Queensland's Next Eldorados? Results of the National Geochemical Survey of Australia Project

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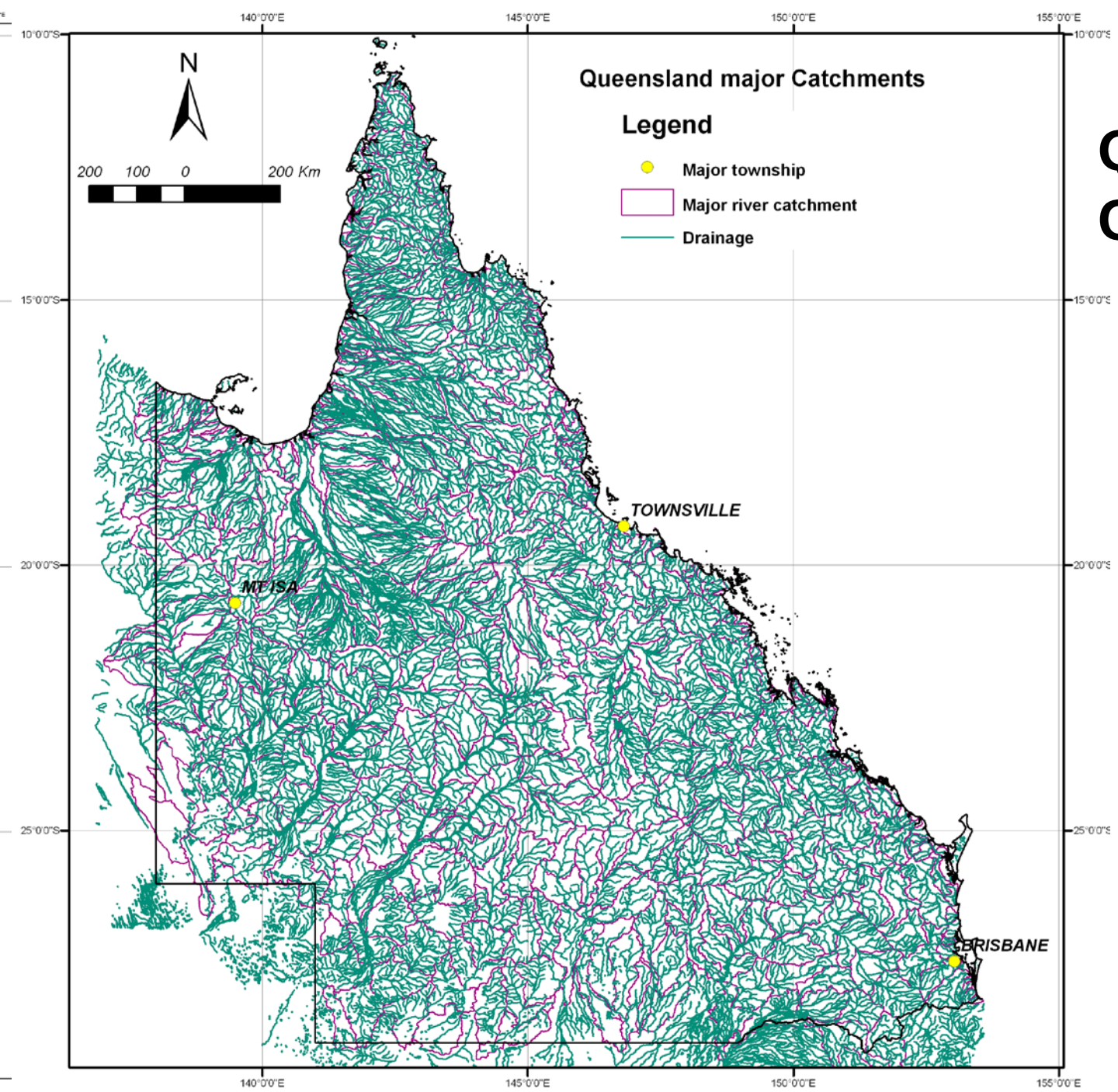
Talk outline

- The National Geochemical Survey of Australia project
- Methodology
- Results
  - Data appraisal
- Queensland Mineral Prospectivity Atlas
  - Mineralisation targets and models

Introduction

- The National Geochemical Survey of Australia (NGSA) program was a collaborative project between Geoscience Australia and the Geological Survey of Queensland
- Onshore Energy Security Initiative Programme (August 2006-June 2011)
- The aim is to create a nationwide, internally consistent geochemical database for the whole continent
- In Queensland, 311 catchments were sampled at an average sampling density of 1 site per 5500 sq km (catchments <1000 sq km were excluded)
- The new dataset comprises major and trace element geochemistry of 68 elements and associated physical parameters using the state-of-the-art analytical techniques



Queensland Catchments

- Catchment boundary is based on Australian Nested Catchments and Subcatchments database (CRES, ANU)
- Sampled near outlet or at the lowest point within the catchment based on digital elevation modelling (DEM)
- Natural mixing

Sampling method

- At every target site, sediments were sampled at two depth intervals: Top Outlet Sediments (0-10cm) and Bottom Outlet Sediments (60-90cm)

- GPS coordinates, a detailed site description, lithologic observations, field pH, and dry (if possible) and moist Munsell® soil colours were recorded and photographs of the sample site were taken

Top Outlet Sediments (TOS)

- TOS were sampled between 0 and 10 cm (below the root zone) with a steel crowbar over 30 x 60cm area
- 6-10 kg of sediment was sampled


