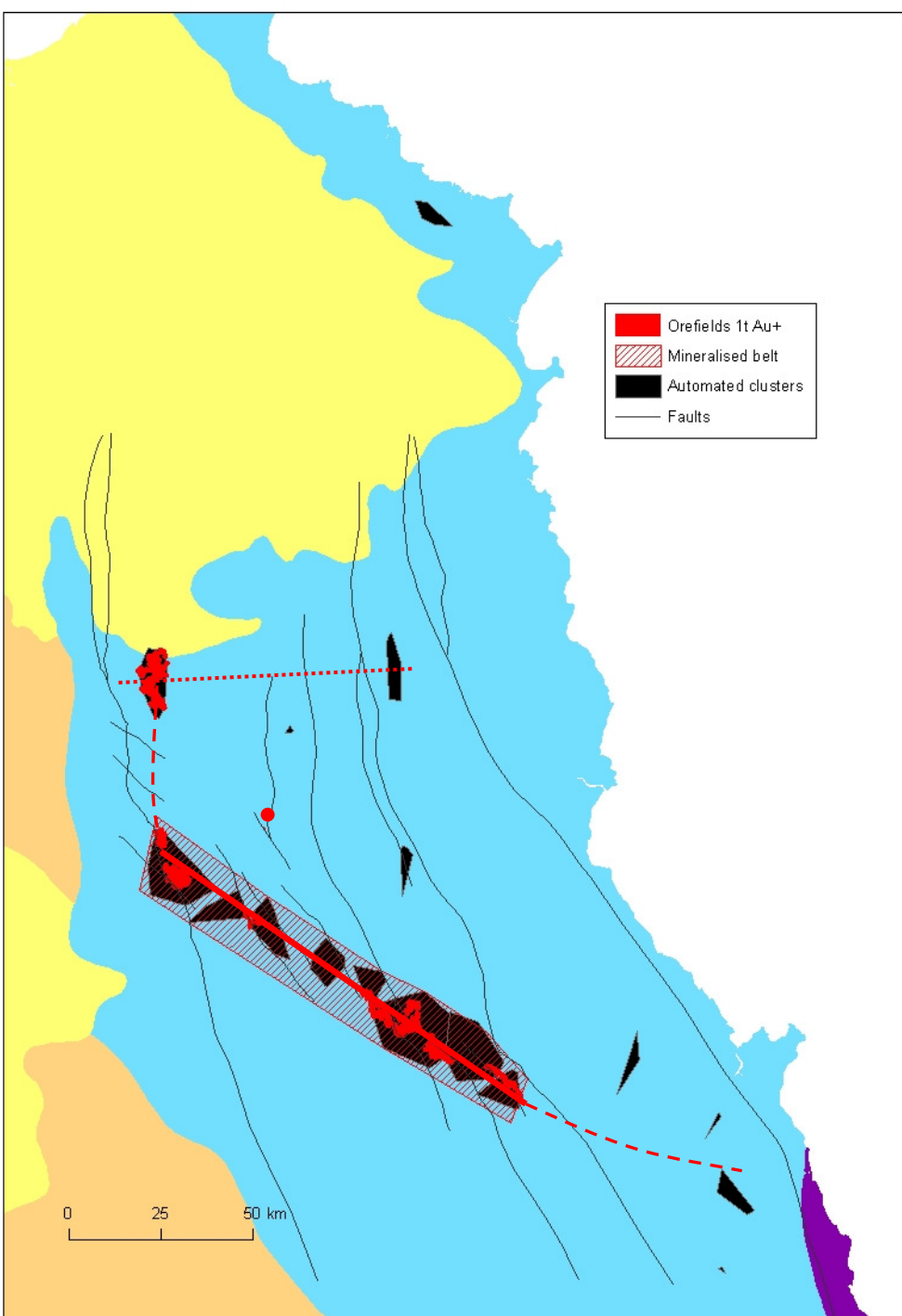
- 1,000 recorded primary gold occurrences

