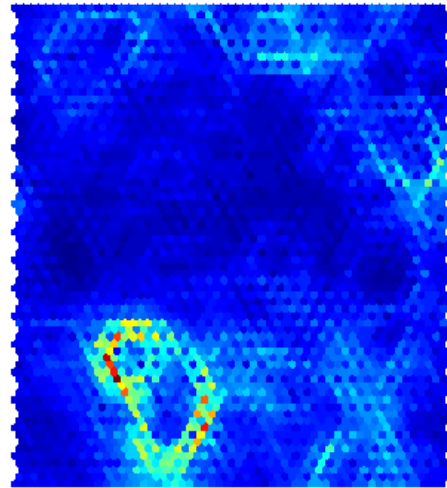
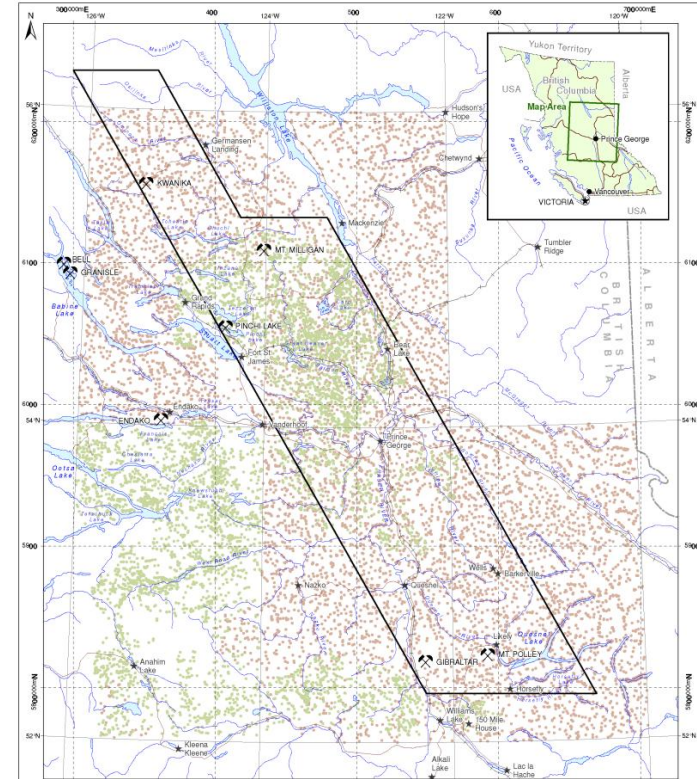


Input nD Data



U-matrix with selected components only

Self-Organized Map

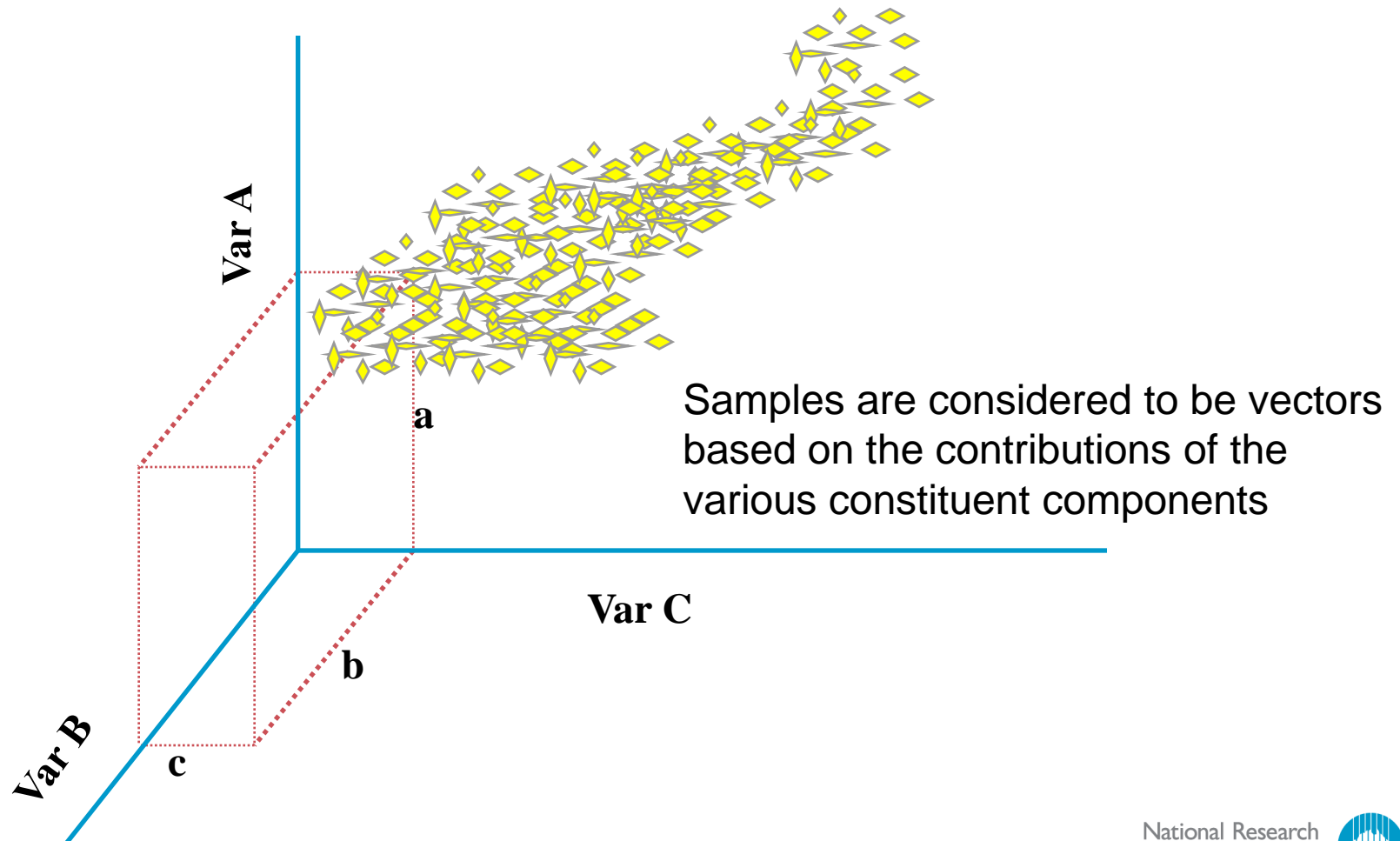


# Self Organizing Maps for Targeting within Regional Geochemical Data Sets

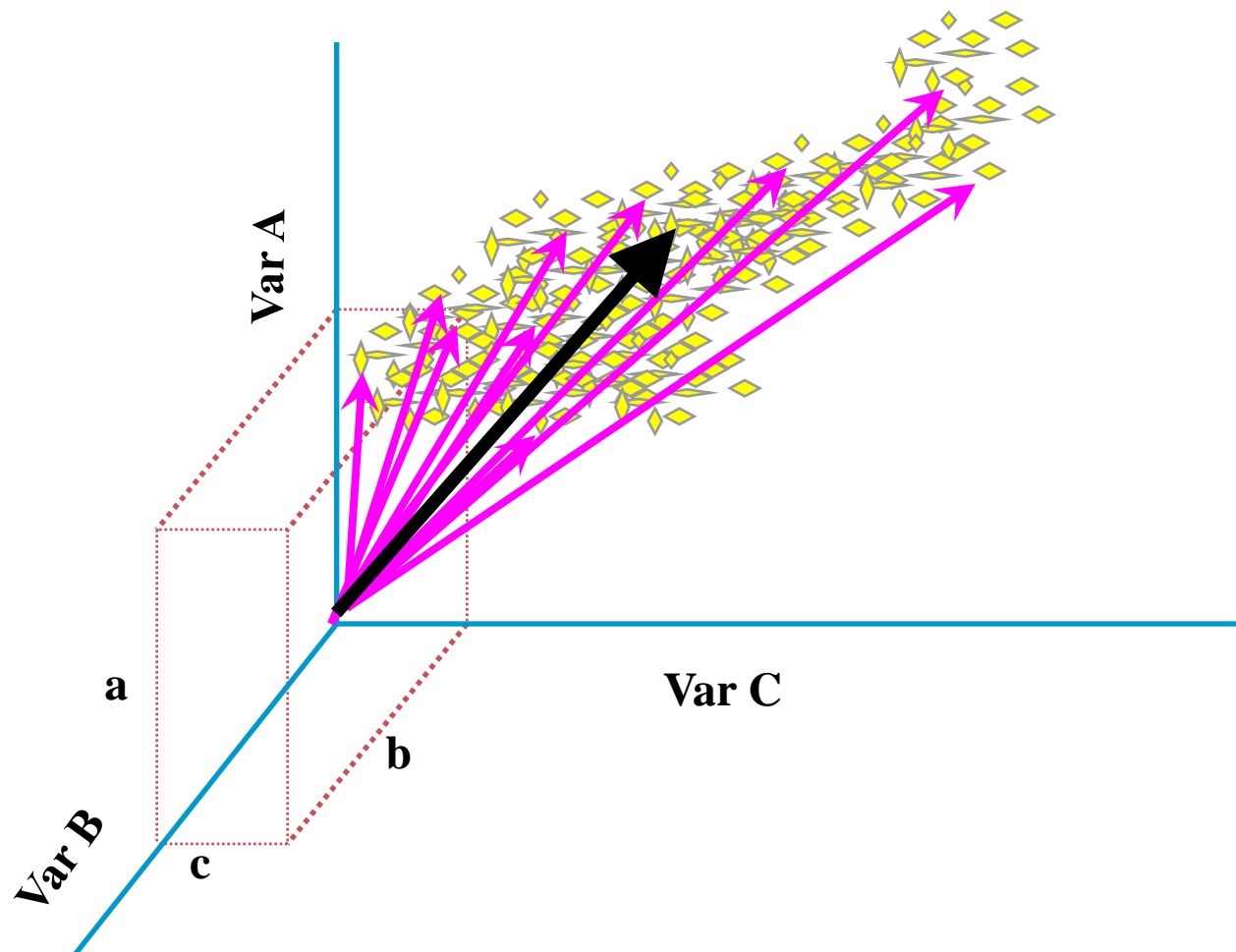
Stephen Fraser, Bruce Dickson,  
Peter Kowalczyk & Jane Hodgkinson

# SOM Background - #1

Consider a grouping of similar/related samples in n-D space



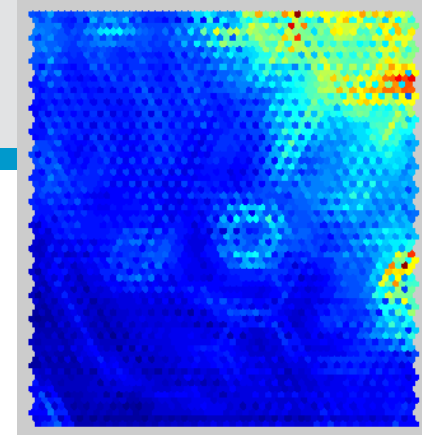
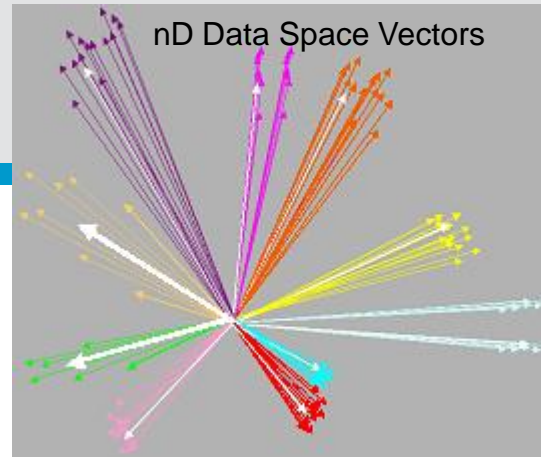
# SOM Background - #1



# Background: Self Organizing Maps

• A segmentation and visualization technique to explore relationships between diverse data types:

- Based on principles of vector quantization and measures of vector similarity;
- Can handle Non-linear relationships and Non-Gaussian data distributions;
- Can handle categorical (nominal) data and “labels”;
- Can handle Nulls, hence sparse data can be accommodated.
- Outputs 2D “orderly-maps” that represent the nD data structure and maintains the relationships between data inputs.