Sampling
• Clean plastic scoop
• Hand gloves


Soil pH

Soil colour

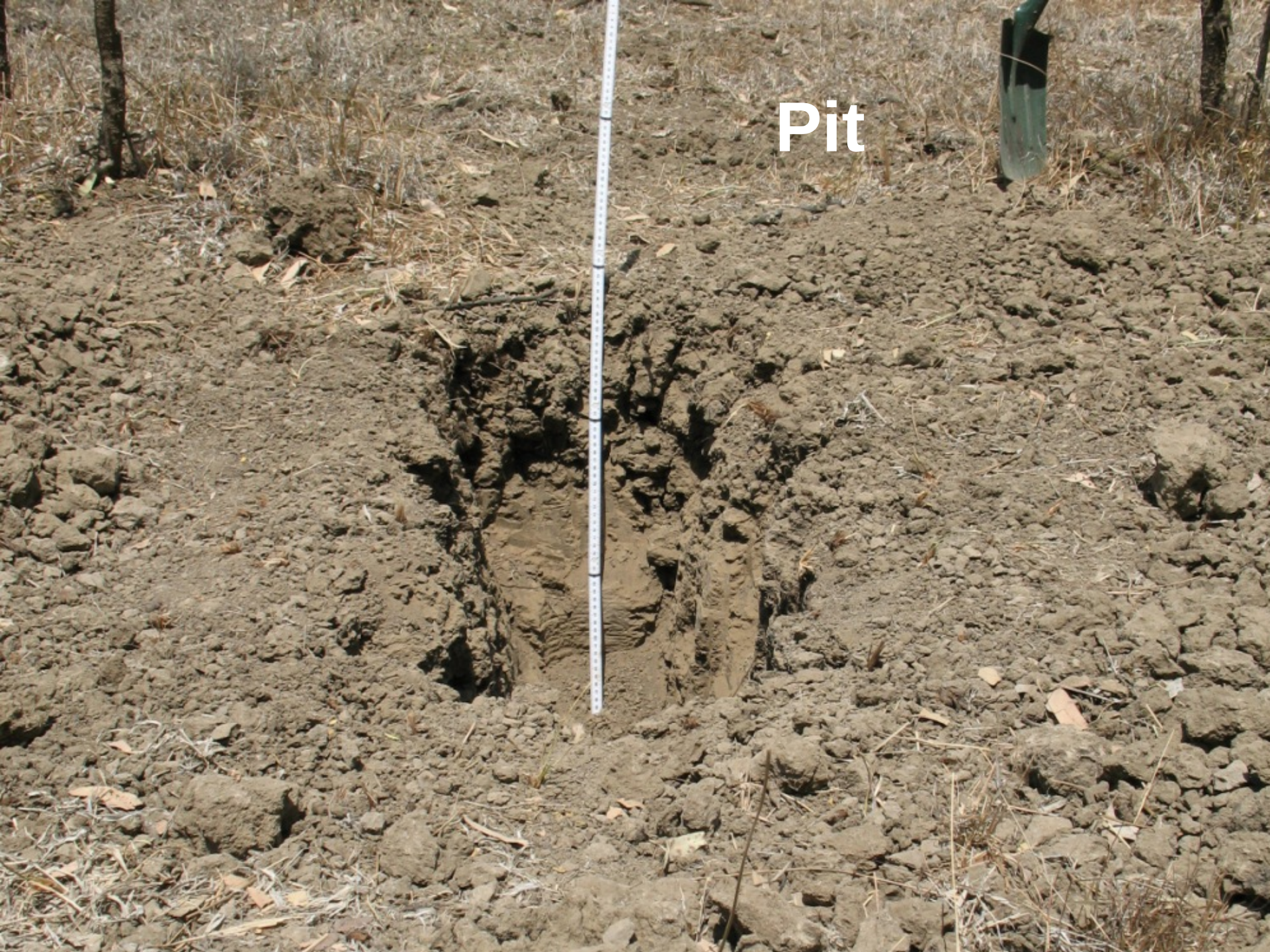
Bottom Outlet Sediment (BOS)

A power auger drilled to the **target** depth of 60 centimetres


A cleaned steel hand auger was used to collect approximately 6-10 kg of composite BOS sample


At least three auger holes over a 10 x 10 metres area


Trench

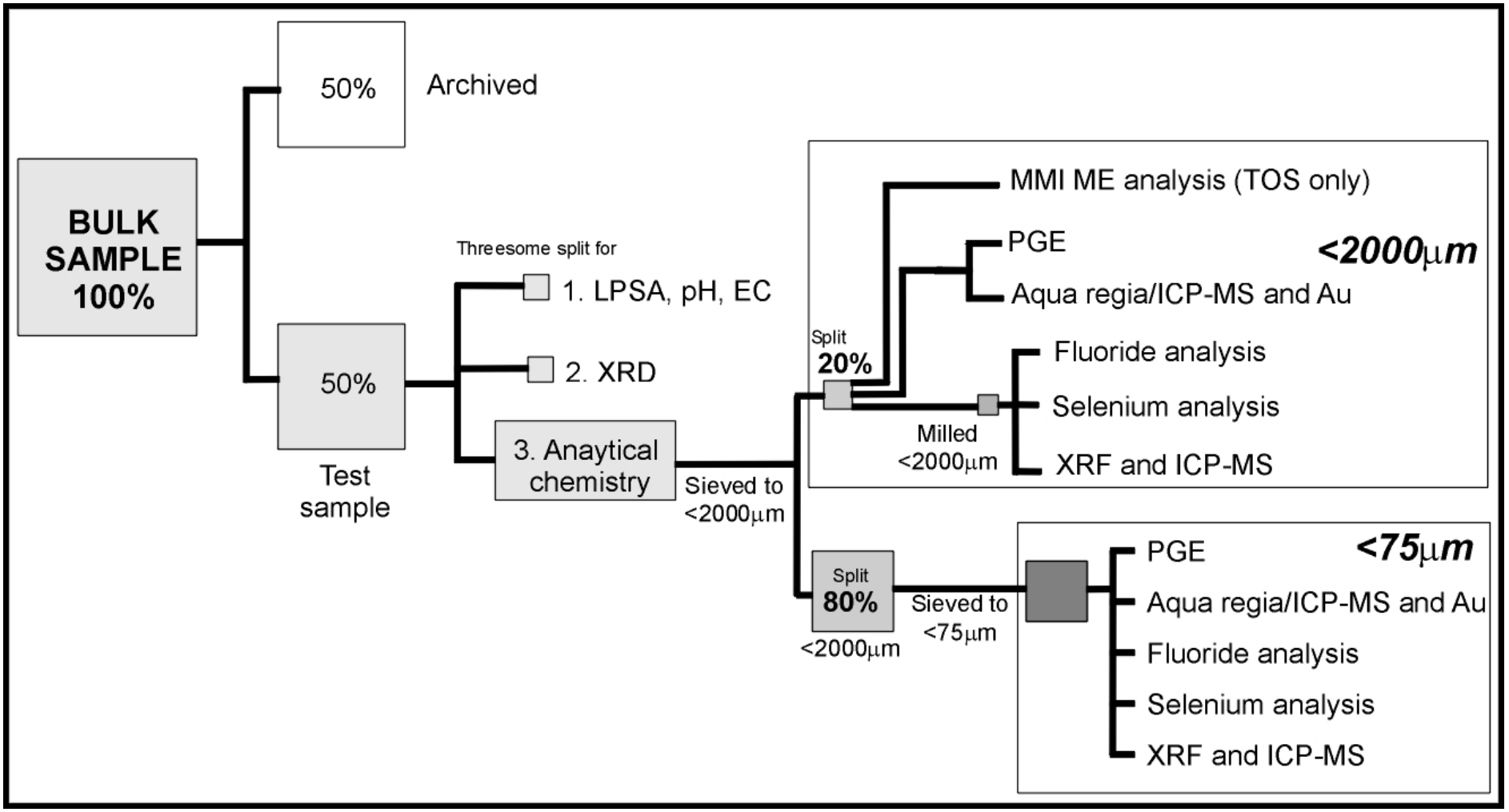

Pit

Sample site rehabilitation

Outlet sediment samples


Packing TOS
and BOS
samples
into plastic
buckets

Sample preparation and analysis



Data management

TARGET SITE	HORIZON	SUBSAMPLE	ANALYTICAL METHOD	ELEMENT	TOTAL ANALYSES
1	2	4	25	68	541

		<2mm	7	68	177
	TOS	<75mm	6	68	119
1					
	BOS	<2mm	6	68	126
		<75mm	6	68	119

Results and discussions

- NGSA samples were analysed using six +1 state-of-the-art techniques; most elements were analysed by >1 methods. Total QLD analyses is **189,891**
- An ocean of data
- Selection of Geochemical data for discussion