- 15 spatially defined ore fields with >100 kg Au

- 14 occur in a belt <30 km wide – >98% of total primary gold

# Spatial distribution of gold deposits – Hodgkinson belt

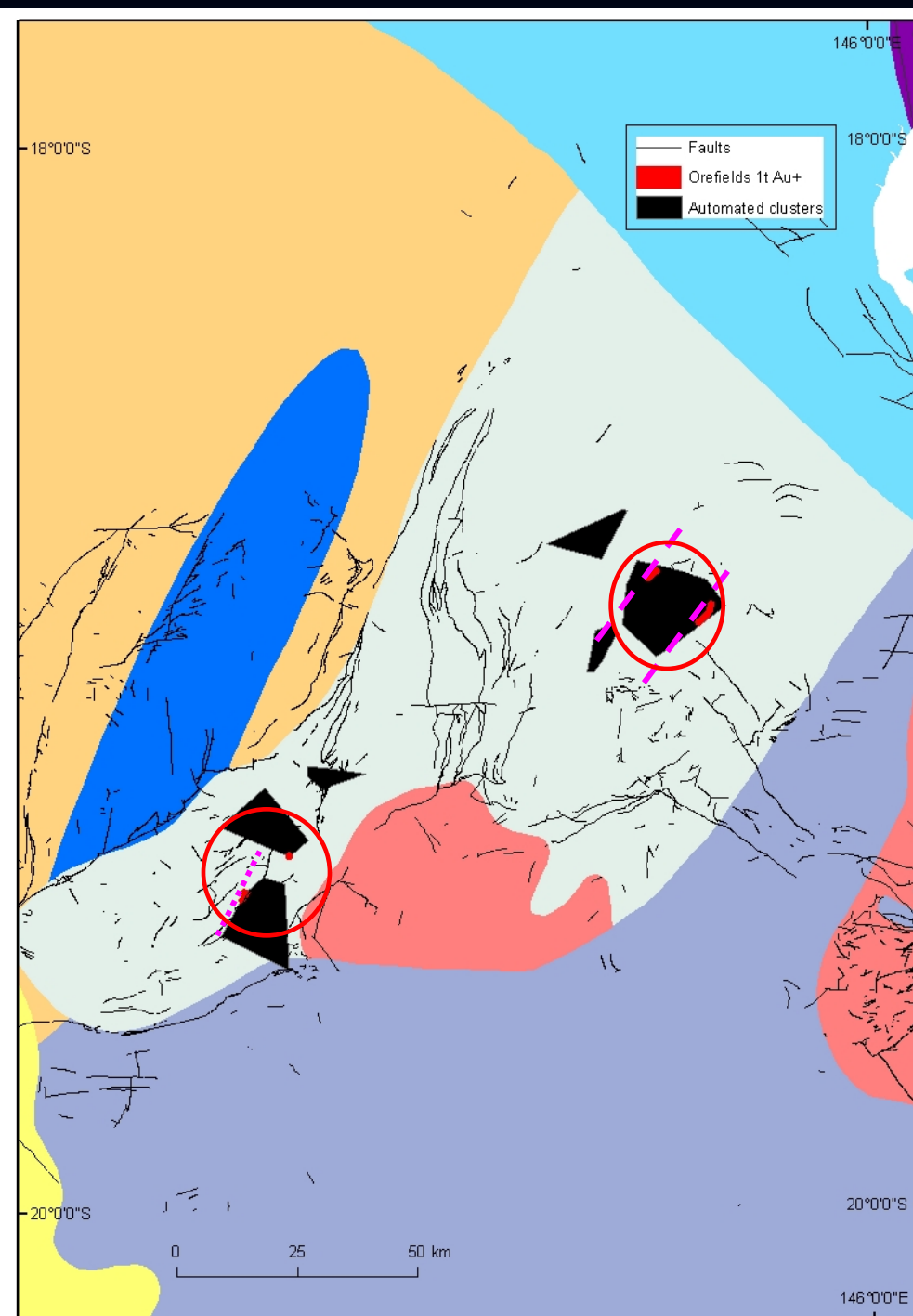
- Nearest Neighbour Hierarchical Spatial Clustering of gold occurrences
- A metallogenic belt (~100 x 20 km) defined by a high density of deposit clusters, possibly extending N and SE
- 10% area, 90% Au