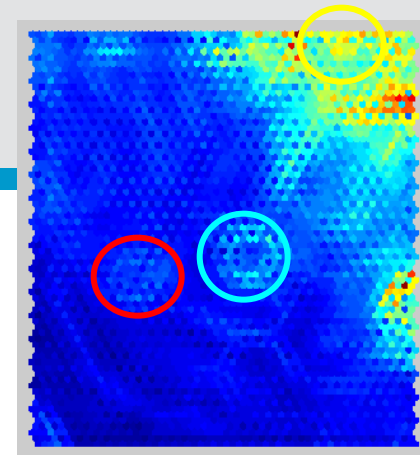
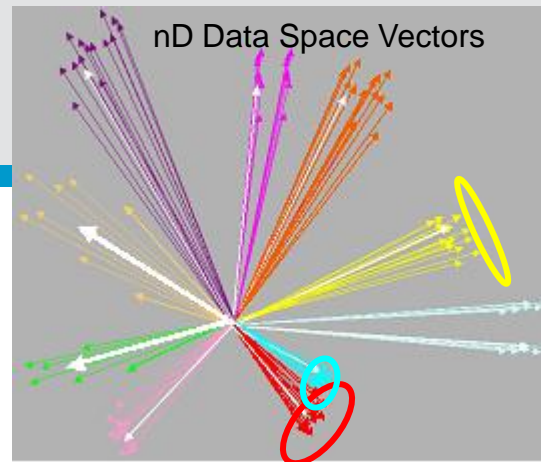


**2D Self Organized  
“Map” Representation of  
Samples: Colours  
indicate similarity or  
dissimilarity of adjacent  
nodes**

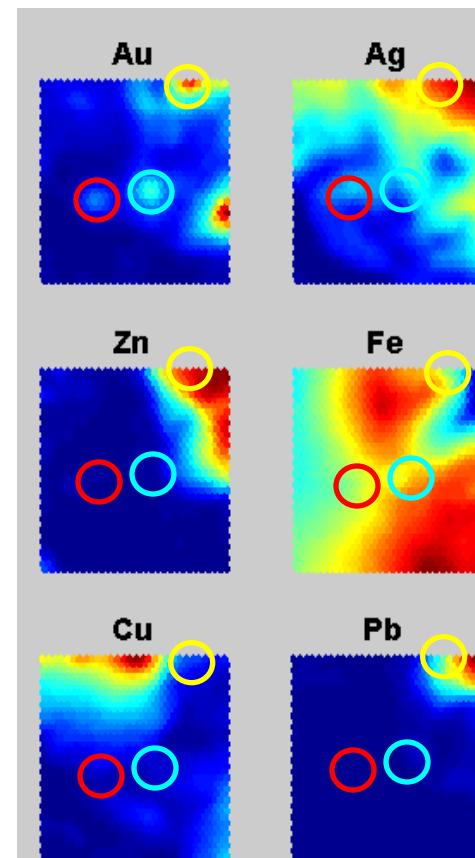
# Background: Self Organizing Maps

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2D Self Organized “Map” Representation of Samples: Colours indicate similarity or dissimilarity of adjacent nodes

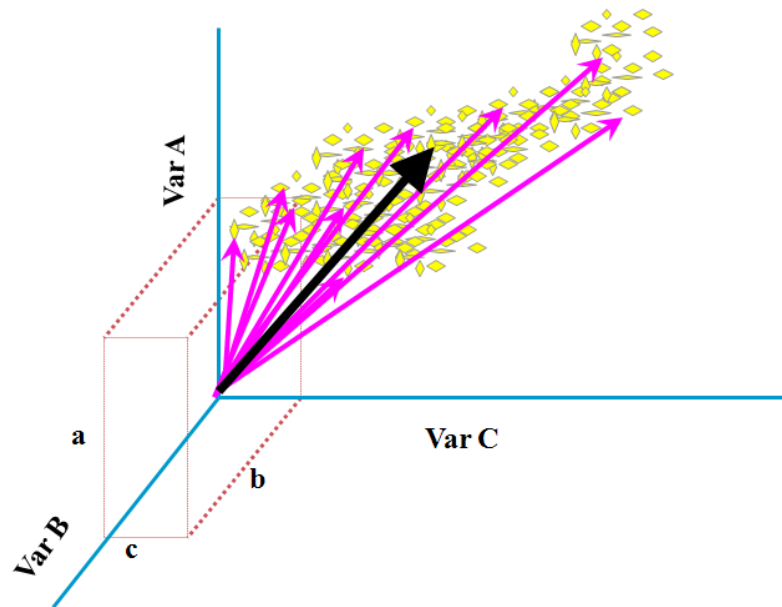


Variable Contributions for samples shown on the “Map” - “Component Plots”: Colours indicate spread of values across range of input values.



# Challenges & Pre-processing of “QUEST” Input Data (140,000km<sup>2</sup> Central British Columbia)

- Stream and Lake Sediment Samples collected from over a ~30 year period from past and present surveys
  - Lake and Stream sediments, collected in a varied background of different rock packages, glacial and fluvial overburden.
  - Different analytical techniques, element suites, detection limits, and levels of precision on sample media, over time;
- Barnett and Williams <sup>[1]</sup> addressed above issues:
  - (1) Select preferred analytical method and detection limit for each element;
  - (2) Re-levelling and blending of adjacent geochemical surveys for the selected method/element combination; and
  - (3) Imputation of missing data values (on a site basis) so spatial coverages of all selected elements were comparable.
- Approximately ~ 15,000 samples x 42 elements used as input.



Quantization Error is the distance a sample is from the SOM node-vector that represents it

## “Global Anomalism” (via Quantization Errors)

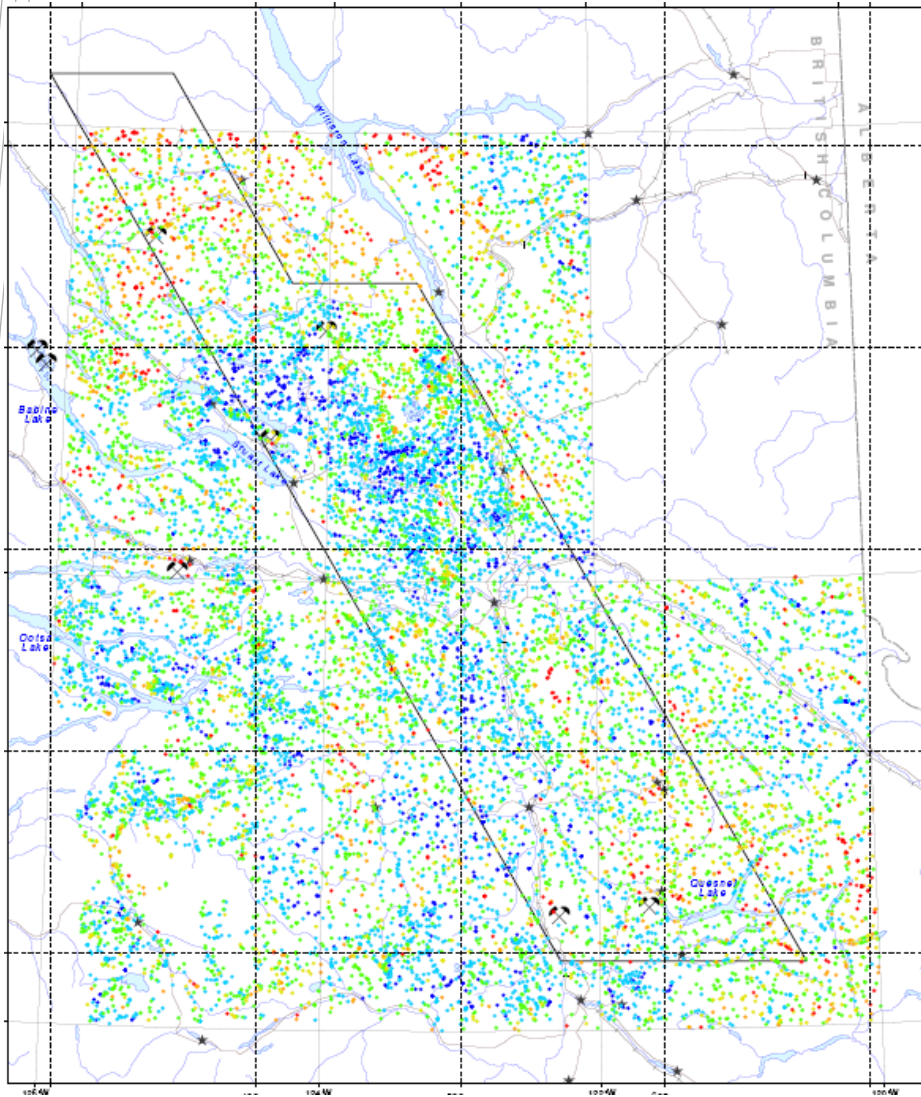
# “Global” Anomalism (as determined by Quantization Error (QER))

QER is calculated for each sample when it is mapped to a Best Matching Unit (BMU).