Selection of Geochemical data for discussion and Geochemical Atlas

ASSAY METHOD	ELEMENTS
Total XRF	Al, Ca, Cl, Fe, K, Mg, Mn, Na, P, S, Si, Ti
Total ICP-MS	Ba, Be, Ce, Co, Cr, Cs, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, La. Lu, Nb, Nd, Pr, Rb, Sc, Sm, Sn, Sr, Ta, Tb, Th, U, V, W, Y, Yb, Zr
AR-ICP-MS	Ag, As, Au, B, Bi, Cd, Cu, Hg, In, Li, Mo, Ni, Pb, Re, Sb, Te, Tl, Tm, Zn
FA-AR-PGE	Pd, Pt
ISE-F	F
AR-Se	Se

Geochemical appraisal

Differences between subsamples

- Least square difference computation
- $R^2 = \Sigma[(C_{75}-C_{Bulk})^2_{i1} + (C_{75}-C_{Bulk})^2_{i2} + ...)]$
  - where C_{75} is the elemental concentration in the <75 mm fraction
  - C_{Bulk} is the elemental concentration in the <2000 mm fraction
  - $_{i1}$ is the different elements considered in the computation

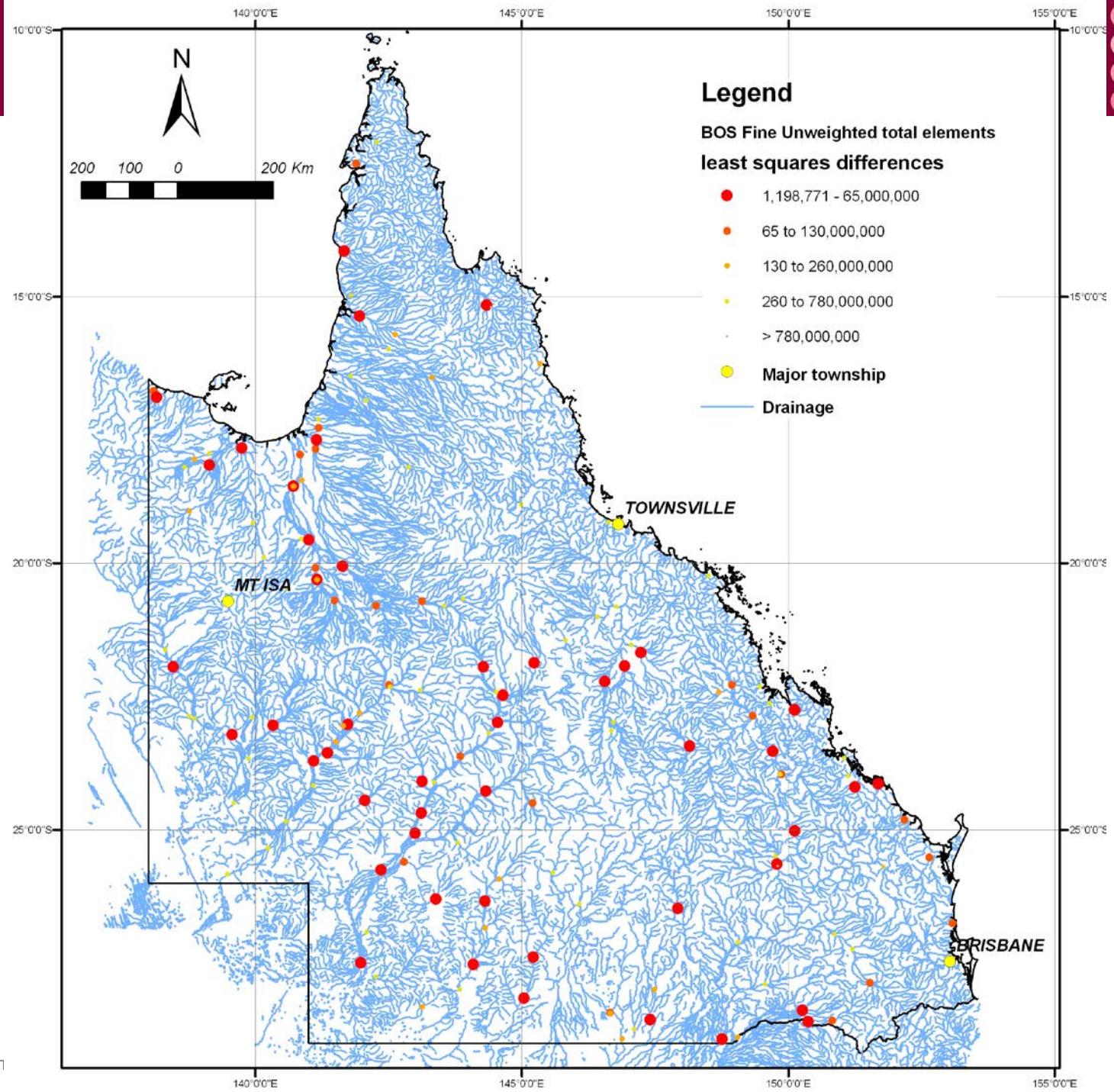
Intra-catchment characteristic

- Homogenisation of sediment

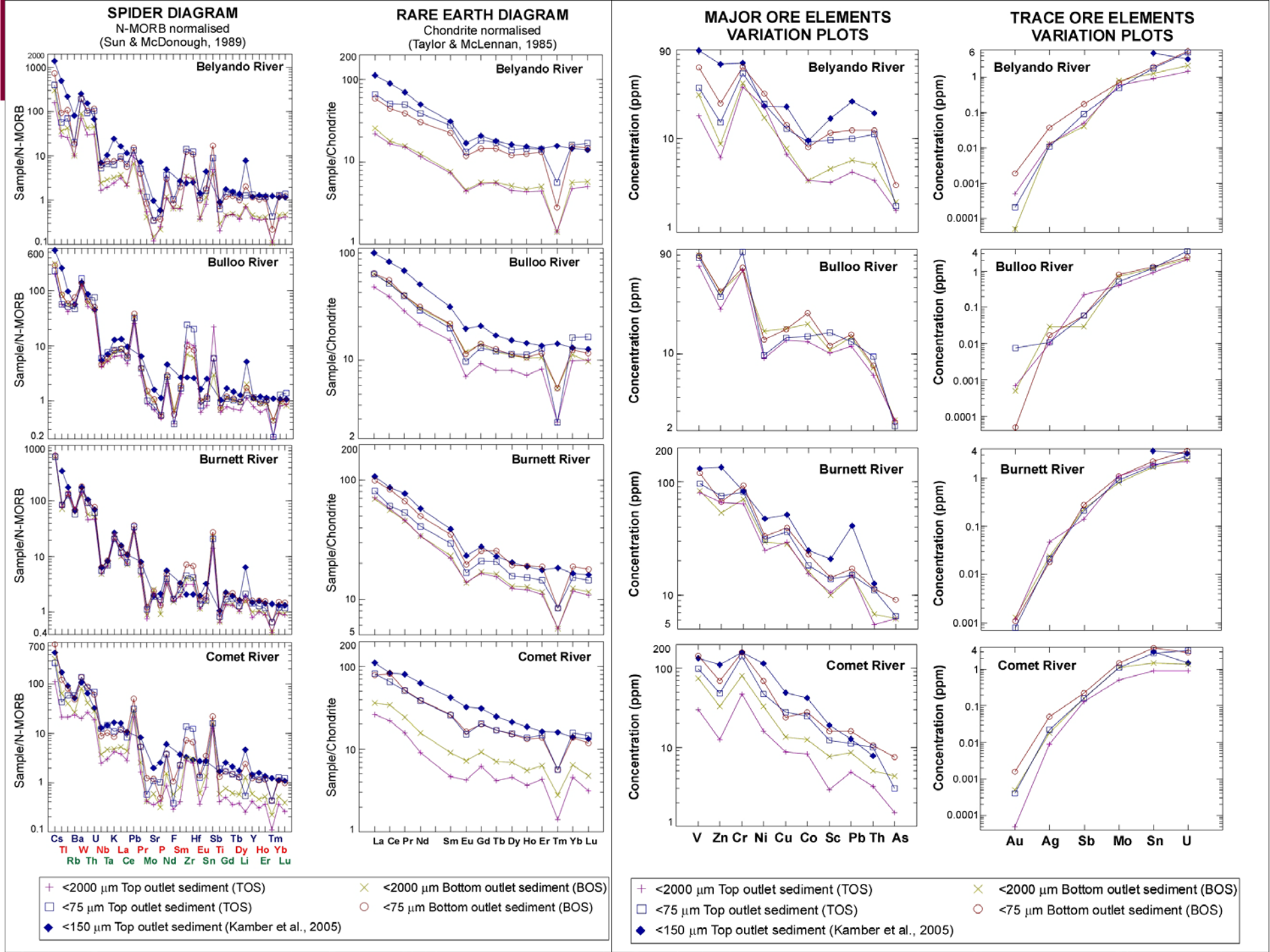
Inter-element relationship

- Pearson Correlation Coefficient

Geochemical background



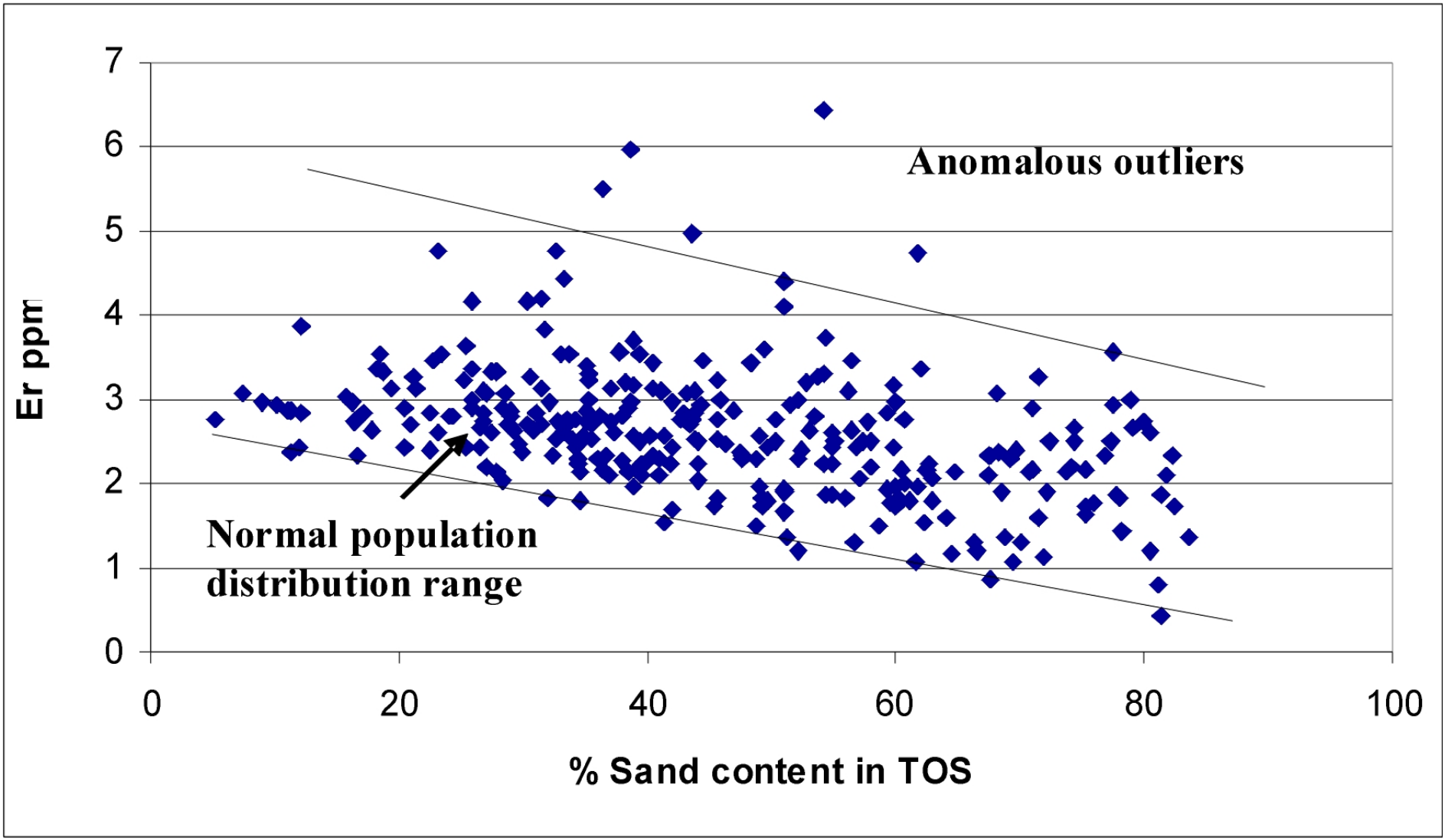
Geochemical differences between subsamples


