Success Rates of Soil Geochemistry Methods

22nd IGES 2005

From Tropics to Tundra

Geochemical Exploration's

Brave New World

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Three Essential Business Processes

- **Innovation**: the introduction of a new technology

requires

- **Quantification**: the testing and measurement of the old technology to allow proper comparison with the new technology

and

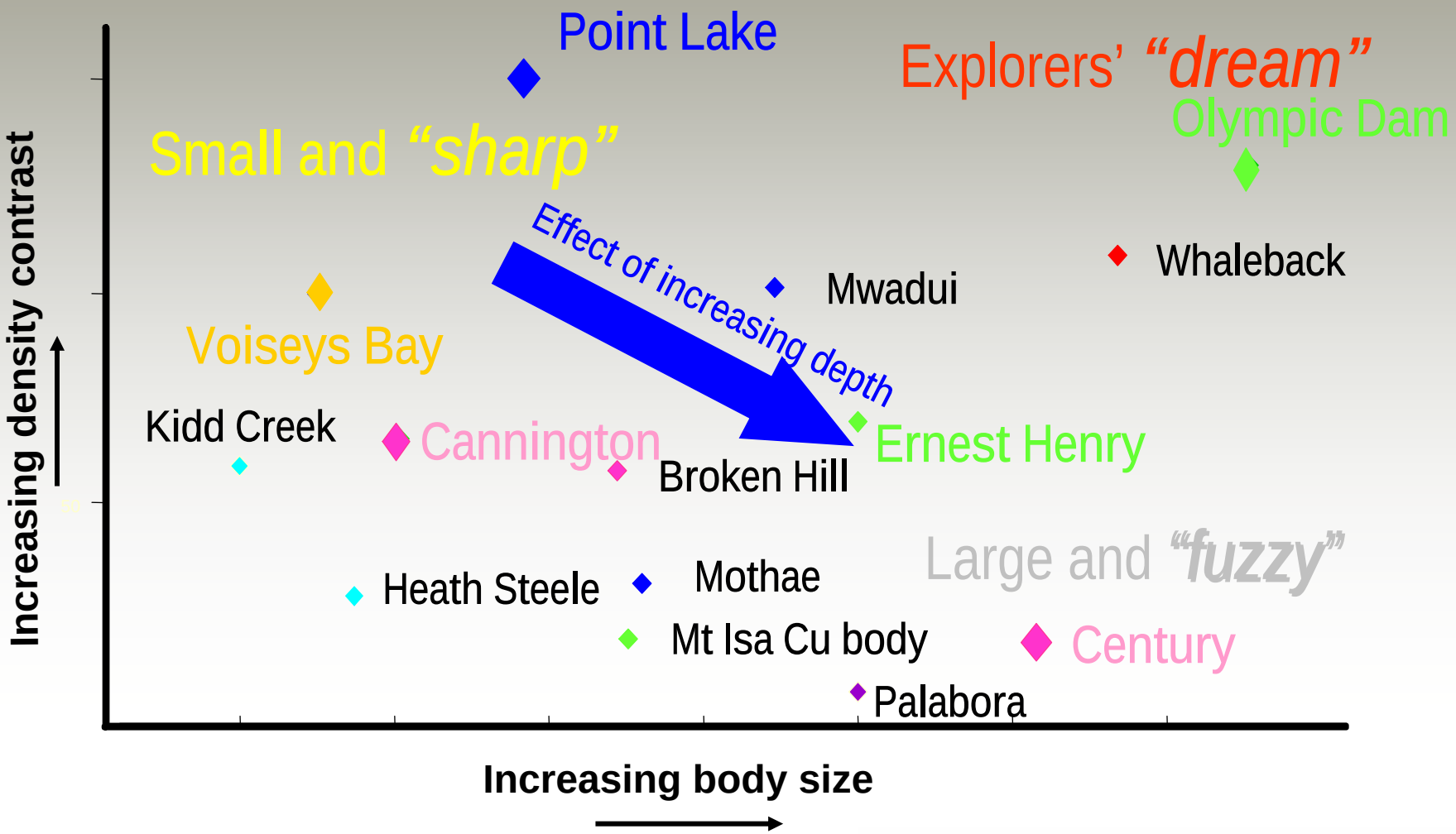
- **Orchestration:** the implementation of the new technology and the continuation of testing and measurement to determine if it has significantly improved the business

The Holy Grail of Exploration Technology

Deposit Size Is Proportional to the Strength of the Response from the Exploration Technology

The search for such a technology should be an on-going process of innovation in any world class exploration company

Conceptual gravity signatures of some ore deposits



The Innovation

Innovation: Partial Digest Geochemistry

Early work indicated it had the potential to be the "Ideal Technology"!