QER is a measure of how “different” a sample is to its BMU

## Quantization Error Value Breakdown

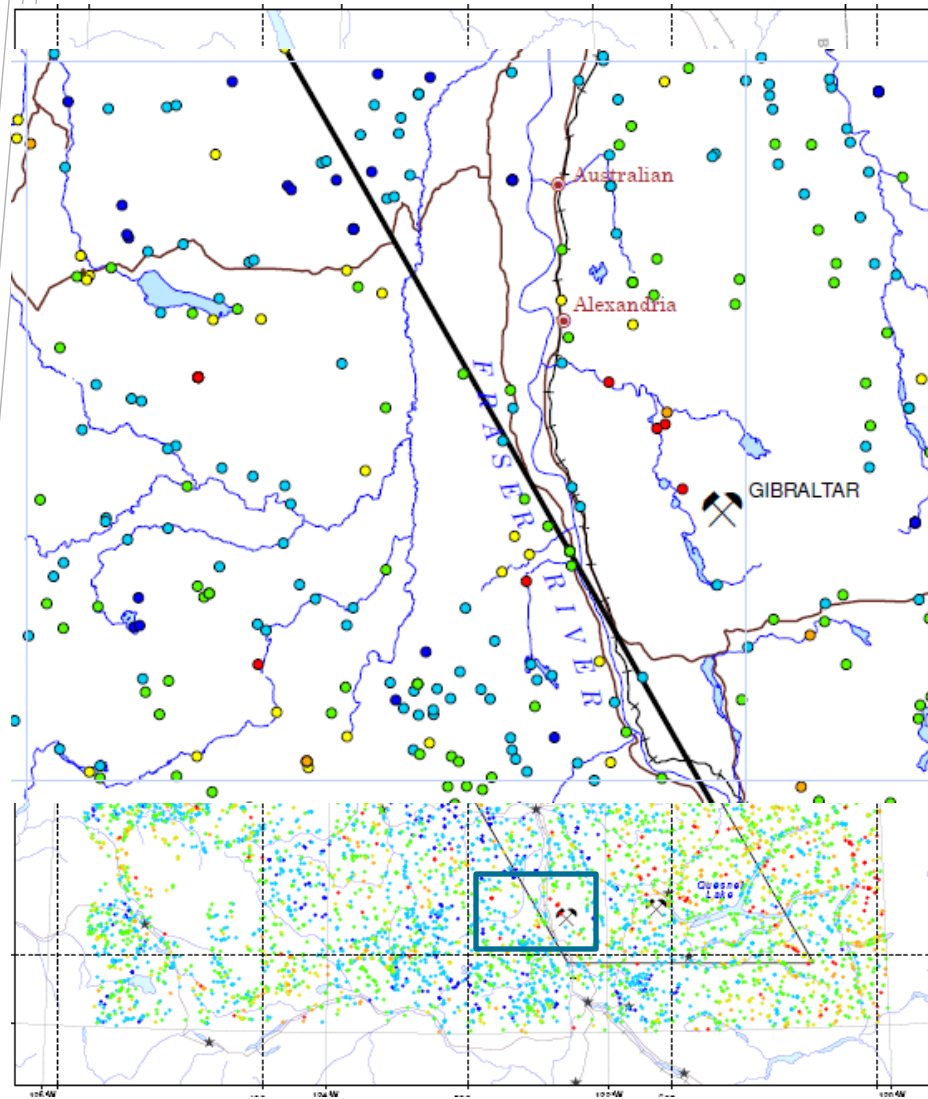
- > 6
- 5 - 6
- 4 - 5
- 3 - 4
- 2 - 3
- 0 - 2



Samples coded by QER



# “Global” Anomalism (as determined by Quantization Error (QER))



Samples coded by QER

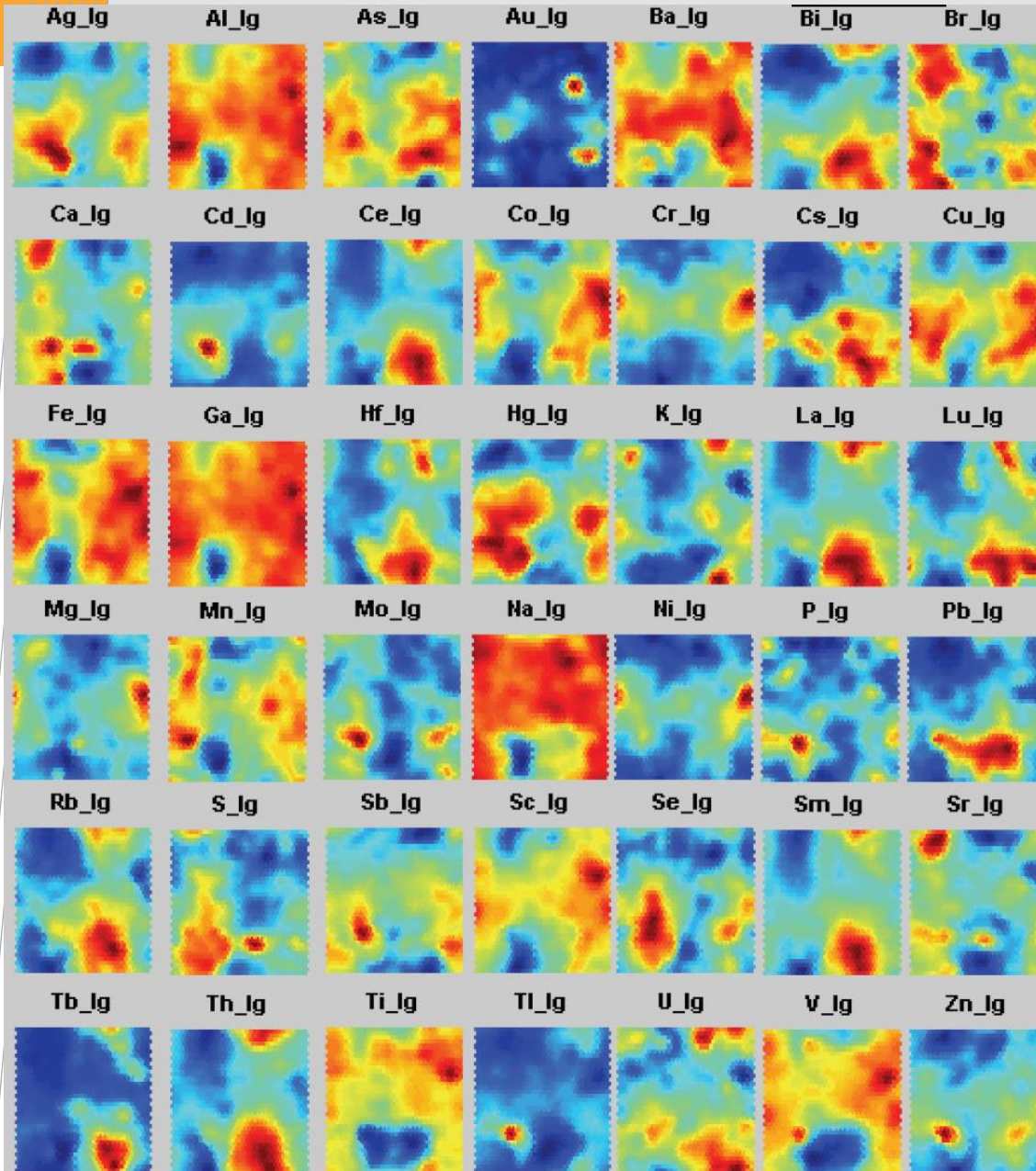
Down stream from Gibraltar –  
anomalous dispersion trail

## Quantization Error Value Breakdown

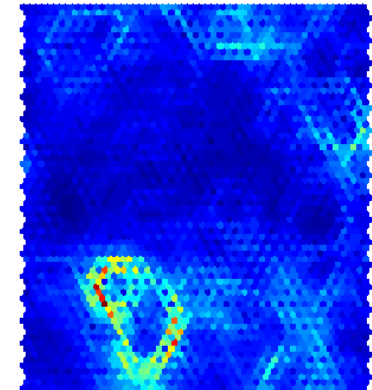
- > 6
- 5 - 6
- 4 - 5
- 3 - 4
- 2 - 3
- 0 - 2