SPIDER DIAGRAM
N-MORB normalised
(Sun & McDonough, 1989)
RARE EARTH DIAGRAM
Chondrite normalised
(Taylor & McLennan, 1985)
MAJOR ORE ELEMENTS
VARIATION PLOTS
TRACE ORE ELEMENTS
VARIATION PLOTS
Belyando River
Bulloo River
Burnett River
Comet River
Sample/N-MORB
Sample/Chondrite
Concentration (ppm)
Cs Ba U K Pb Sr F Hf Sb Tb Y Tm
Tl W Nb La Pr P Sm Eu Ti Dy Ho Yb
Rb Th Ta Ce Mo Nd Zr Sn Gd Li Er Lu
La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
V Zn Cr Ni Cu Co Sc Pb Th As
Au Ag Sb Mo Sn U
<2000 μm Top outlet sediment (TOS)
<75 μm Top outlet sediment (TOS)
<150 μm Top outlet sediment (Kamber et al., 2005)
<2000 μm Bottom outlet sediment (BOS)
<75 μm Bottom outlet sediment (BOS)

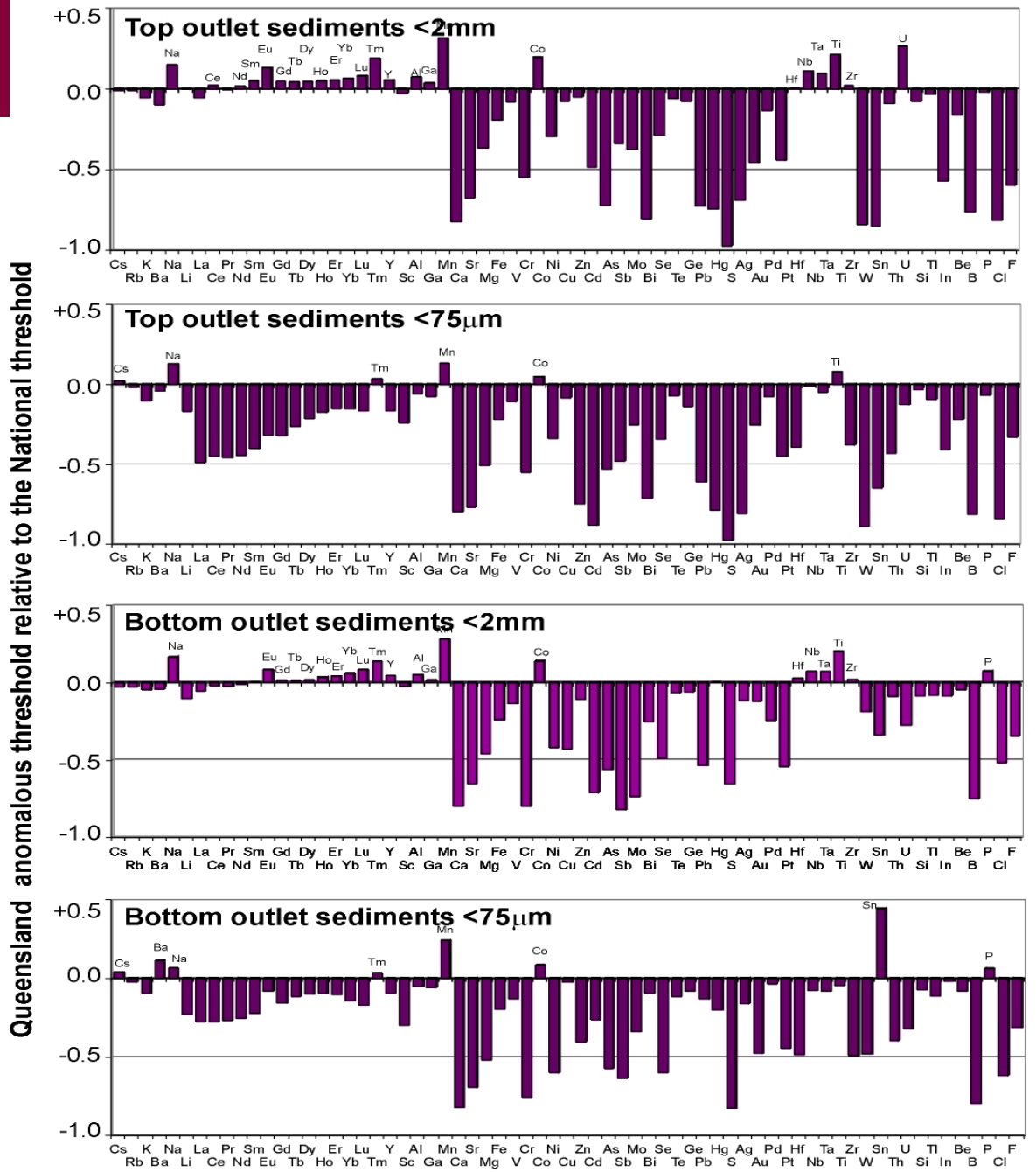
Queensland Mineral Prospectivity Atlas

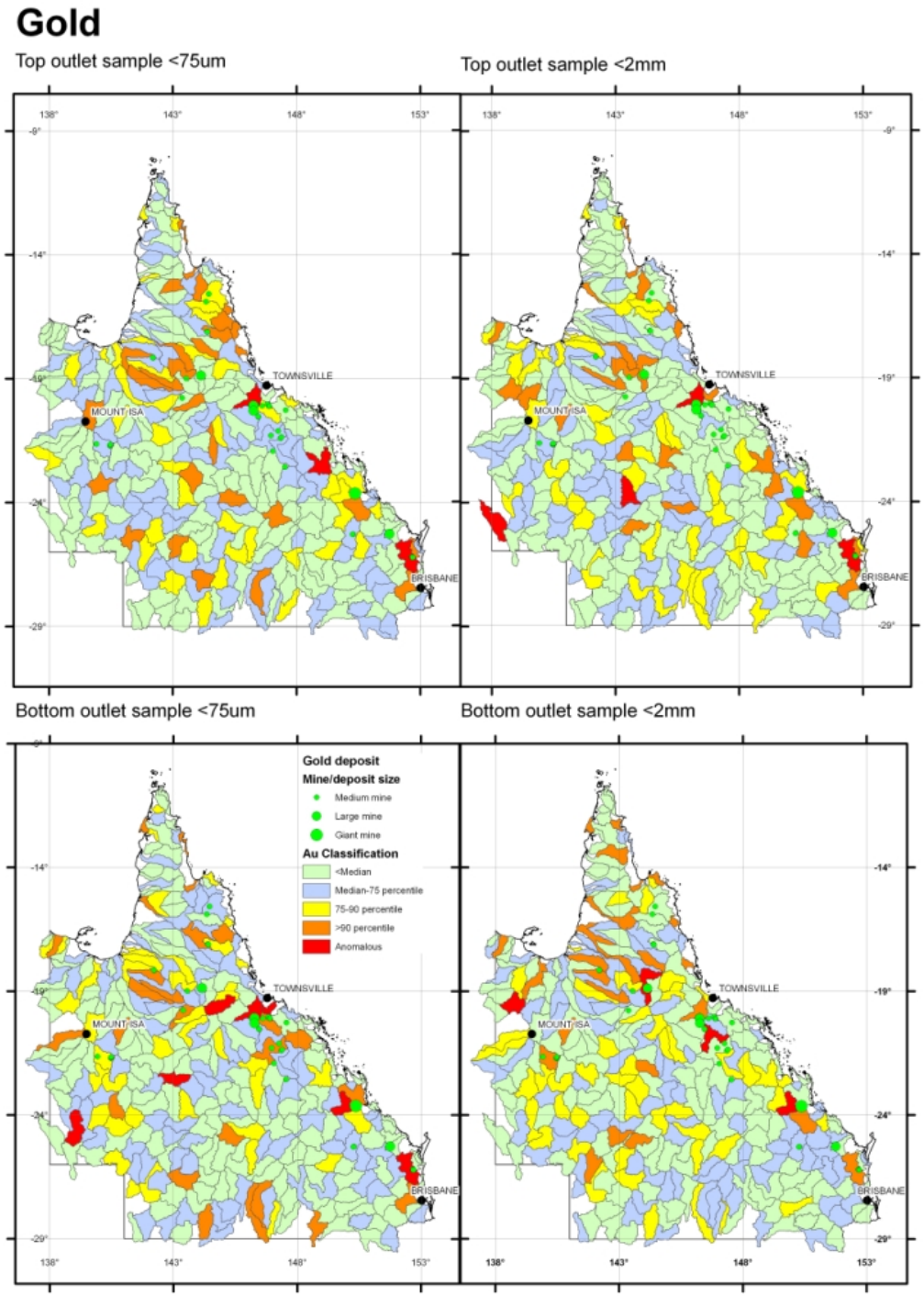
- Subsample and catchment are unique
- State-wide NGSA data were treated as a single population and analysed statistically
- Catchments were ranked by statistical breaks to highlight their mineral potential
- Four statistical breaks are at 50, 75 and 90 percentiles and the interpreted anomalous population (mean + 2SD)
- Sixty-eight (68) elements are included in this atlas
- The Atlas has the capacity for identifying undiscovered regional mineral potential