# Spatial distribution of gold deposits – Broken River

- Two major mineralised areas, separated by >60 km of permissive tract with only minor gold occurrences
- NE alignment of individual gold deposits and occurrences within ore fields
- No apparent overall regional trend of gold ore fields

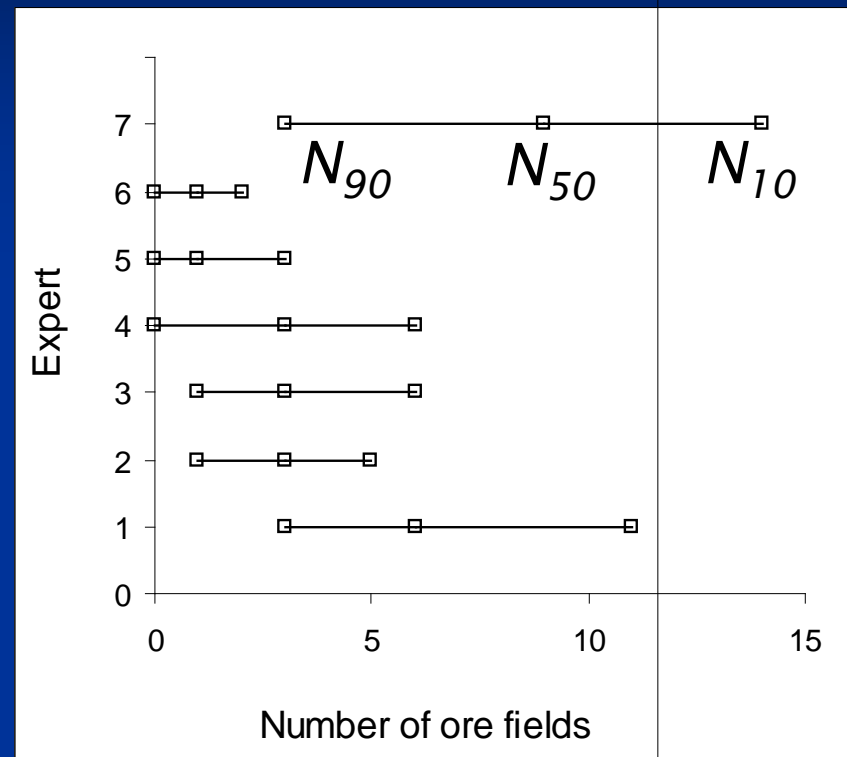


# Number of undiscovered ore fields

Expert workshop, to estimate number of deposits at:

- 90% probability (lowest likely,  $N_{90}$ )
- 50% probability (best estimate,  $N_{50}$ ), and
- 10% (highest likely,  $N_{10}$ )