# K-means Cluster Normalized Elemental Maps

# Component Plots for each of the 42 elements



U-matrix



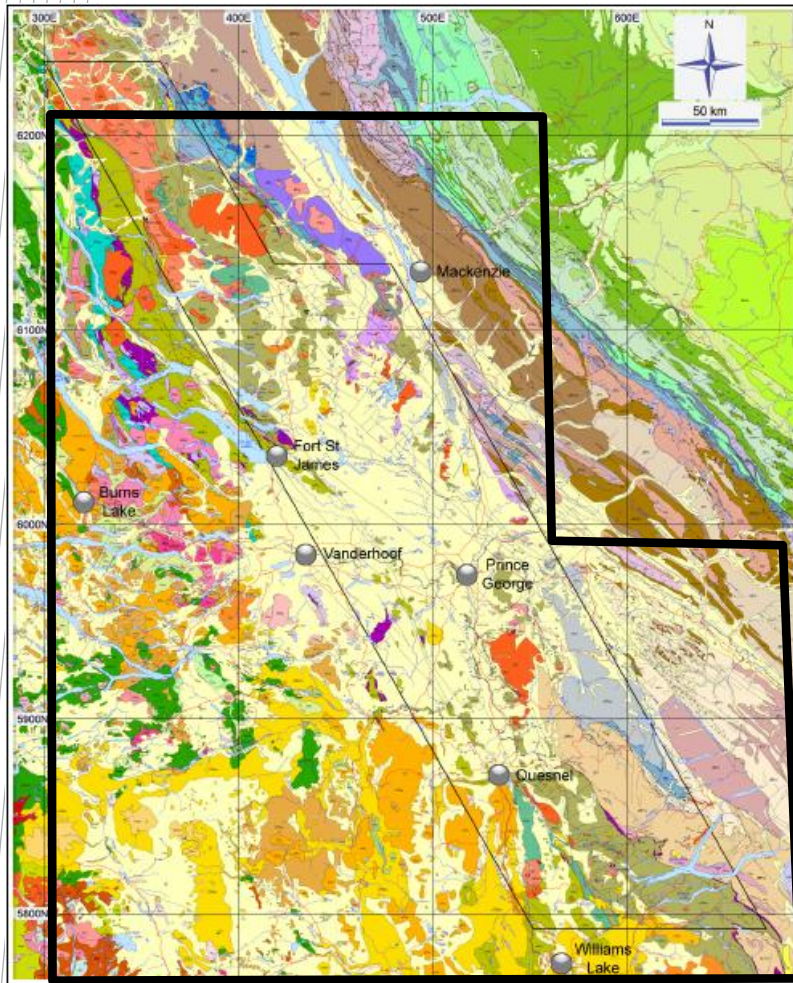
U-matrix with selected components only

Color code

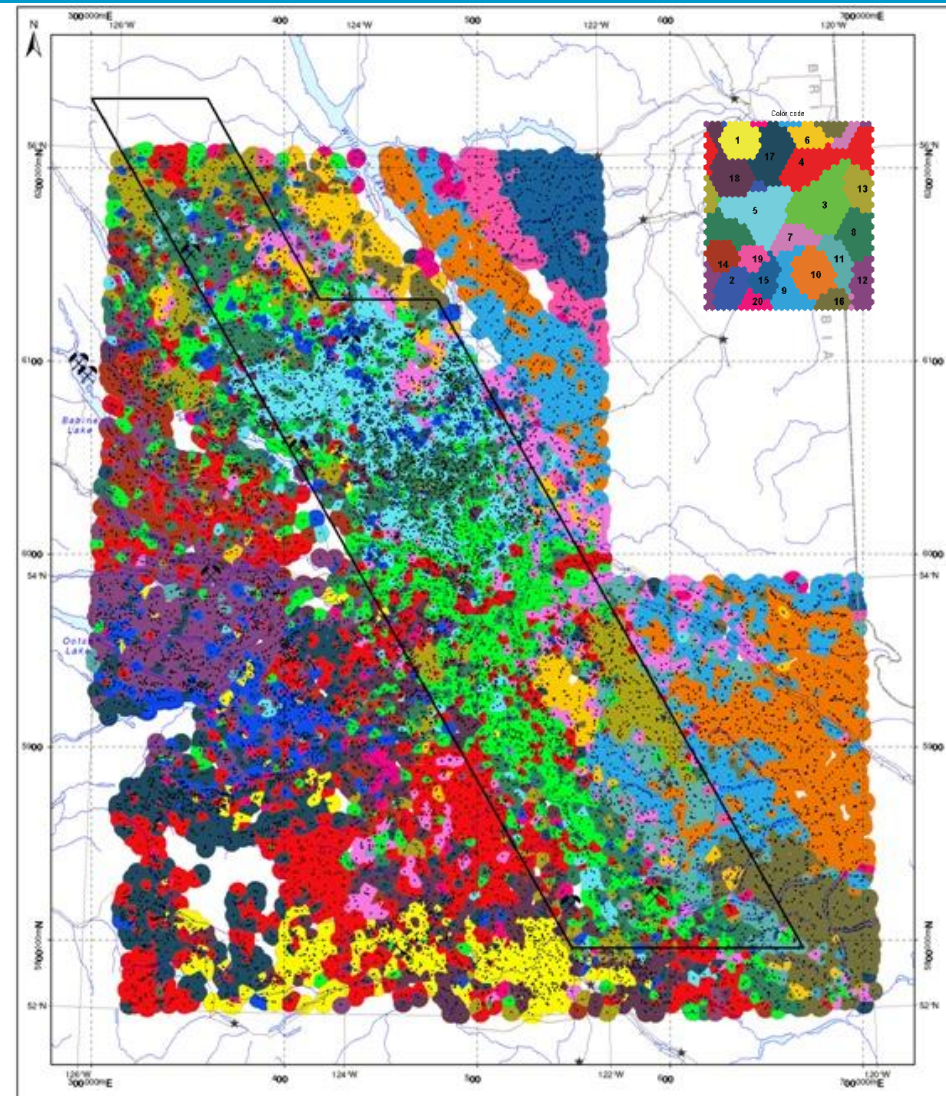




# Surficial Geology vs Samples Coded by K-means on SOM Nodes (20 clusters)



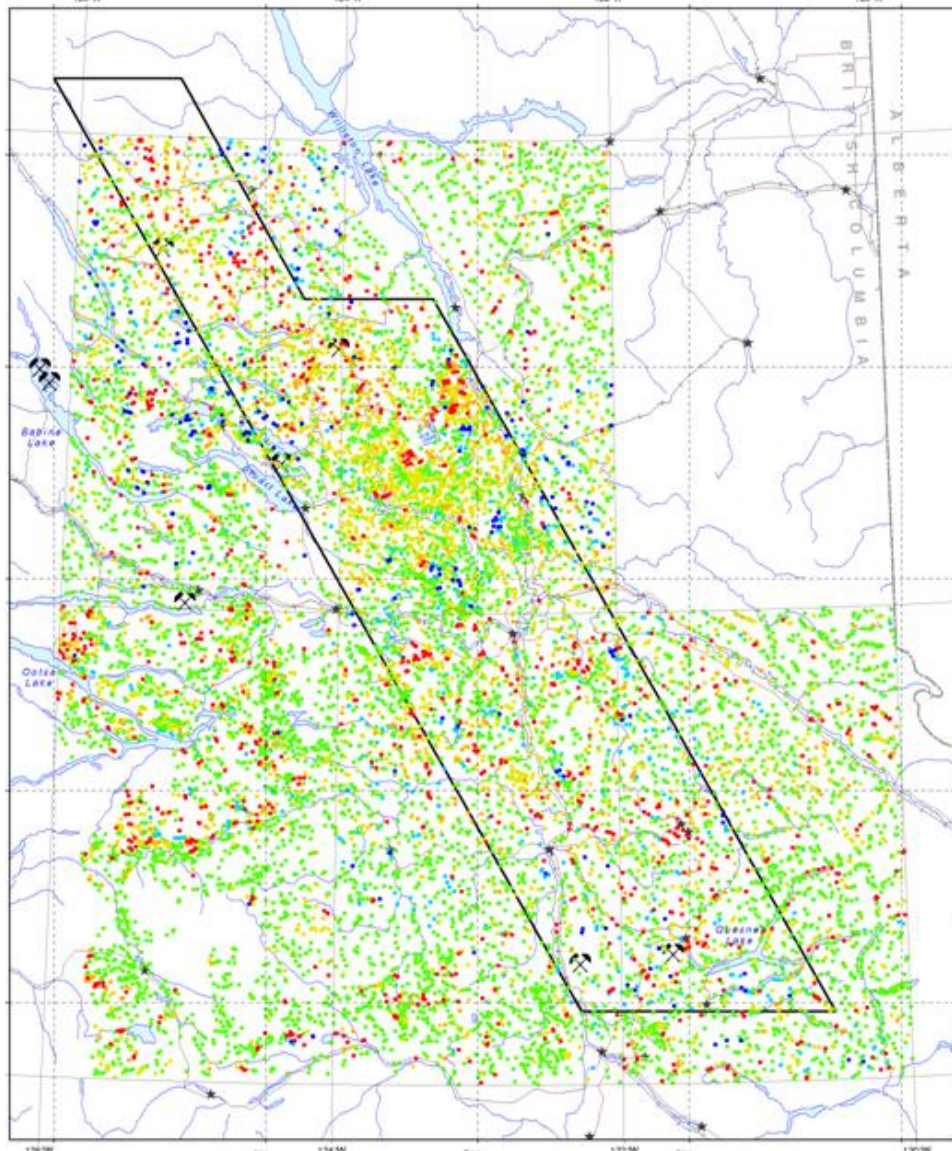
Surficial Geology



K-means on SOM Nodes

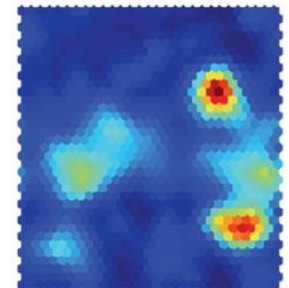


# Cluster-Normalized Elemental Maps – Au – example



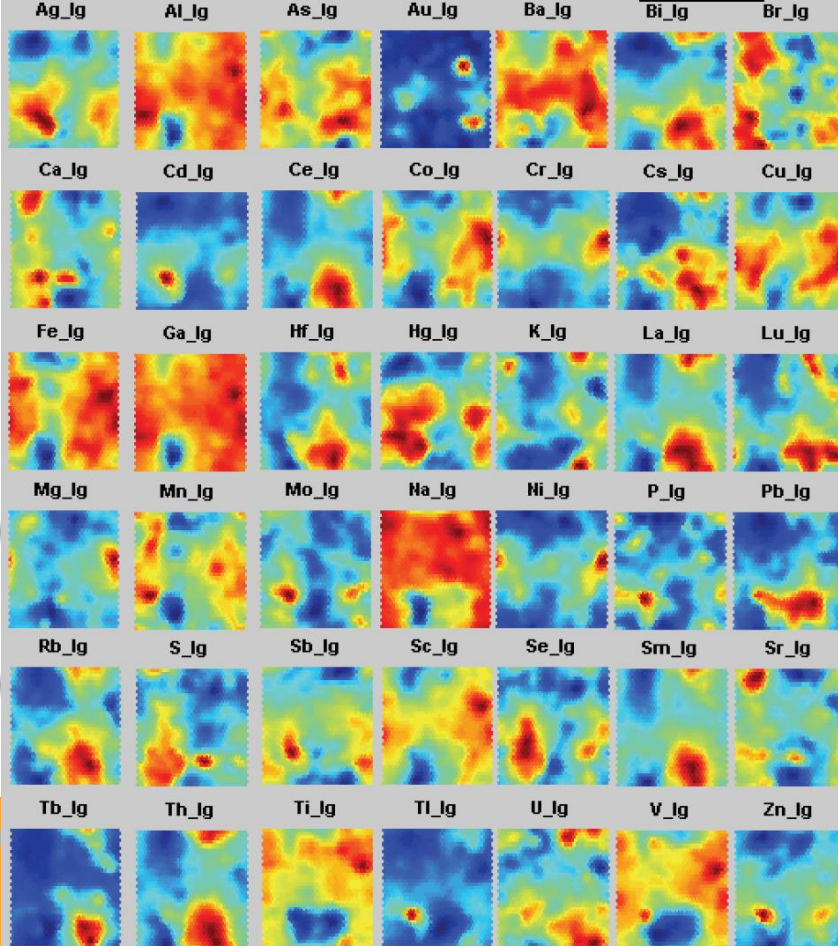
Normalized Gold Anomaly  
Value Breakdown

- > 1.5
- 1 to 1.5
- 0 to 1
- -1 to 0
- -1.5 to -1
- < -1.5



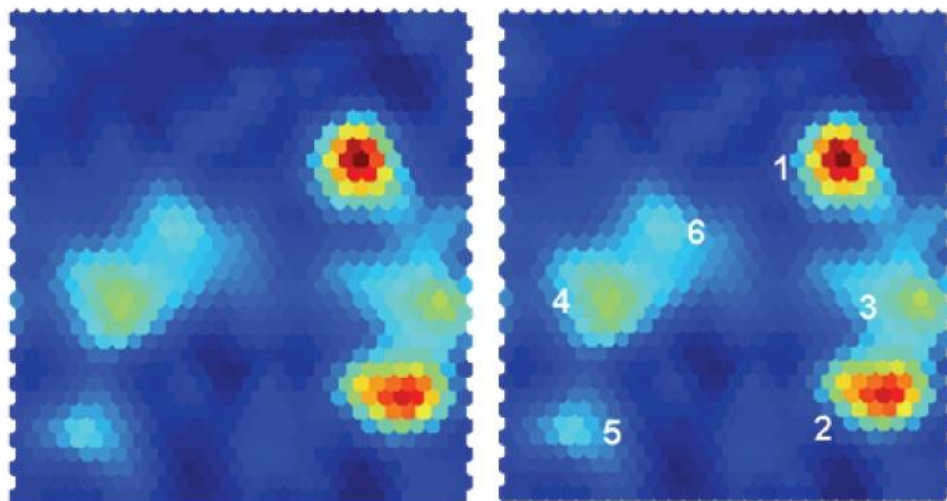
Maps for each  
element available  
from GBC web site





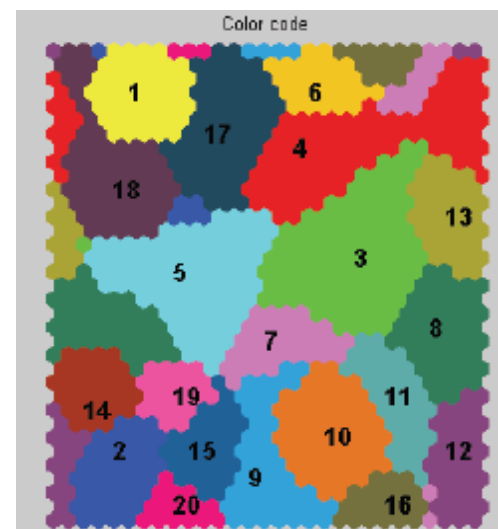
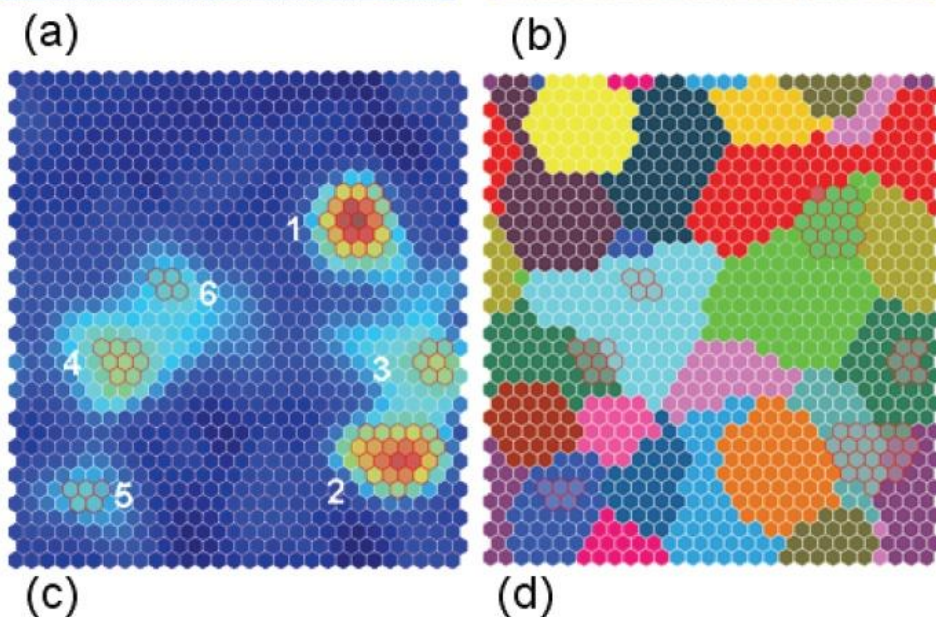
# Component Plot - Element Distributions