The simple concept



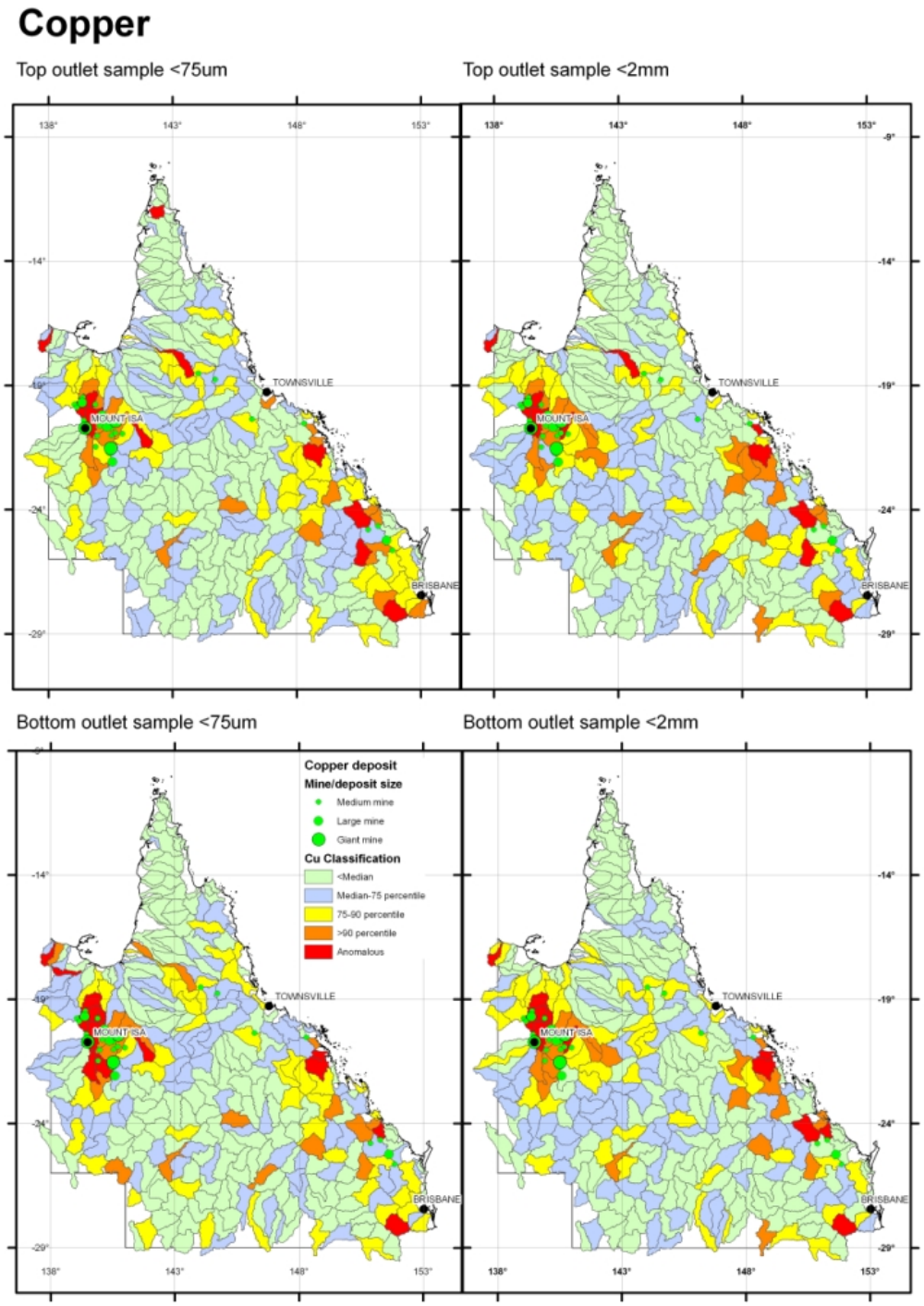
Benchmarking





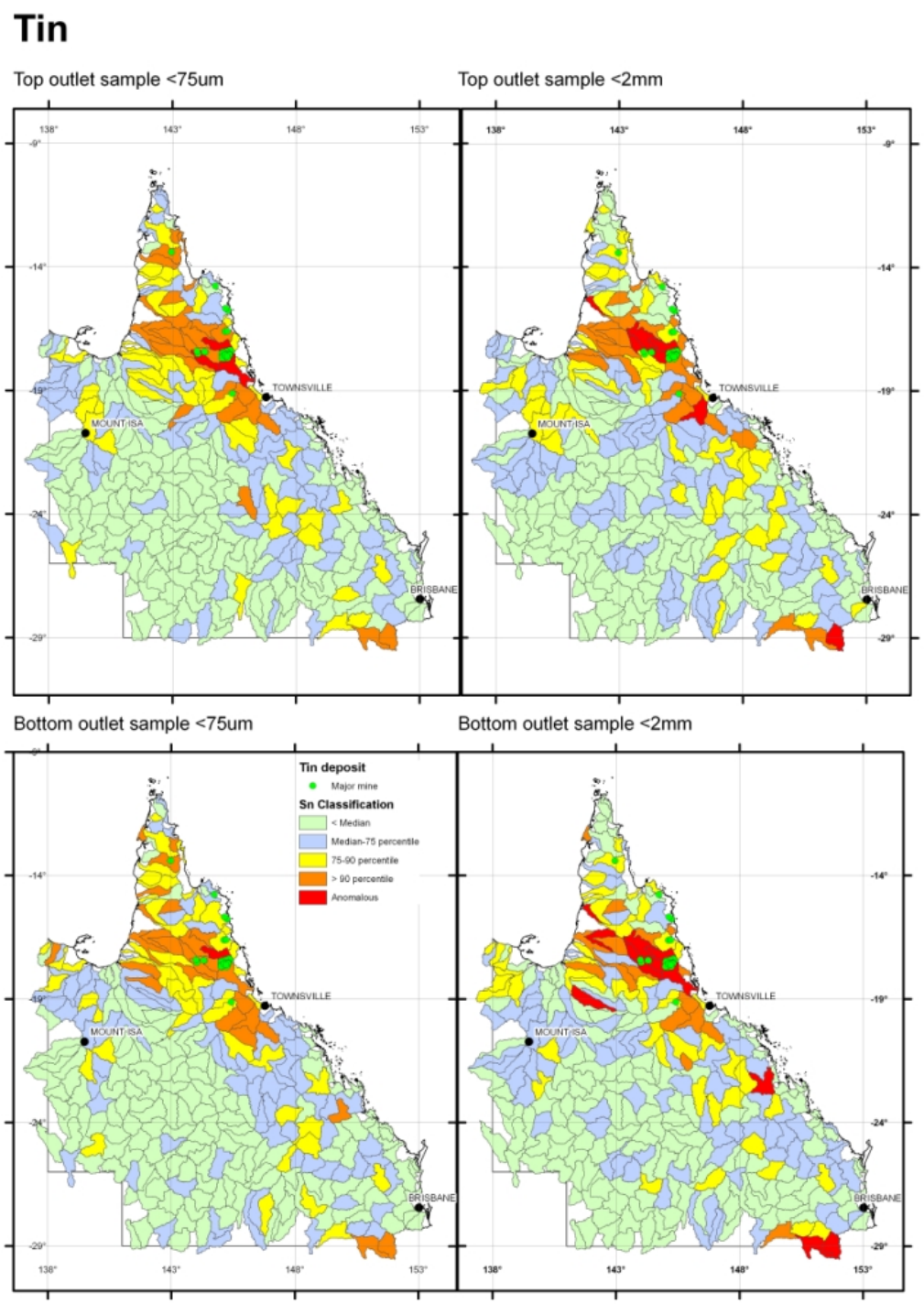
Gold anomalies

- Relatively widespread- known and NEW anomalies
- **Mary River** = Gympie mine associated with As, Hg, Cr, Ni; ± Ag, Mg, Mn, P, Sb, S and Se
- **Fitzroy & Isaac Rivers** = Mount Morgan mine, associated with Zr, Ti, Si, Sm, Hf ± Al, Ga, Fe and Sc that suggested detrital or residual deposit signatures
- **Thomson & Western River** anomalies = NEW. Association with Sr-Cl-Ba-Mn-S-Re-Zn and mobile elements is likely linked to ground water. Needs follow-up
- **Eyre Creek** are associated with B-Re; weakly with Cd-In-Mo; geochemical signature is similar to IOCG deposit e.g. Kalman
- **O'Shannassy River** anomaly is associated with Ca-F-Mg-Pb-Gd-P-Sb-U; either lithologic association (limestone and phosphatic rocks) or fluoroapatite vein association.