- **Big** deposits = **strong** responses;
- **Mid**-sized deposits = **moderate** responses;
- **Small** deposits = **weak** responses; and
- Worked in covered terrains.

Big Focus of Management Attention!

Innovation: Partial Digest Geochemistry

Despite the EMPIRICAL evidence, there was disbelief:

- Focus on mechanism;
- Inadequate comparisons of the techniques in published literature and from research institutes; and
- Everyone has a story about it!!

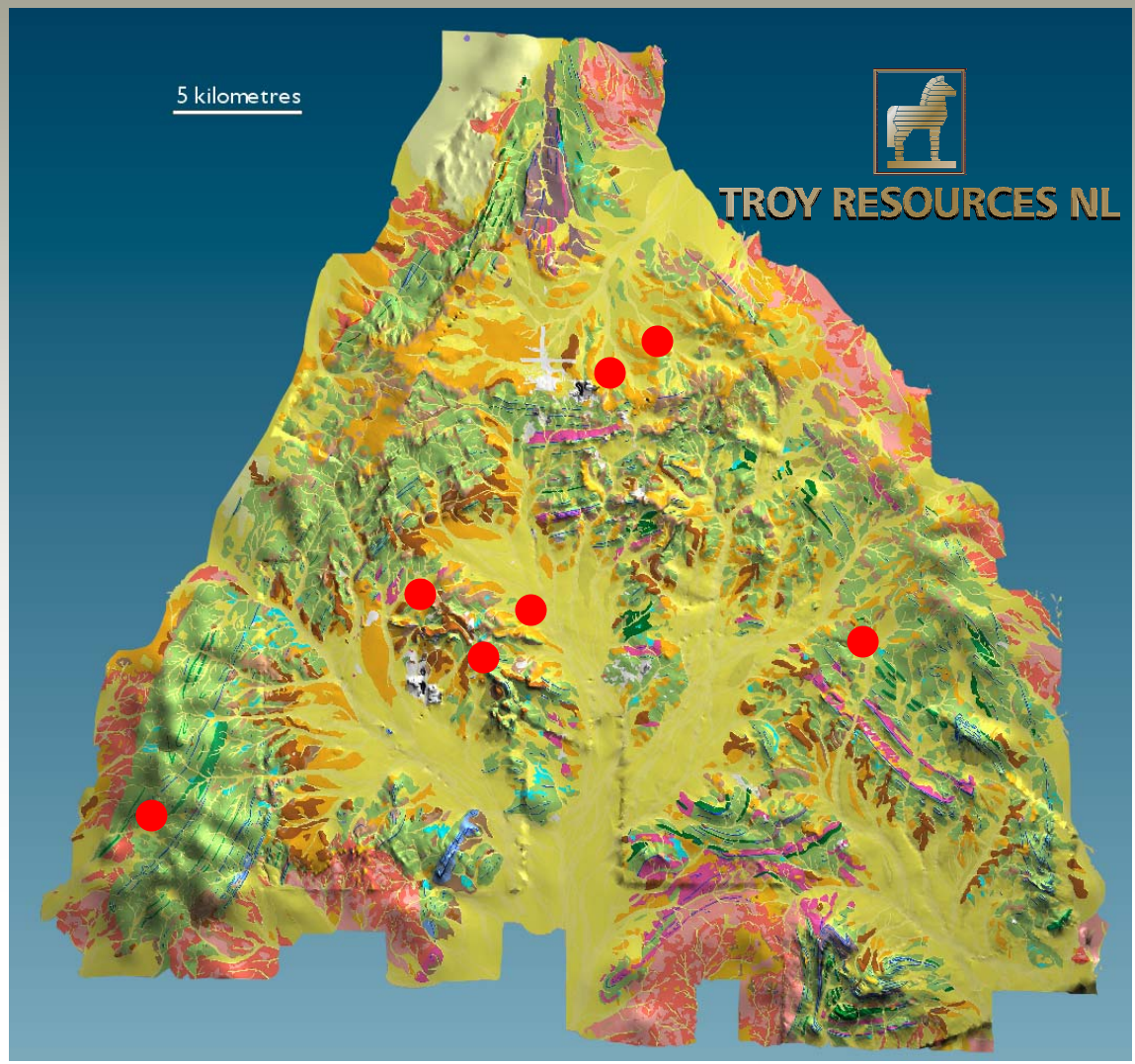
The Quantification

Quantification: What do we measure?