# Au Component Plot



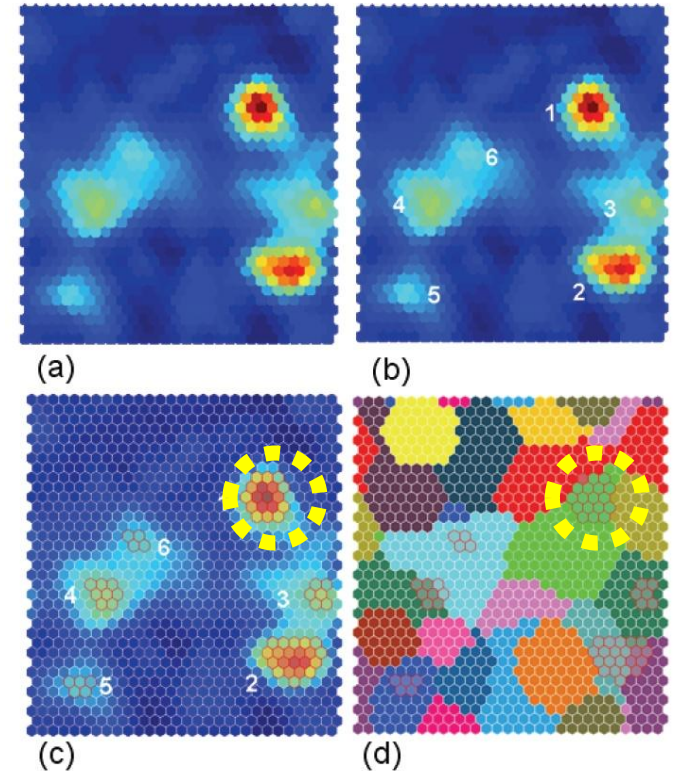
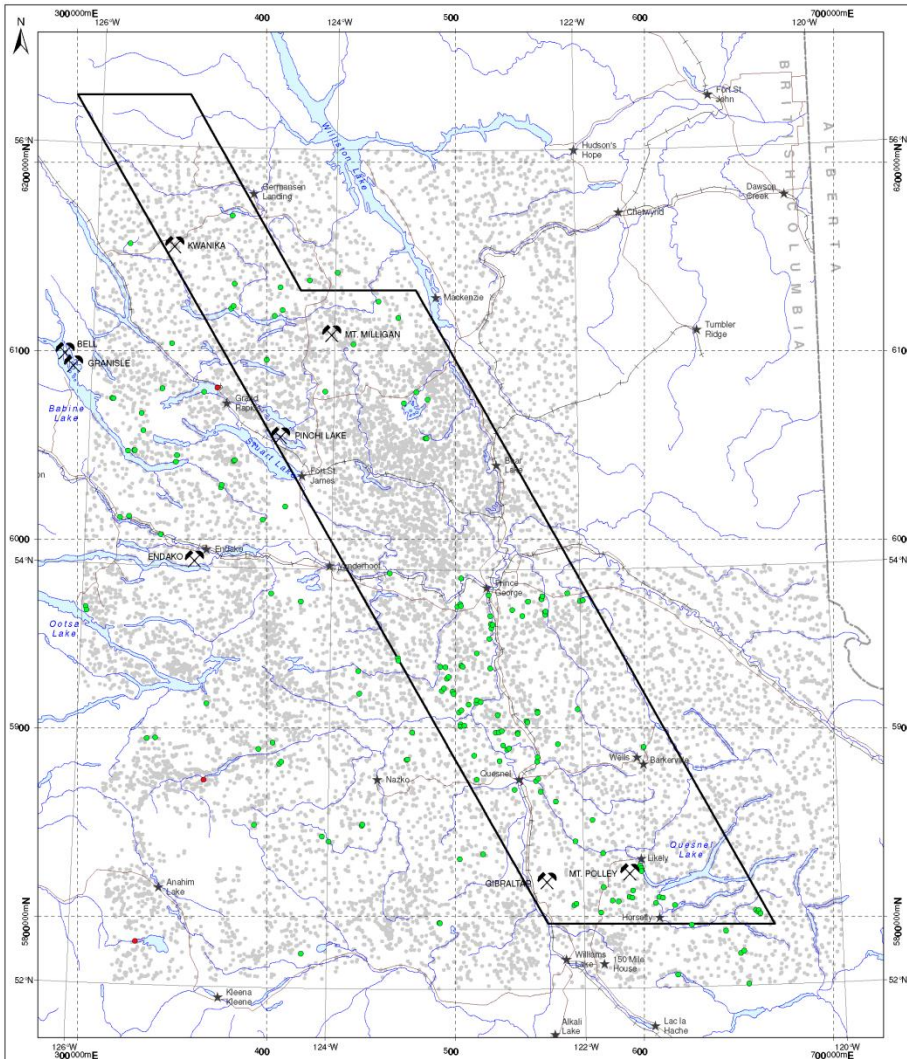
Six groups of BMU's are identified as anomalous in gold

These BMU's are selected, and then plotted on a map.



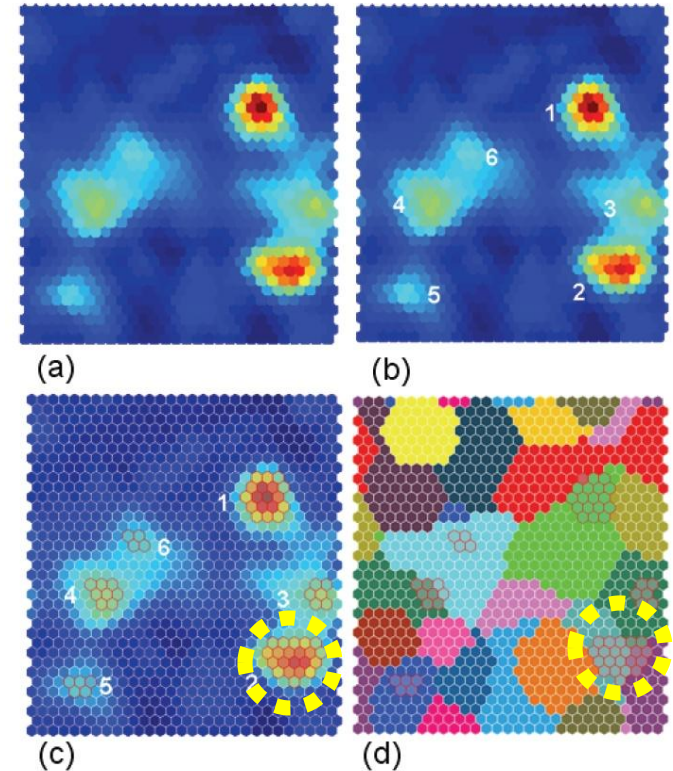
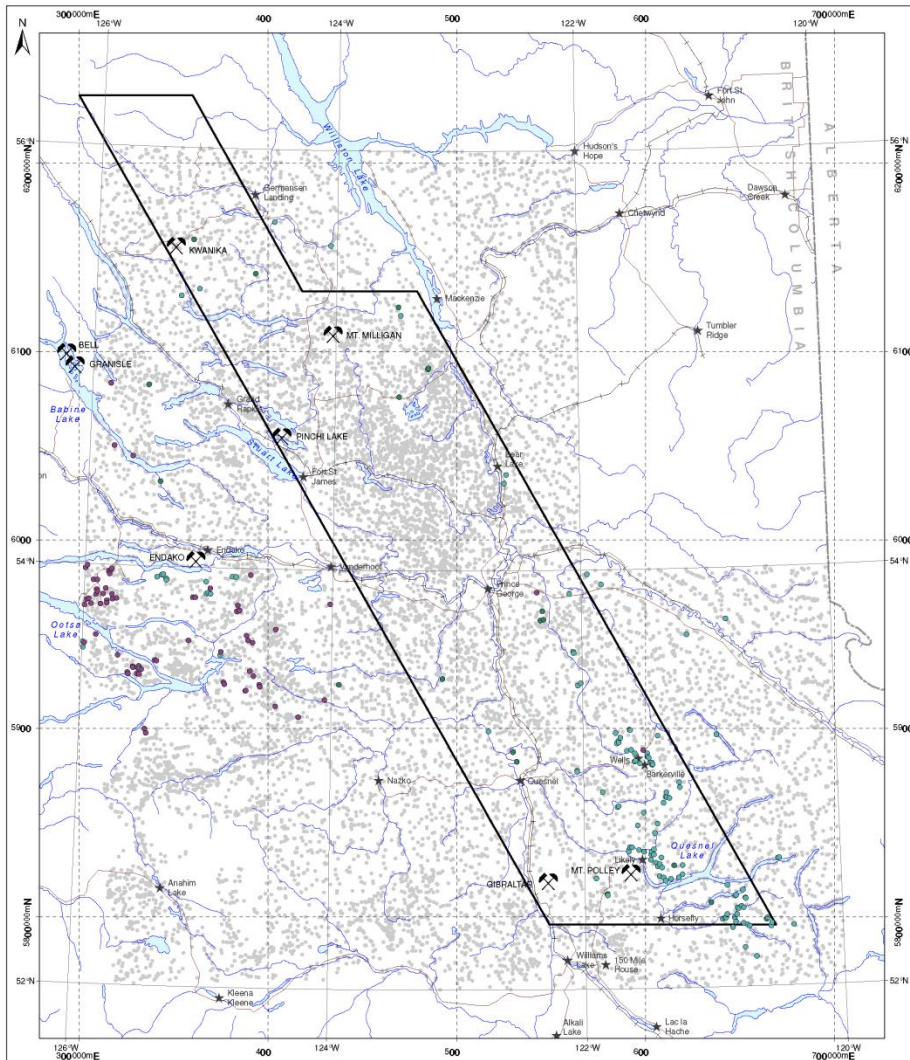