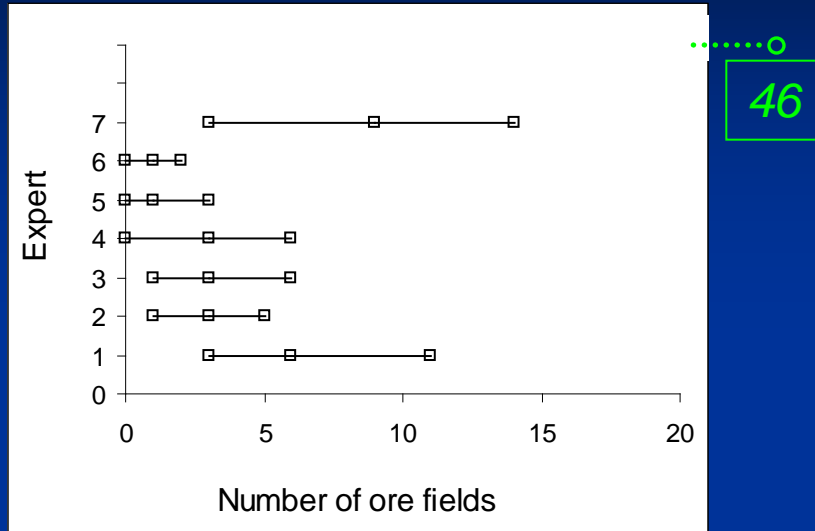
Mathematical aggregation of  $n$  individual estimates by equal-weight linear opinion pool:



$$f(x) = \sum_{i=1}^n w_i f_i(x) \mid w_i = 1/n$$

# Number of undiscovered ore fields

## Hodgkinson – Au-Sb (>1 t Au)



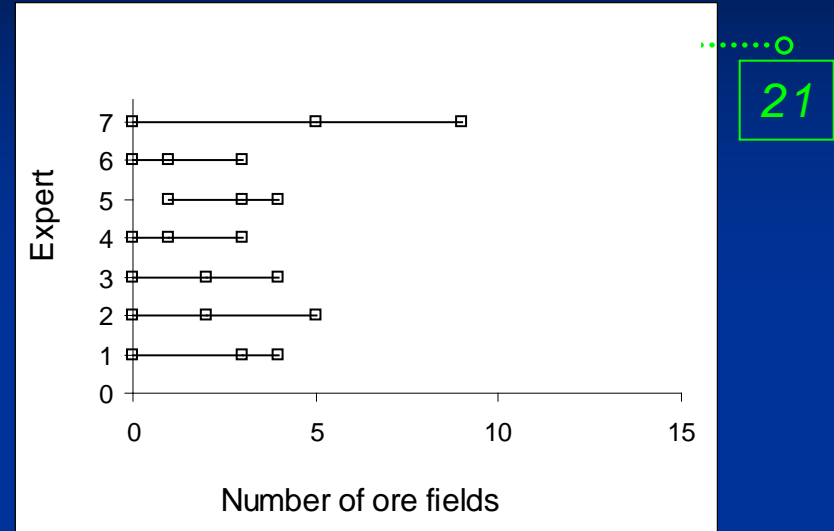
### Expert estimates

$$N_{90}=1 \quad N_{50}=3 \quad N_{10}=10$$

### Regression estimates

$$N_{90}=6 \quad N_{50}=16 \quad N_{10}=46$$

## Broken River – Au-Sb (>1 t Au)



### Expert estimates

$$N_{90}=0 \quad N_{50}=3 \quad N_{10}=5$$

### Regression estimates

$$N_{90}=3 \quad N_{50}=7 \quad N_{10}=21$$

Singer & Kouda (2011), regression model – permissive area  $A$  and median deposit tonnage  $T$ :