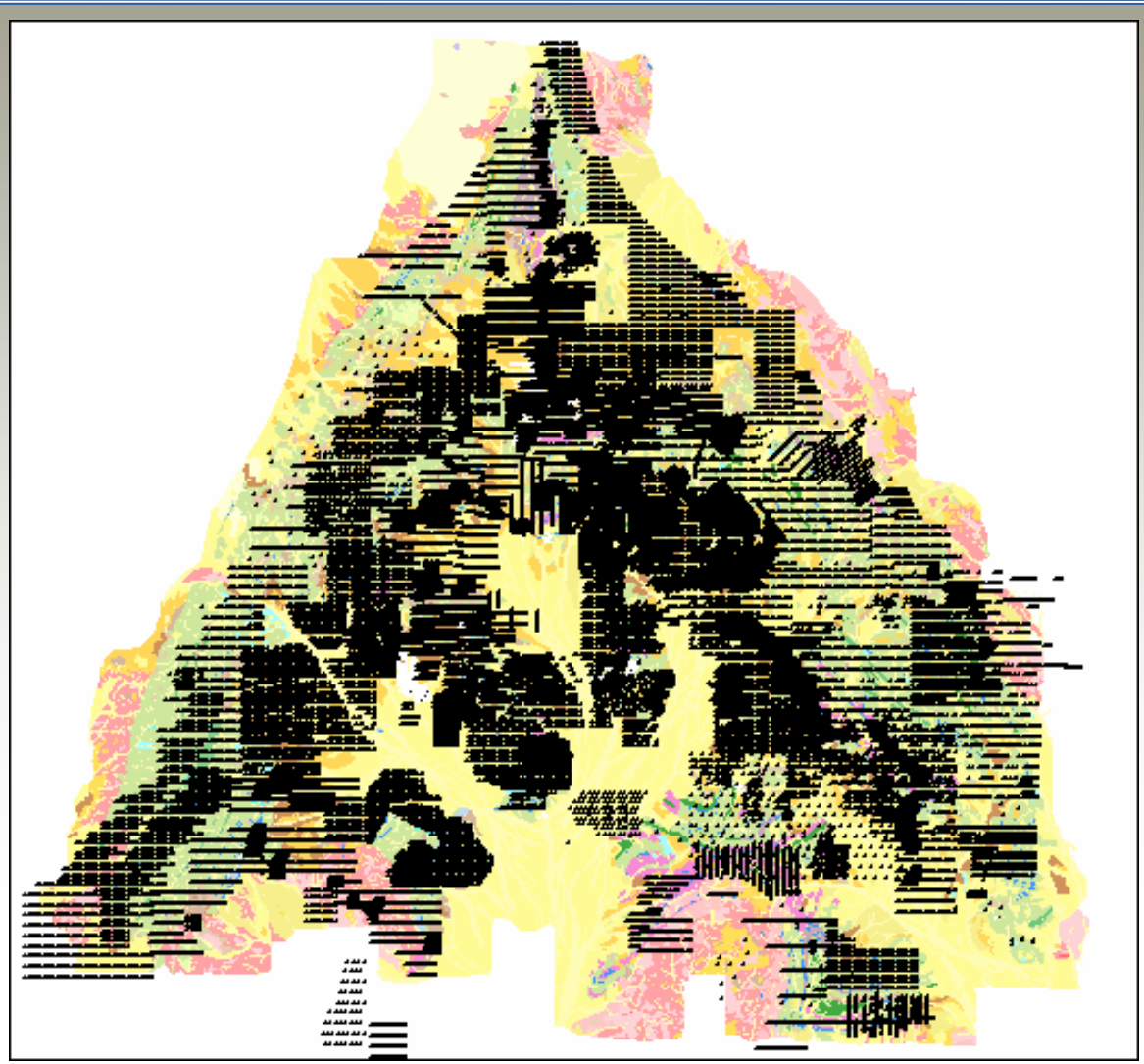
- SUCCESS =
  - Discrimination of barren rock from mineralization and preferably with size proportional to response;
- FAILURE =
  - no response over big deposits;
  - strong response over barren rock and weak mineralization (false positives)

Both these types of failure are potentially catastrophic for the missed opportunity and the destruction of shareholder wealth through over-drilling