# Spatial Distribution of Group 1 of the Anomalous Au BMUs



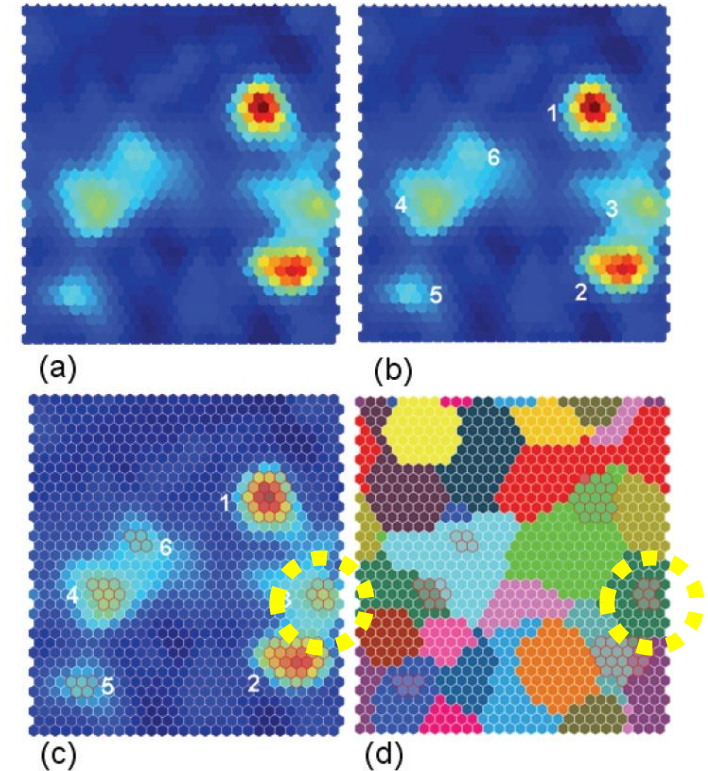
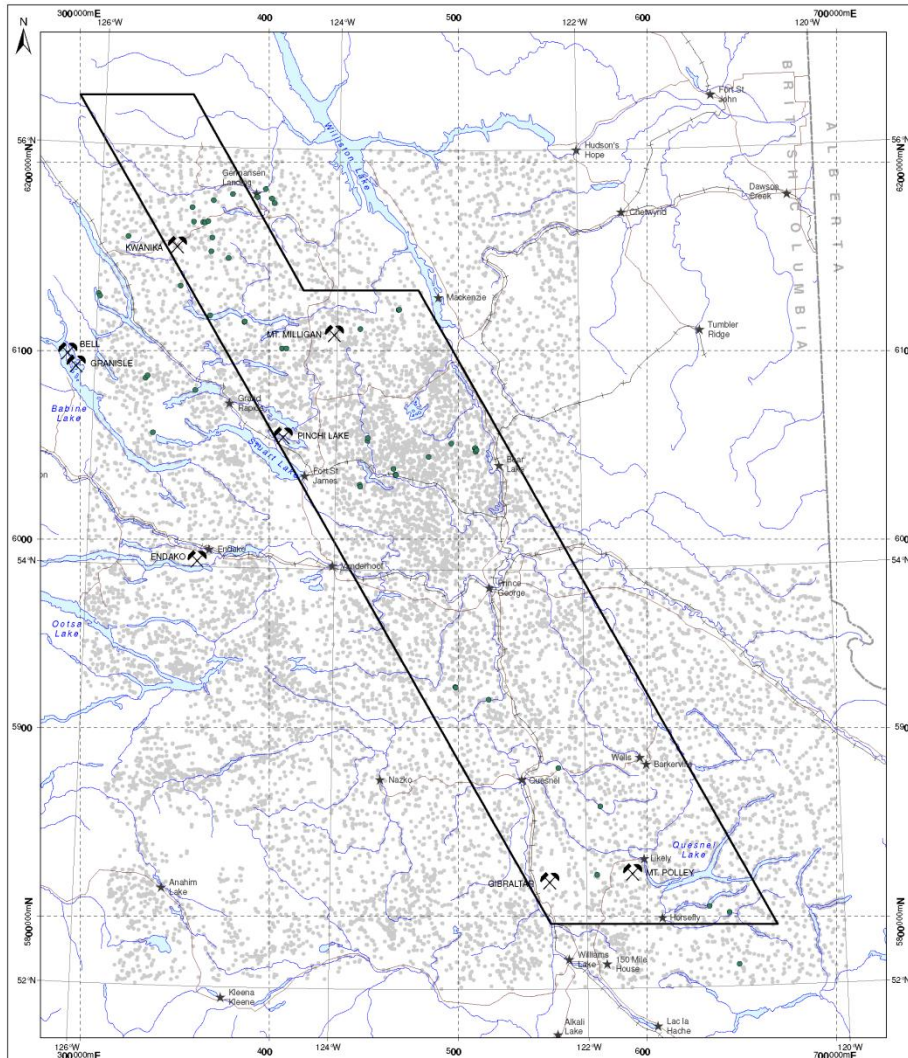


# Spatial Distribution of Group 2 of the Anomalous Au BMUs



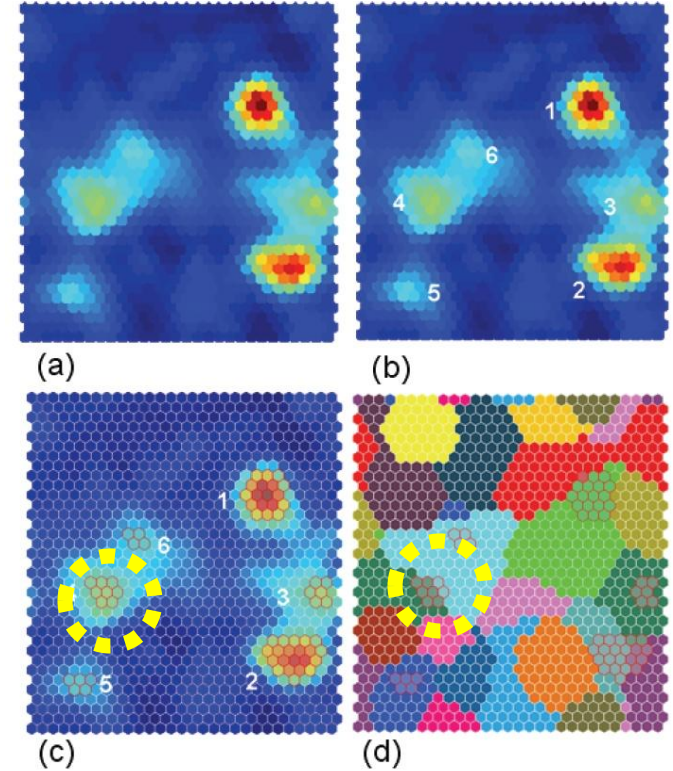
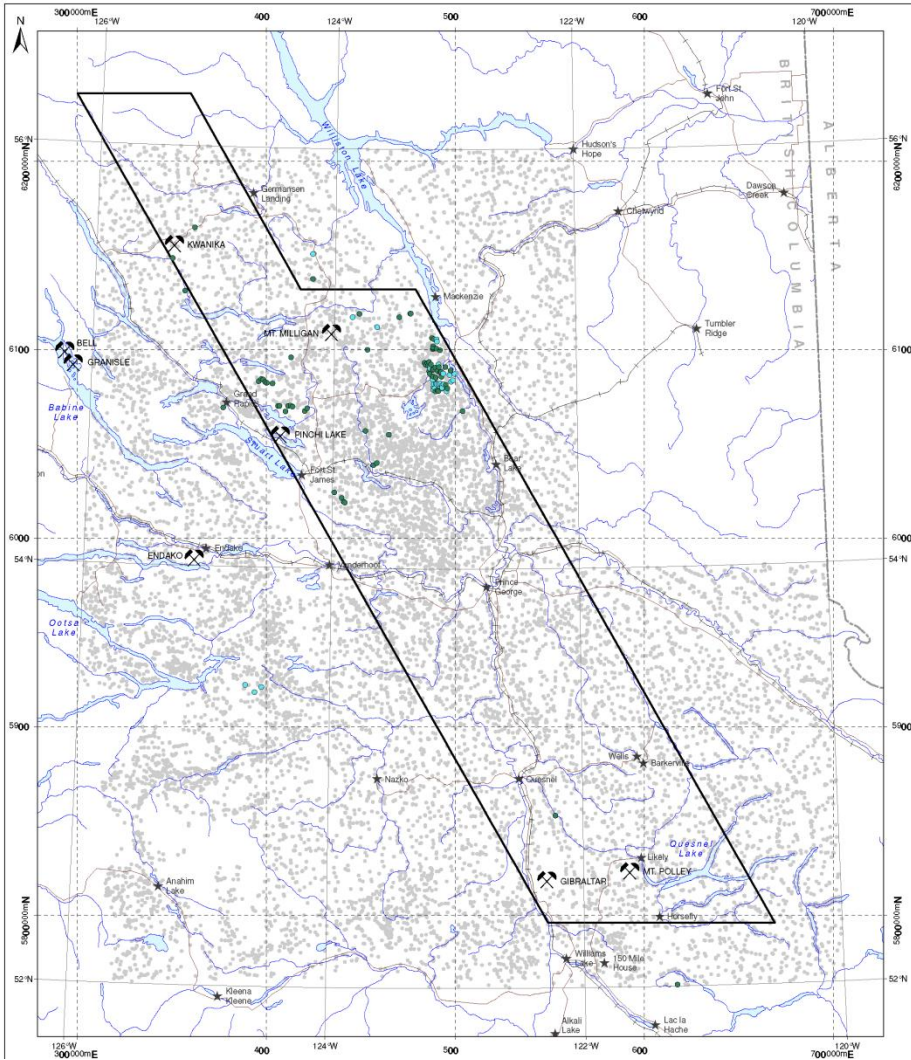