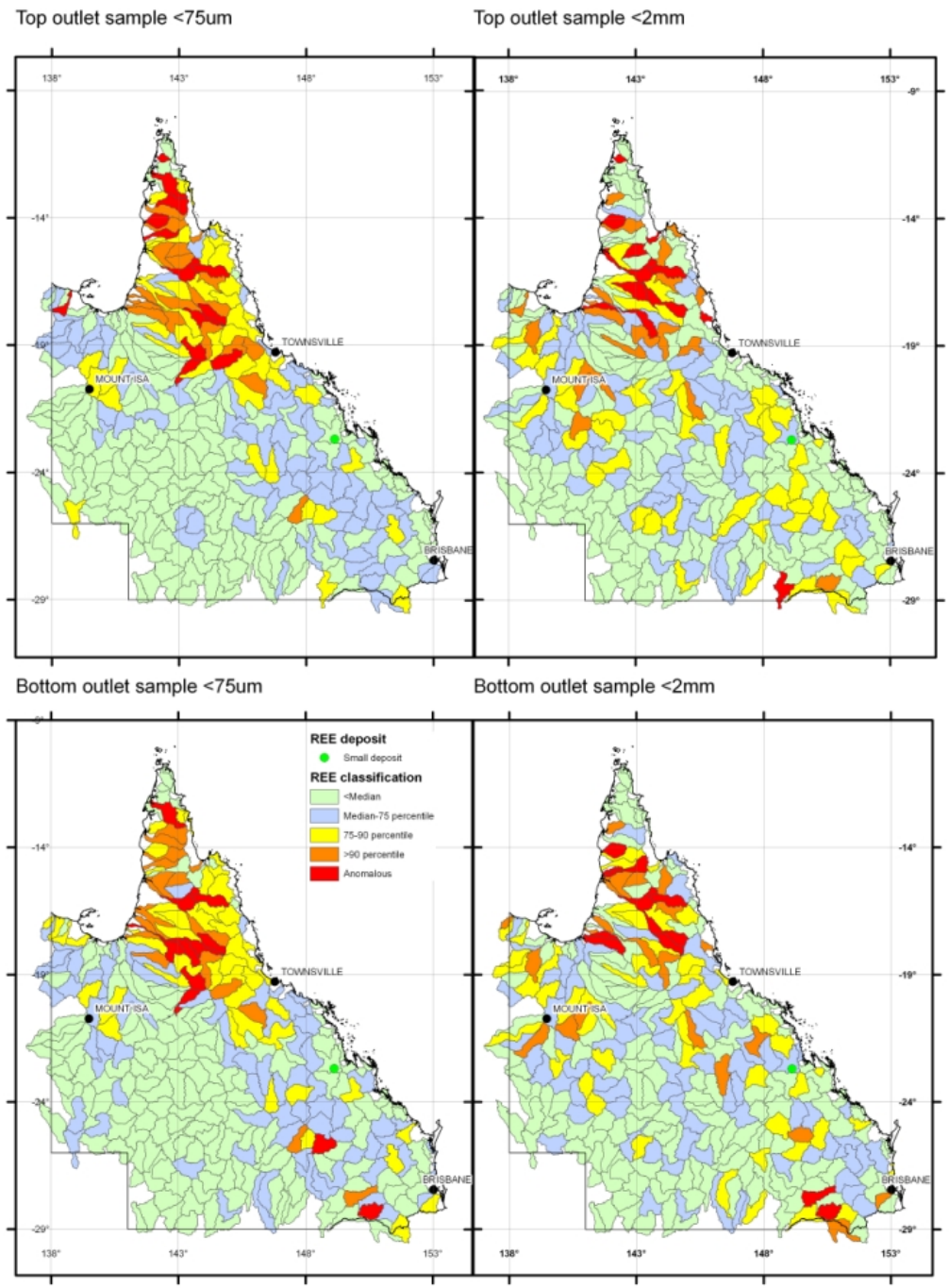
Copper anomalies

- Copper anomalies in and around the **Mount Isa Block** are associated with known Cu mines
- Anomalies within the **NEO** are identified around the Texas-Silverwood Block (Condamine River catchment), along the Don River (90 km southwest of Rockhampton), in the Boyne River catchment (40 km south of Gladstone) and in the Funnel Creek and Pioneer River catchments near Mackay
- Copper anomaly was identified in the **Westmoreland** region along Settlement Creek



Tin anomaly

- Tin anomaly in **Cape York** region is associated with As, Bi, Be, Cs, F, K, Rb, Ta, rare earth elements (La, Tb, Dy, Er), Th and U
- The anomaly in **Texas** region is associated with As, Be, Cs, K, Na, Rb and Ta
- Late stage concentration of incompatible elements under oxidised conditions, such as pneumatolitic veins or a highly fractionated magma system