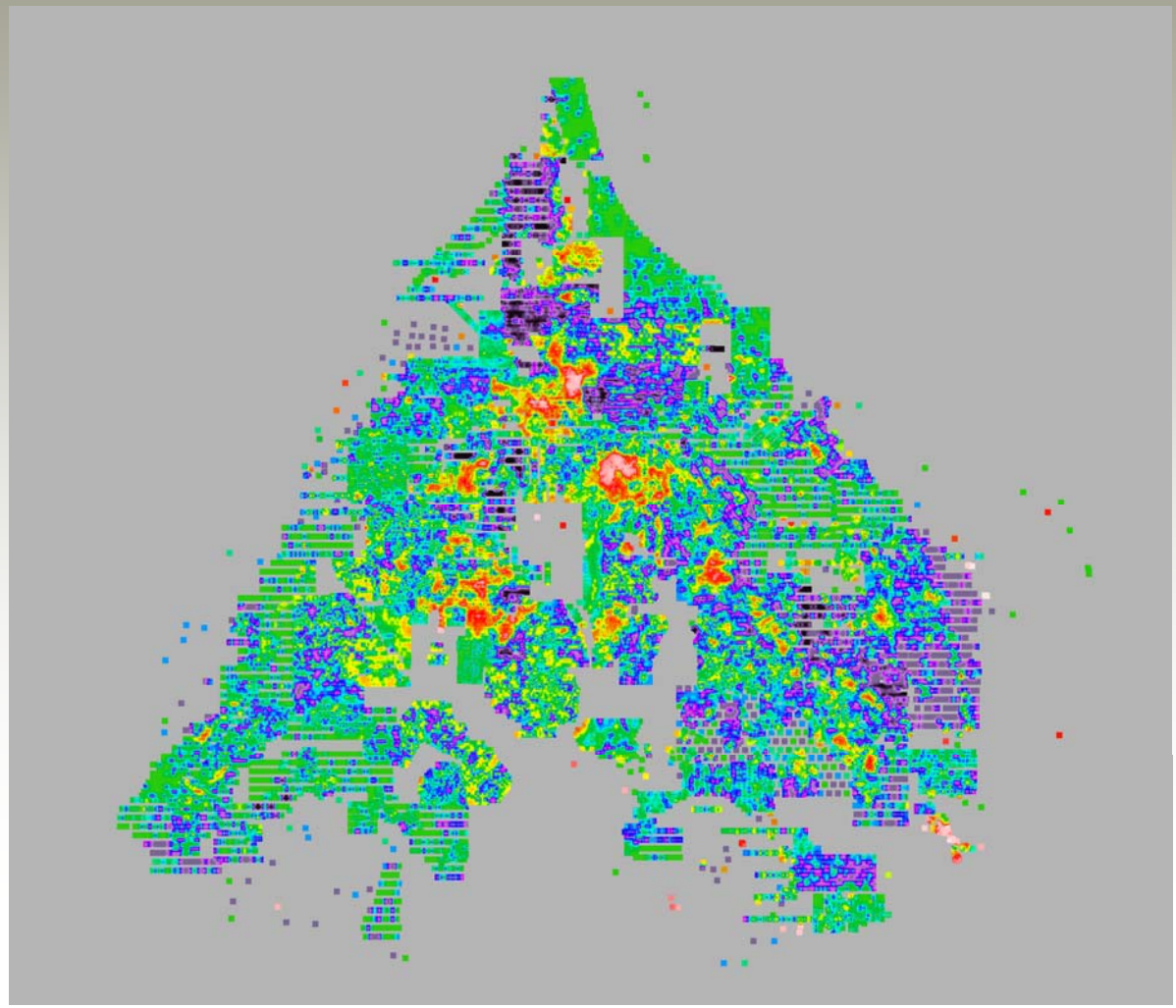
Quantification: Where have we been?