# Spatial Distribution of Group 3 of the Anomalous Au BMUs



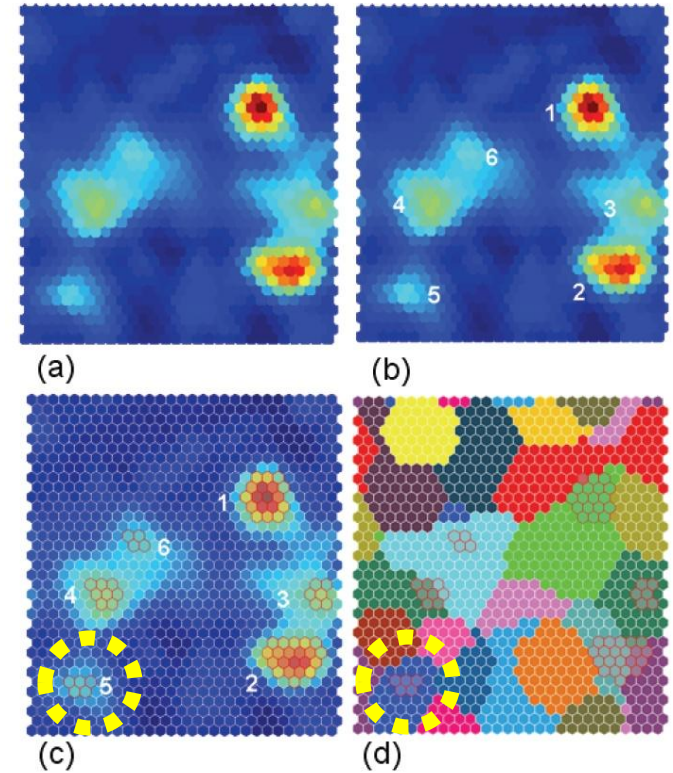
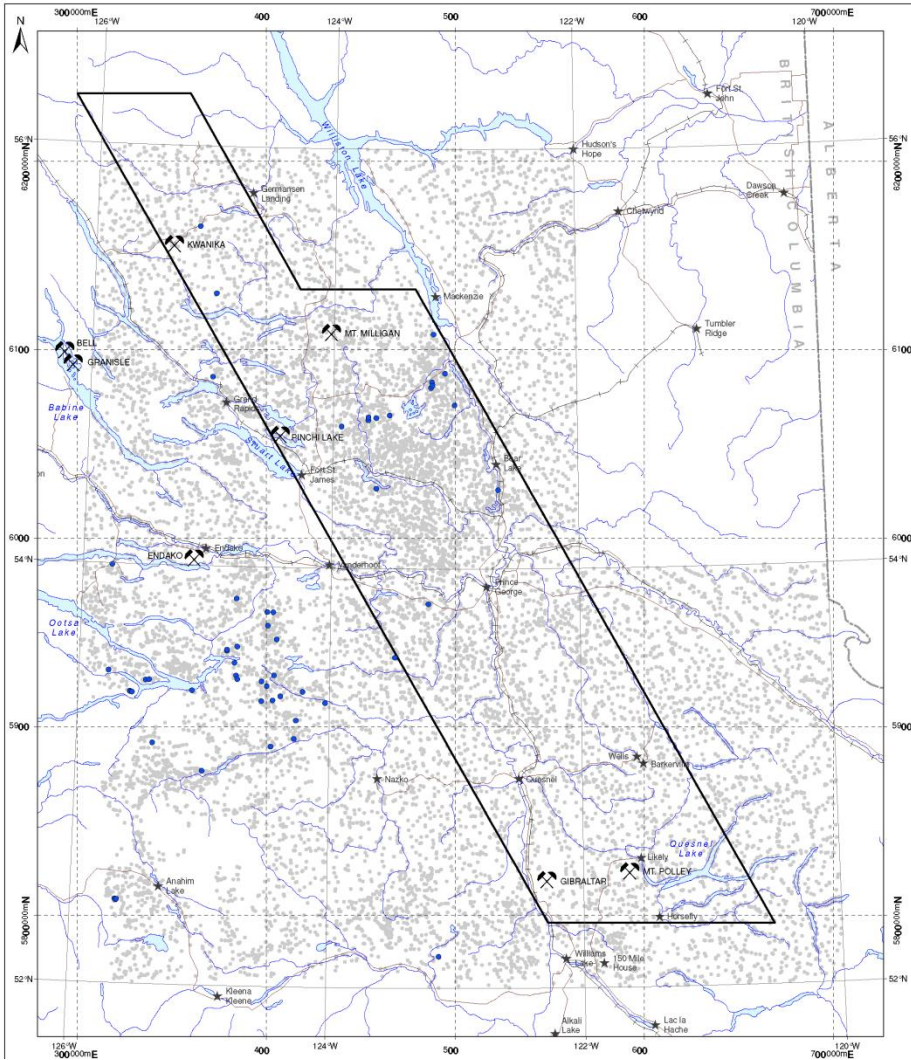


## Spatial Distribution of Group 4 of the Anomalous Au BMUs



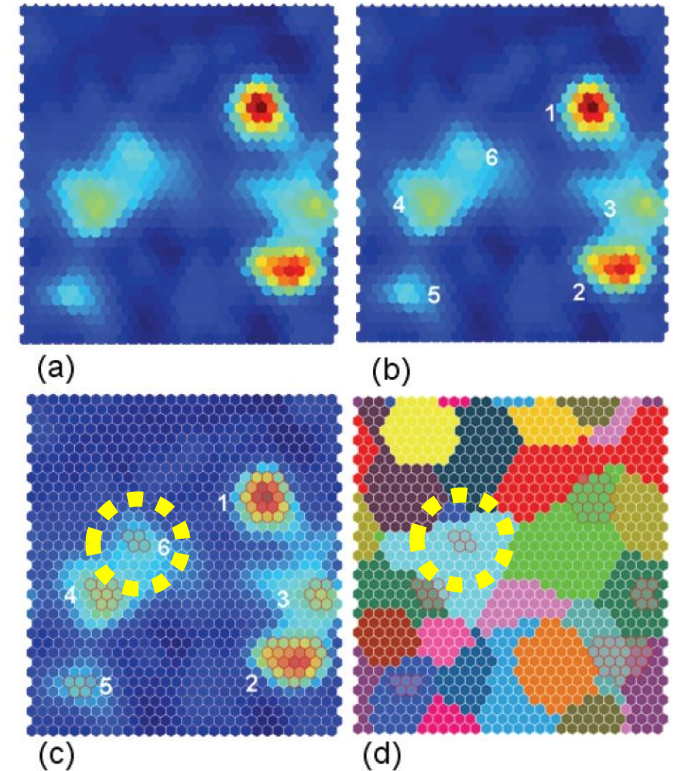
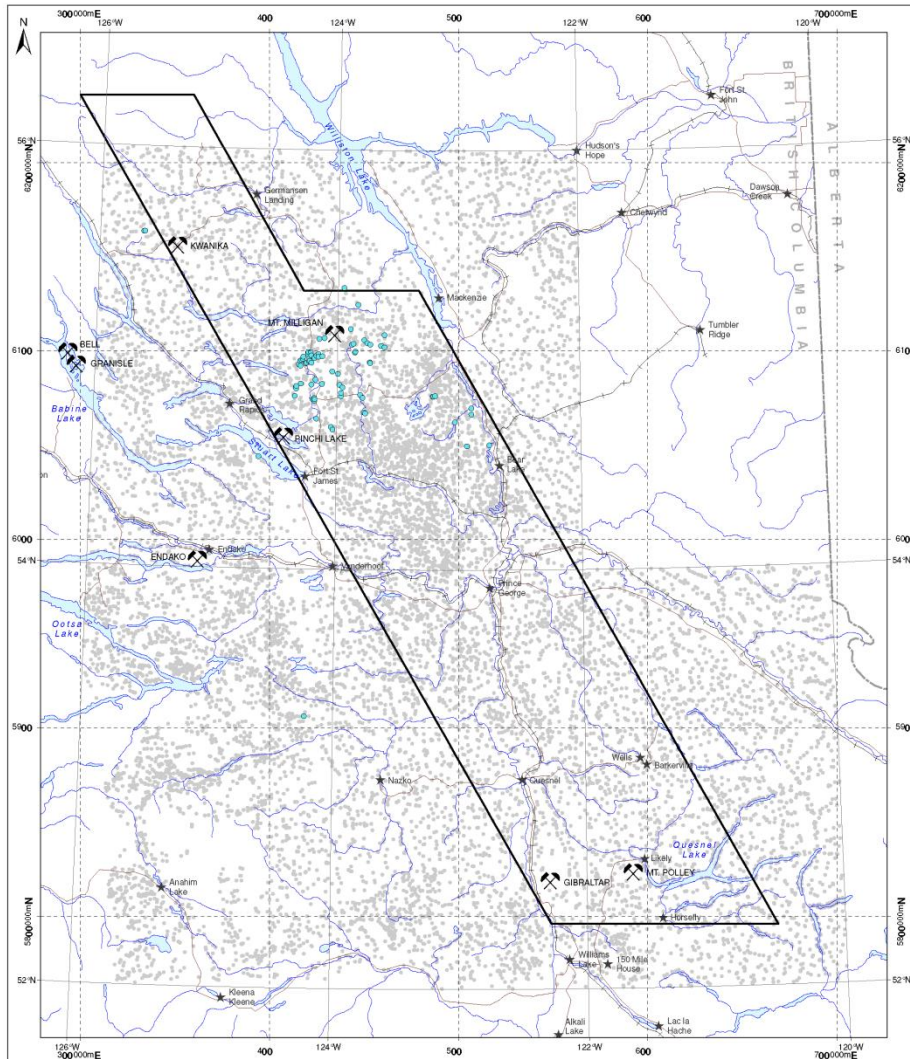


## Spatial Distribution of Group 5 of the Anomalous Au BMUs



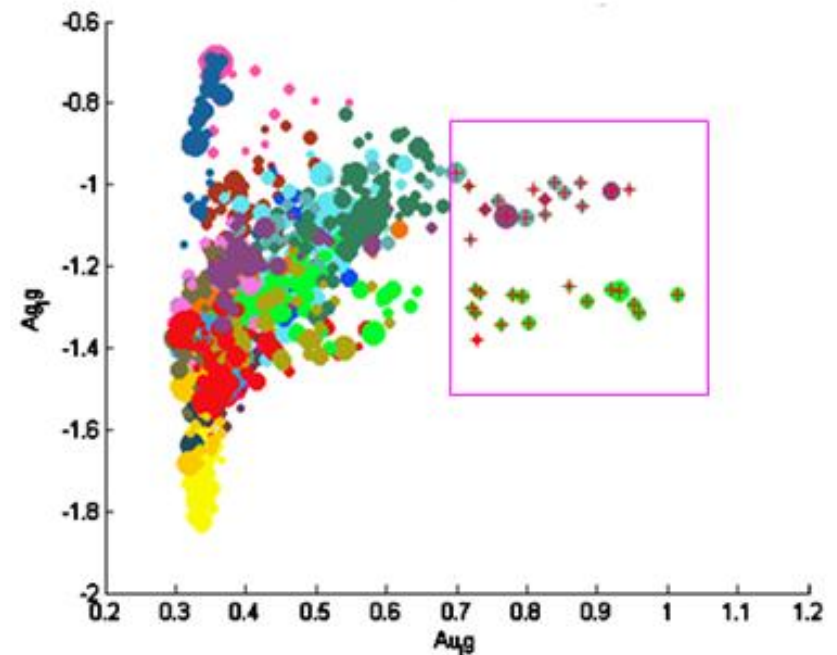
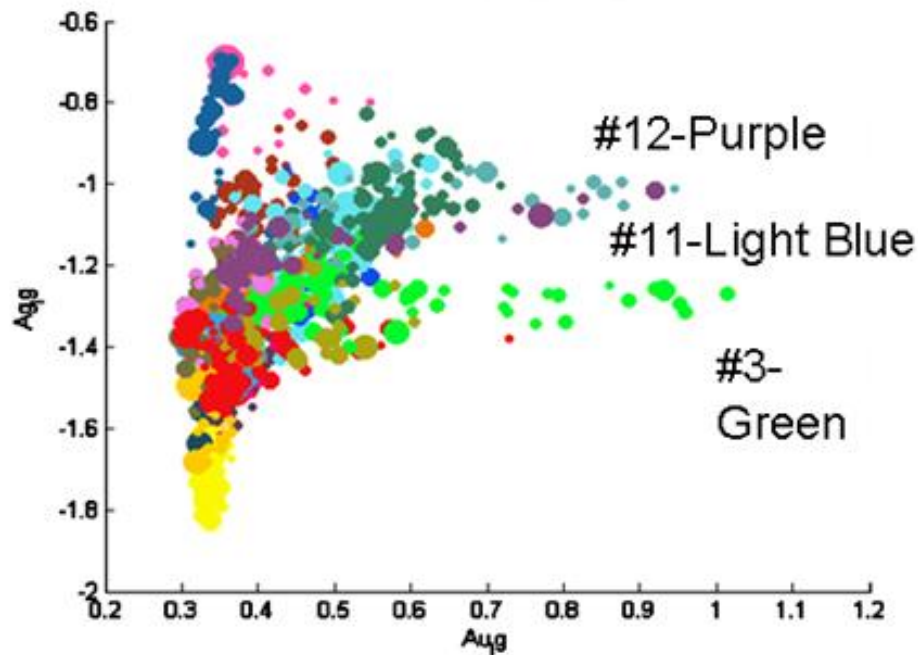