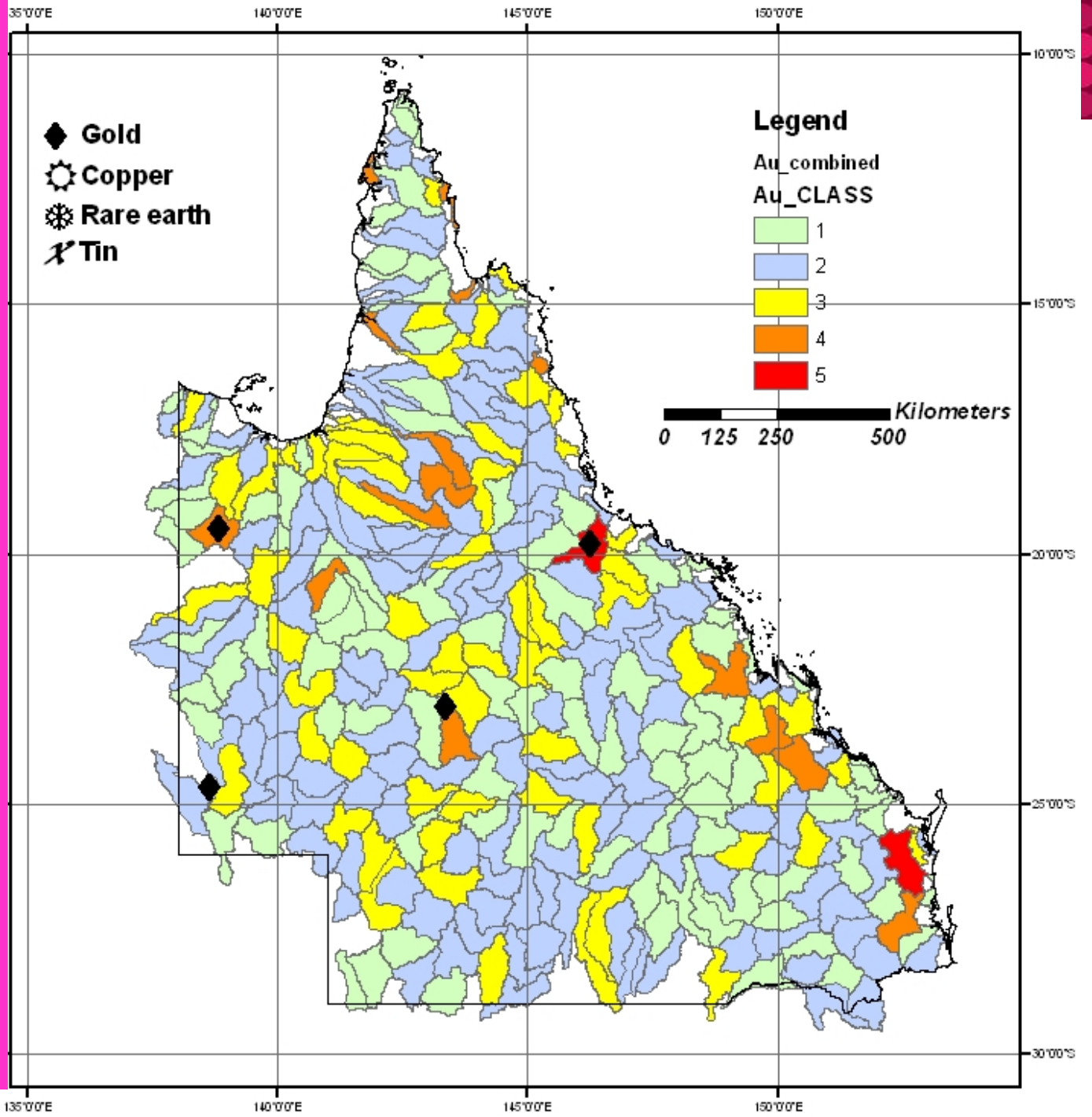
Total Rare Earth Elements

REE anomalies occur in three distinct regions:

- **Cape York Peninsula**: anomaly covers regions from the Georgetown Block to areas north of Weipa
  - Association of REE with fluorine suggests a strong link to possible detrital heavy minerals derived from fluorite-rich granite or vein systems
- Around **Texas-Silverwood Blocks** within the Condamine and Moonie Rivers, and Commoron and Warrill Creeks.
- Within the **Comet River** catchment: primarily for medium-heavy REE associated with Co, Fe, Ni, Sc, Ti, V, Ga, In, Nb and Ta.
  - Elemental association postulates a likely peralkaline intrusive source

Eldorado?

Rare earths



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- TANG, J.E.H. & BROWN, D.D., 2011: Queensland Mineral Prospectivity Atlas, National Geochemical Survey of Australia. *Queensland Geological Record* **2011/08**.