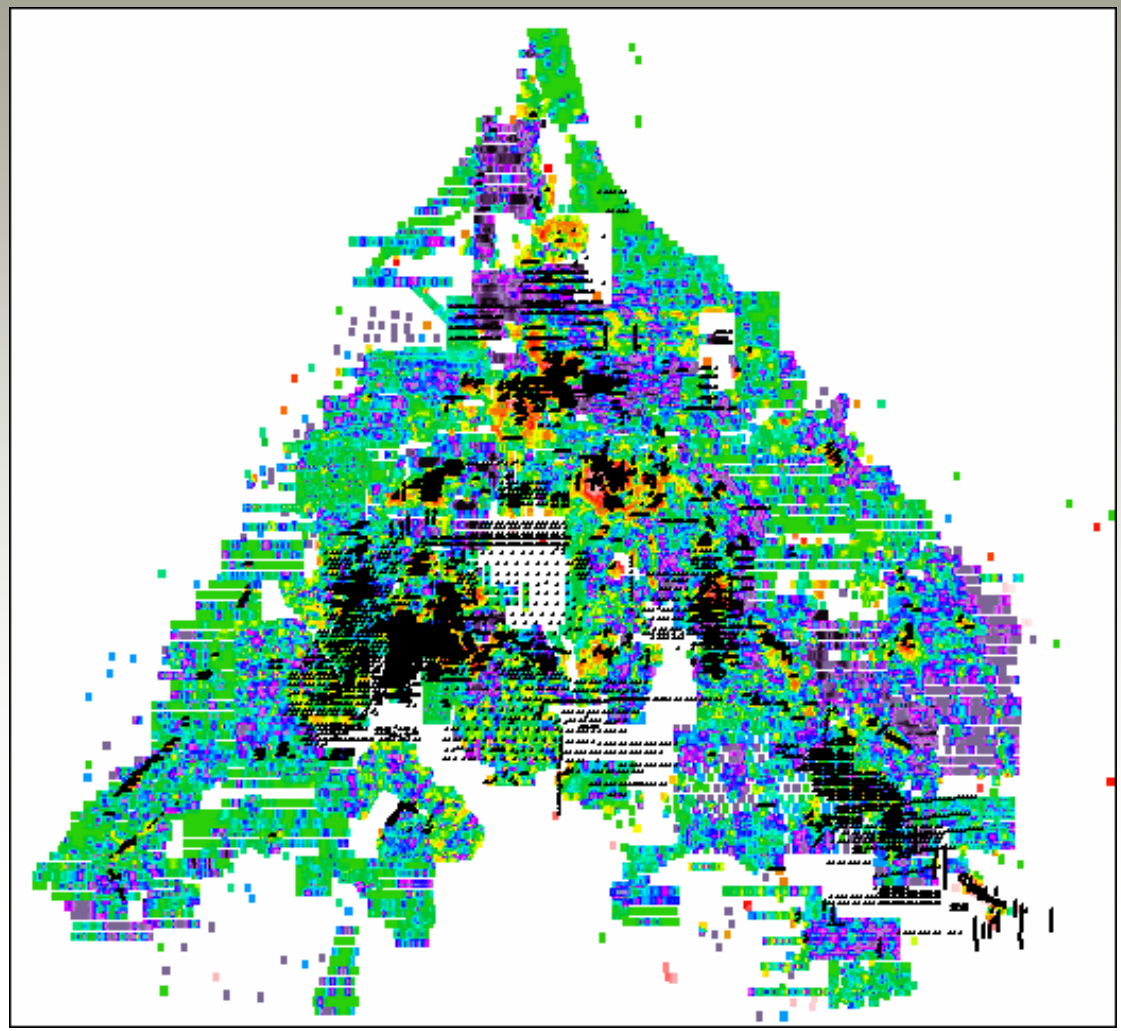
Quantification: Surface Geochemistry



Quantification: Drilling of Soil Anomalies



Success Rates: 5 out of ????!!!