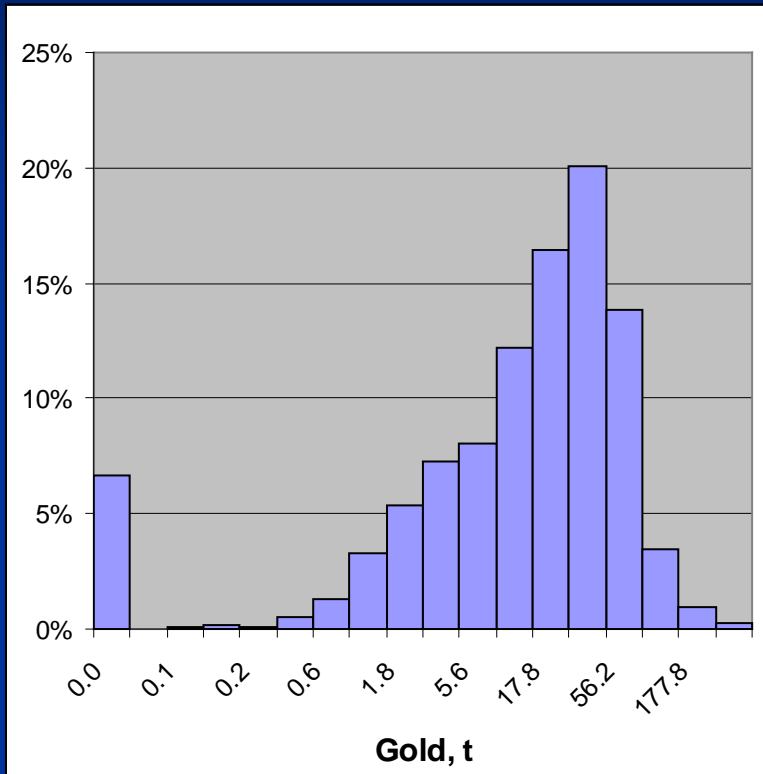
$$\log_{10}(N_{50}) = 4.21 - 0.5\log_{10}(A) - 0.225\log_{10}(T)$$

$$\log_{10}(N_{90}, N_{10}) = \log_{10}(N_{50}) \pm 0.449\sqrt{1.009 + 0.003(3.173 - \log_{10}(A))^2(-0.329 - \log_{10}(T))^2}$$