# Spatial Distribution of Group 6 of the Anomalous Au BMUs



# Node Cross-plots of Selected Elements

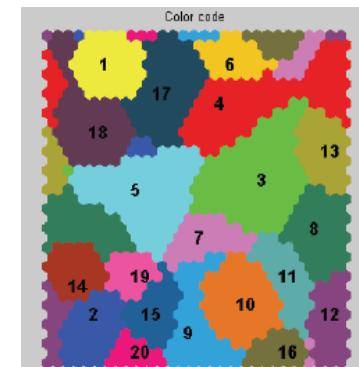
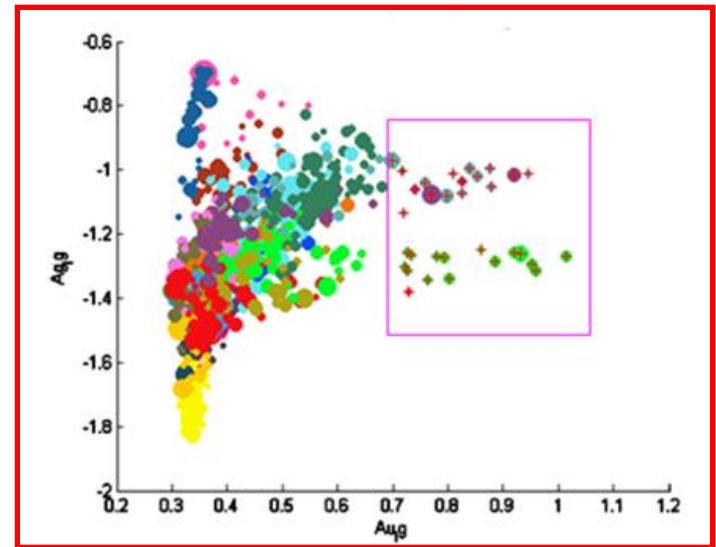
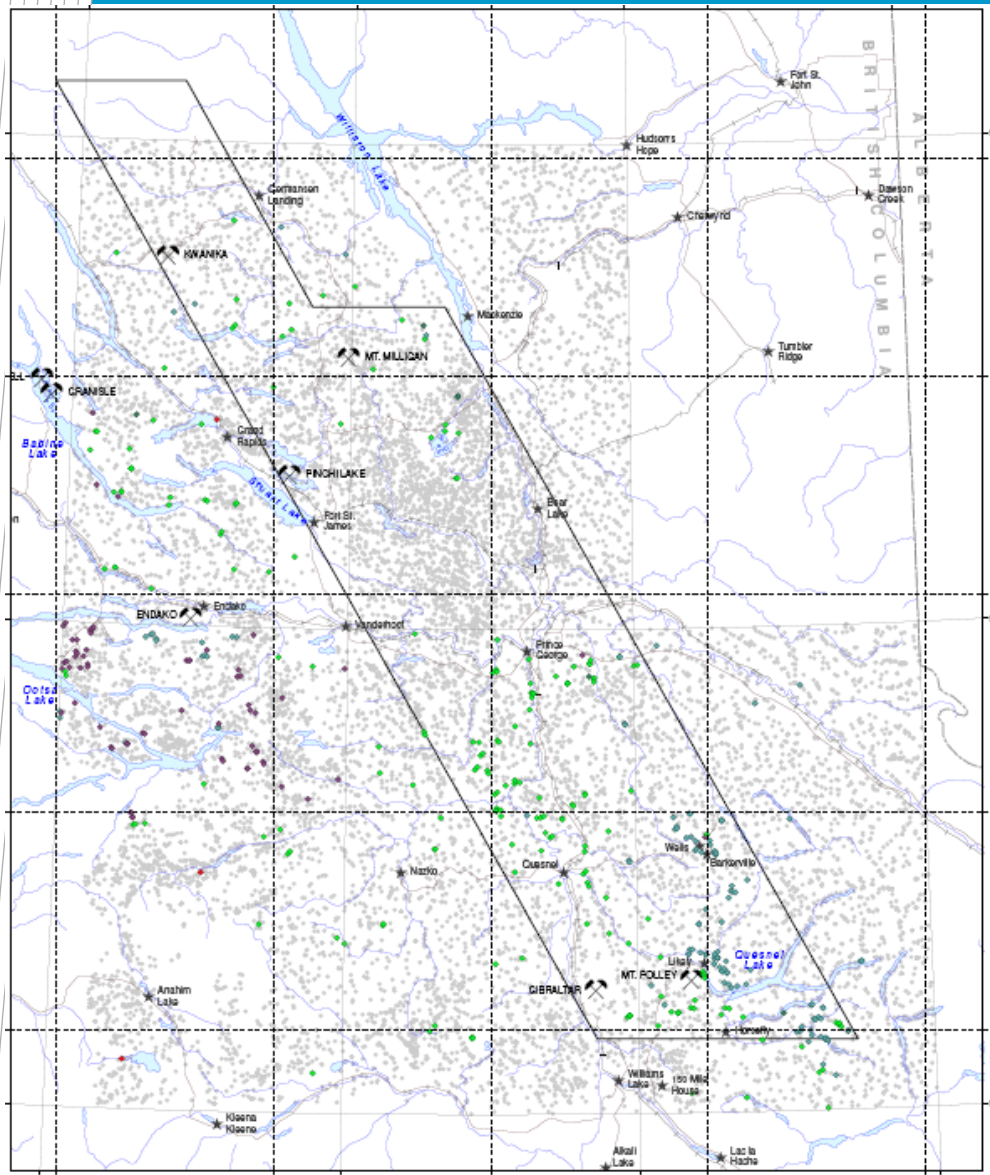
# Cross-Plot of Au vs Ag SOM Node values



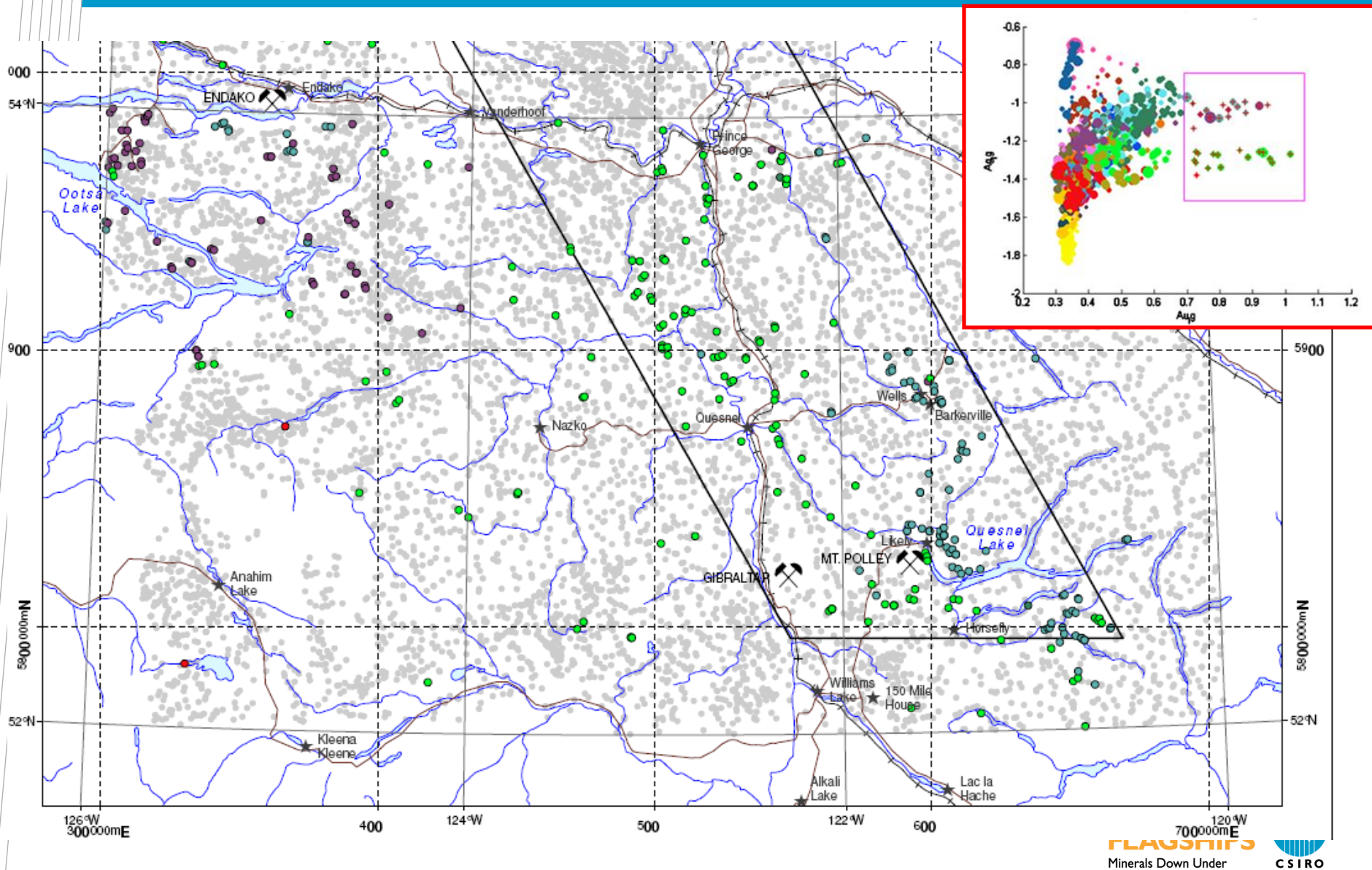
Three elevated Au “associations” evident



# Spatial Distribution of Selected Ag vs Au Samples –High Au



# Spatial Distribution of Selected Ag vs Au Samples – High Au



# Summary and Conclusions

- SOM has been able to identify and target “anomalous” samples in the combined “QUEST” Stream & Lake Sediment data set.
- “Anomalous” element distributions have been generated using the following SOM approaches:
  - Quantization Errors (Global Anomalism)
  - K-means Cluster Normalization of SOM-Nodes (Normalized Elemental Maps)
  - Component Plots - (Population Distributions)
  - Cross-plots of Selected Elements
- Report and Digital Output data available from:
  - <http://www.geosciencebc.com/s/2009-14.asp>

## ACKNOWLEDGEMENTS

- Agencies and geologists responsible for collecting, analysing and cataloguing the sediment data sets.
- Colin Barnett and Peter Williams for their levelled and imputed grids;
- Fion Ma (Geoscience BC) for transforming the SiroSOM outputs into quality maps.
- Christa Sluggett for her role as our prime Geoscience BC contact.
- Geoscience BC for supporting this project and allowing Fion to assist.

www.csiro.au

# Thank you



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**FLAGSHIPS**  
Minerals Down Under