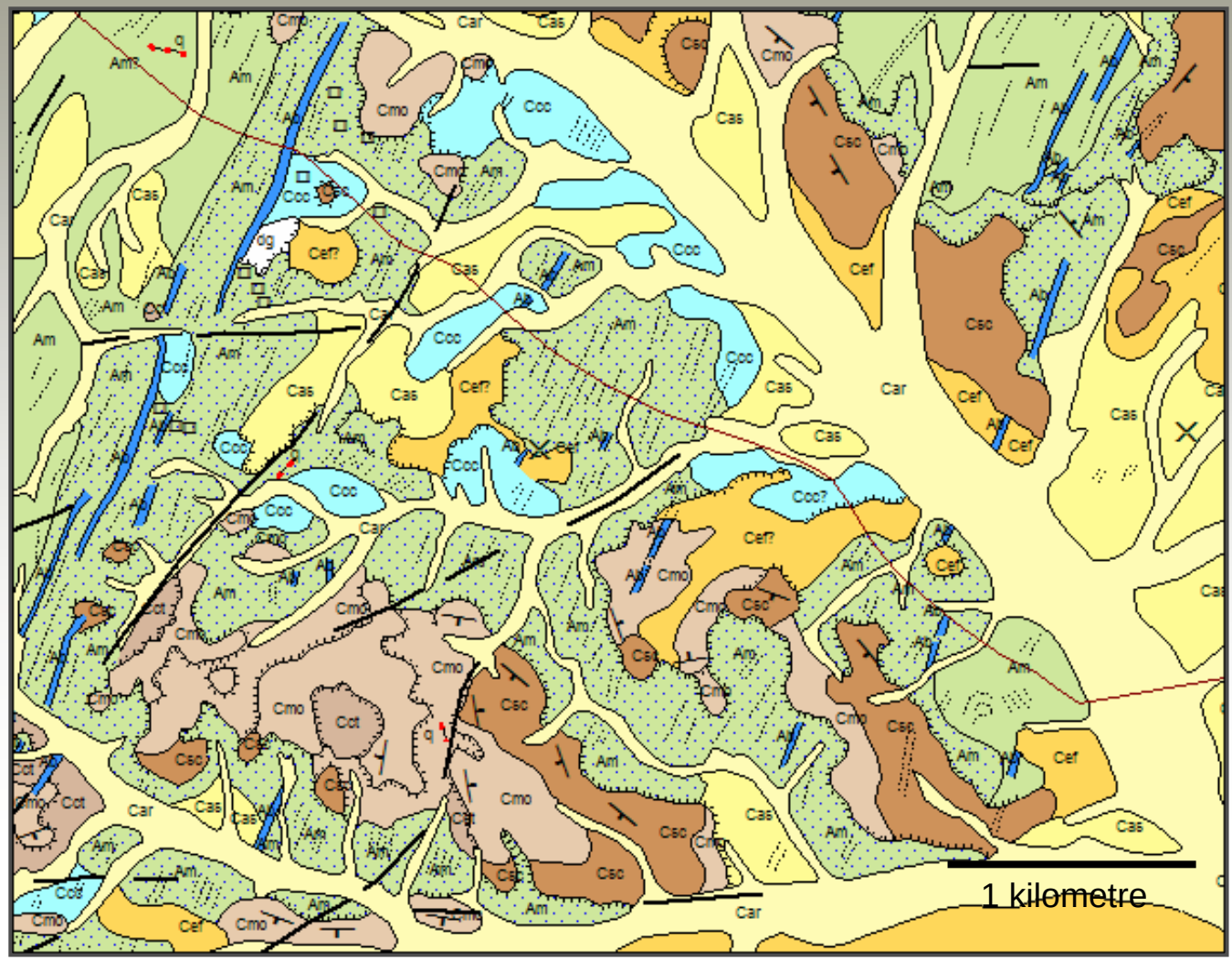


Quantification: Comparison of Soil Techniques

Requirements:

- A good database;
- A good Surface Geology Map that domains units with different natural backgrounds of metals; and
- A normalisation technique.

Surface Geology Map: Final Product



Surface Geology Maps: Yilgarn Conclusions

Four-fold main classification is sufficient for understanding regolith development and geochemical dispersion as they have markedly different natural backgrounds:

- Alluvium:
- Colluvium:
- Outcrop: fresh and weathered (saprolite, mottled and pallid)
- Ferricrete and related eluvium.

Most regolith maps are too complex, too genetic and simply unhelpful.

Quantification: Normalisation by Response Ratios

Background to anomaly contrast

Background = mean of lowest quartile of data.

A “times background” value that is

simple, robust, easy to use and interpret.

Quantification: Normalisation by Response Ratios

Normalise to account for:

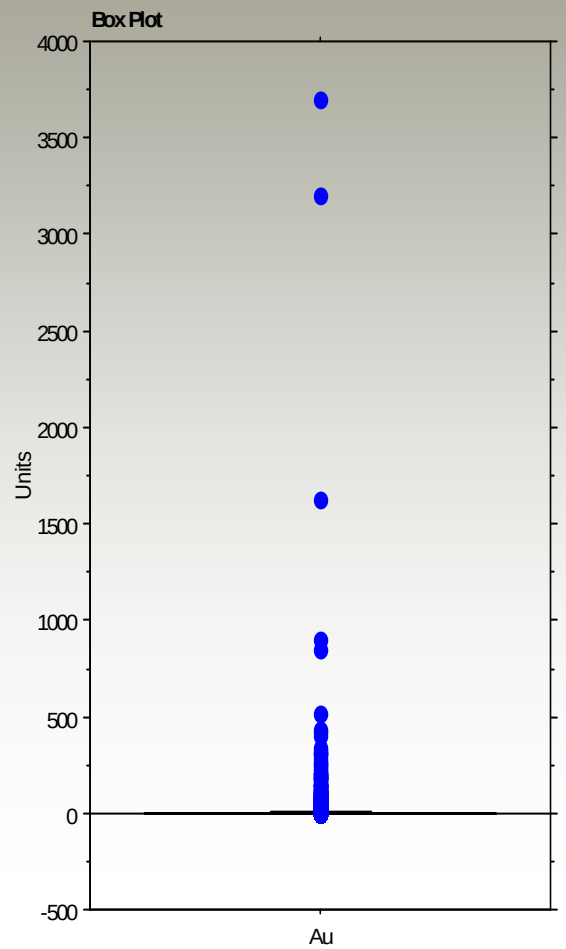
1. Different sampling media;
2. Different detection limits and analytical techniques;
3. Intra-batch variation for each analytical technique;
4. Different natural backgrounds in different regolith units.