# Undiscovered gold endowment

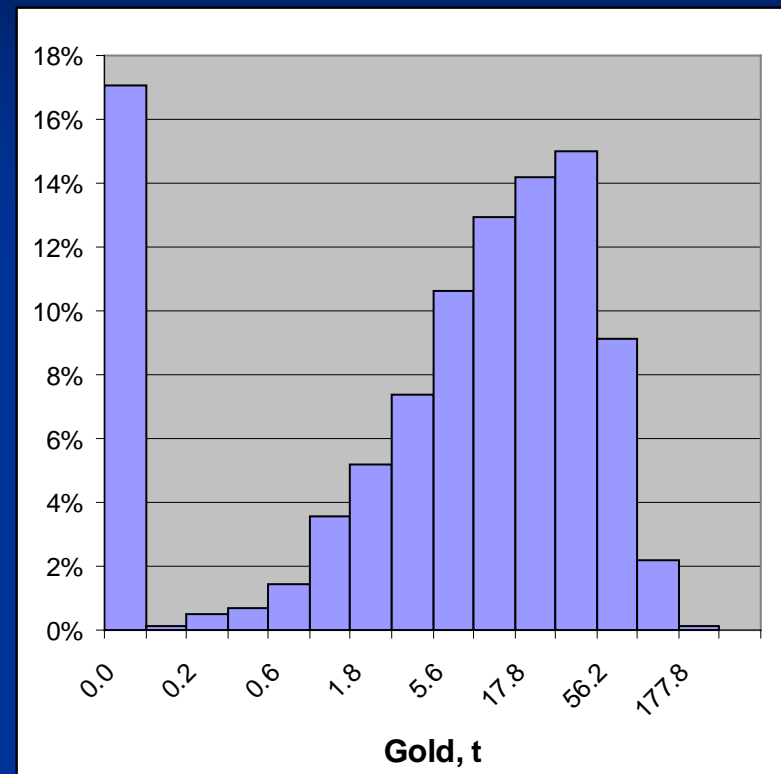
Hodgkinson – refractory Au



$$E(M) = 40 \text{ t Au}$$

$$M_{50} = 21 \text{ t Au}$$

Broken River – refractory Au



$$E(M) = 24 \text{ t Au}$$

$$M_{50} = 12 \text{ t Au}$$

# Gold potential

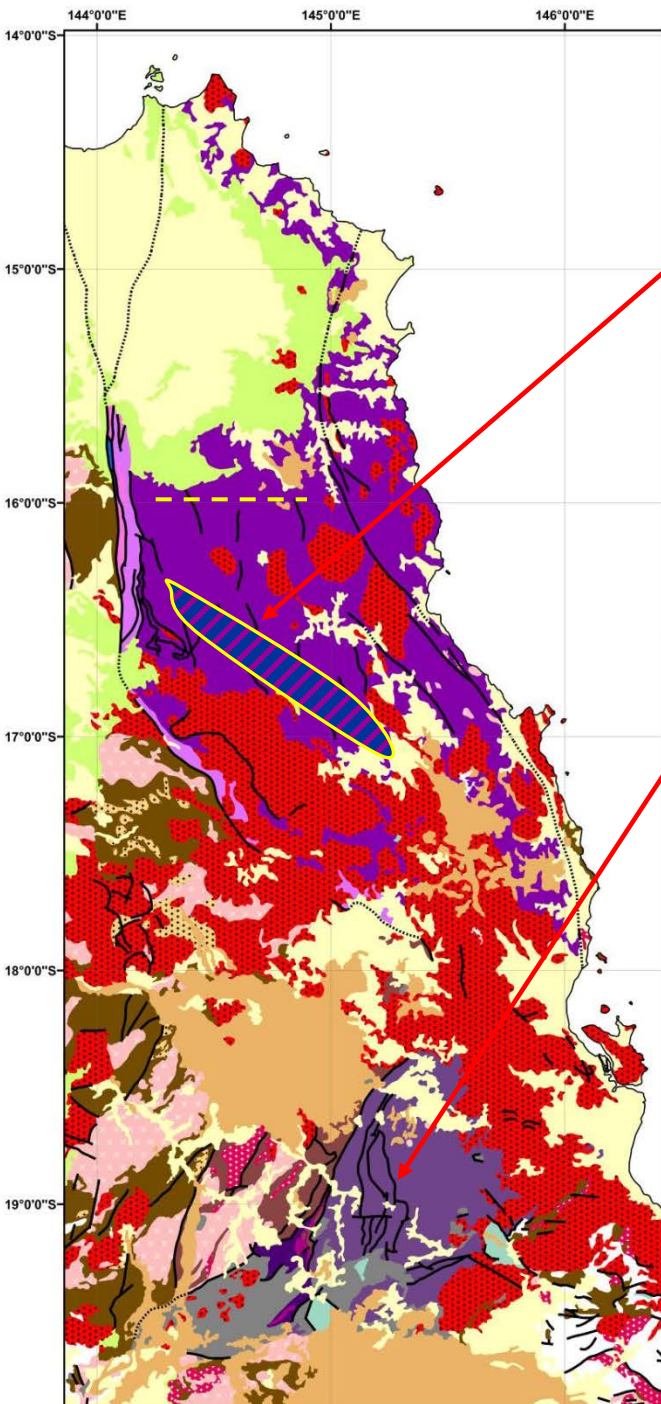
## **Hodgkinson province (20,000 km<sup>2</sup>):**

- 1 to 10 significant (>1 t Au) undiscovered refractory Au ore fields
- ~30 t of contained Au (90% certainty of >1 t Au)

## **Broken River province (6,000 km<sup>2</sup>):**

- Up to 5 significant (>1 t Au) undiscovered refractory Au ore fields
- ~20 t of contained Au (80% certainty of >1 t Au)

**Likely metallogenic belt(s) in the Hodgkinson province**



# Acknowledgements

## **Contributors (Geological Survey of Queensland):**

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Janelle Simpson

## **Workshop participants:**

Neil Phillips (Phillips Gold), Trevor Jackson (Territory Minerals), Terry Delahunty (Mt Moss Mining), Mike Barr (Mt Moss Mining), Ian Withnall (Geological Survey of Queensland)