Do in one stage: unique combinations

Quantification: Normalisation by Response Ratios

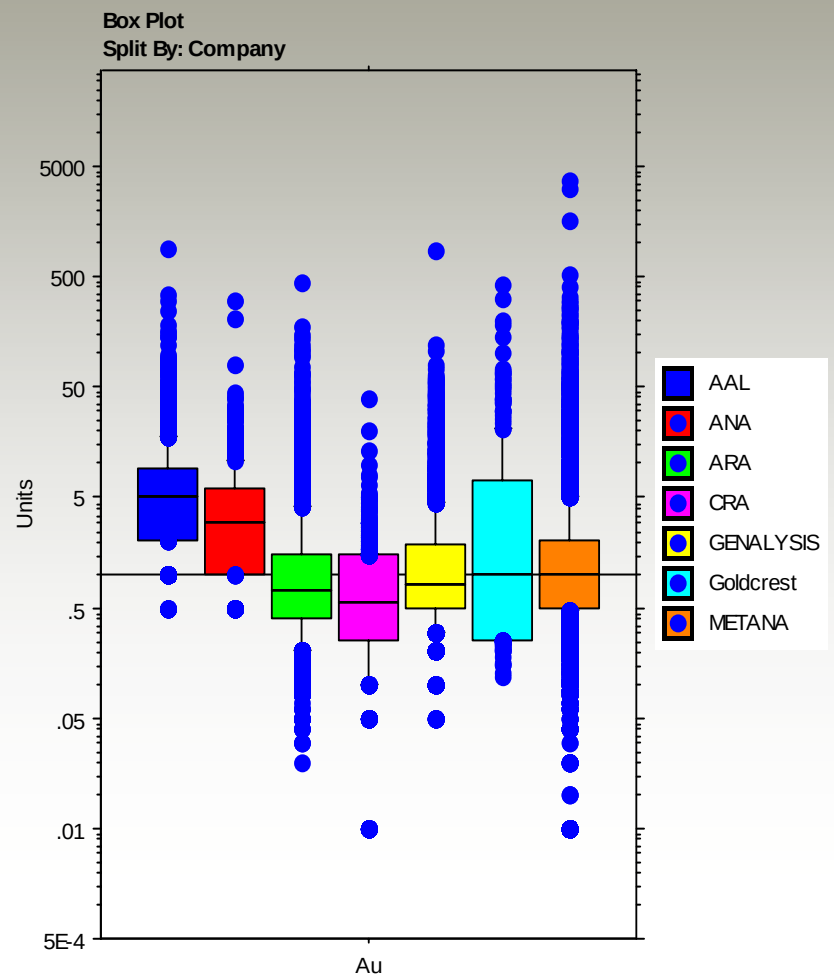
Raw Data

27,438 samples



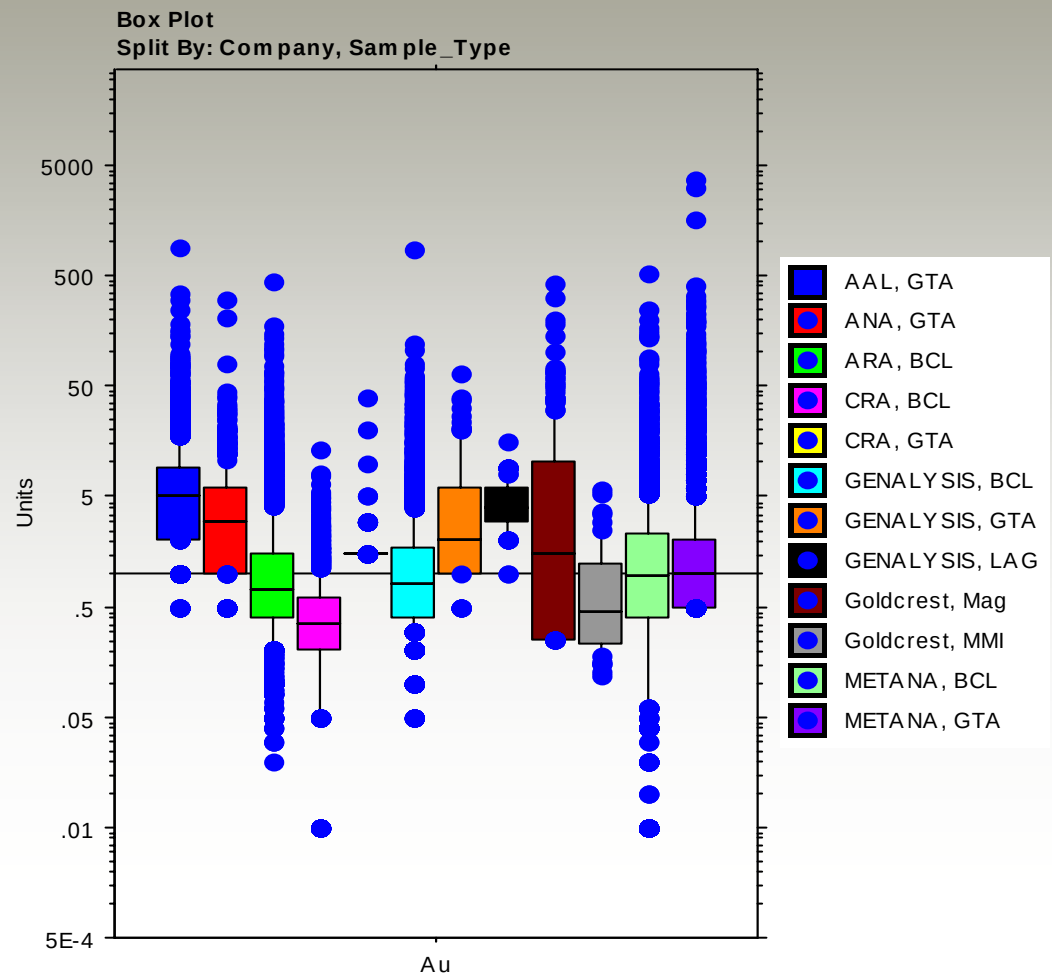
Quantification: Normalisation by Response Ratios

Raw Data
Laboratory



Quantification: Normalisation by Response Ratios

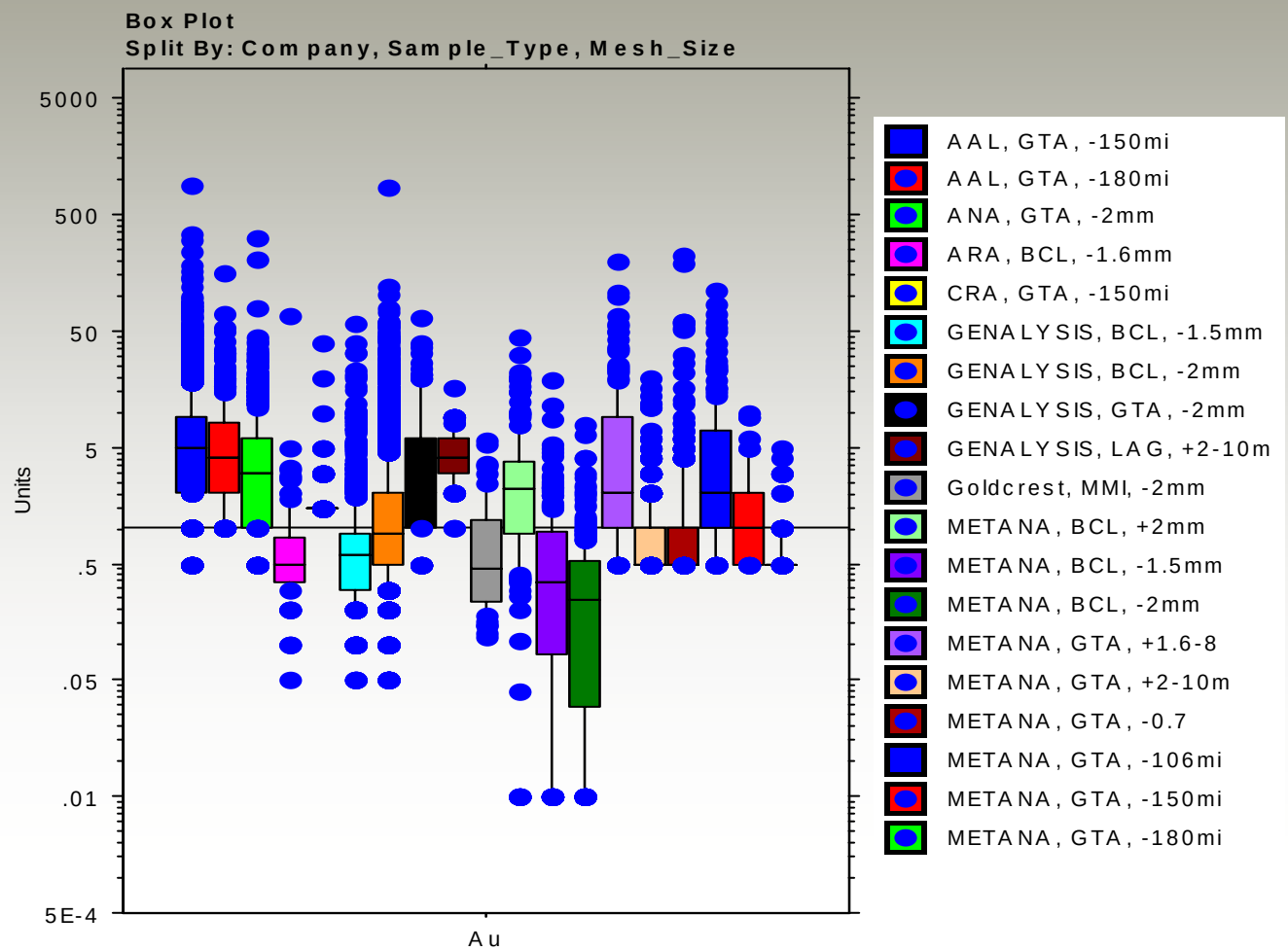
Raw Data
Laboratory
and
Method



Quantification: Normalisation by Response Ratios

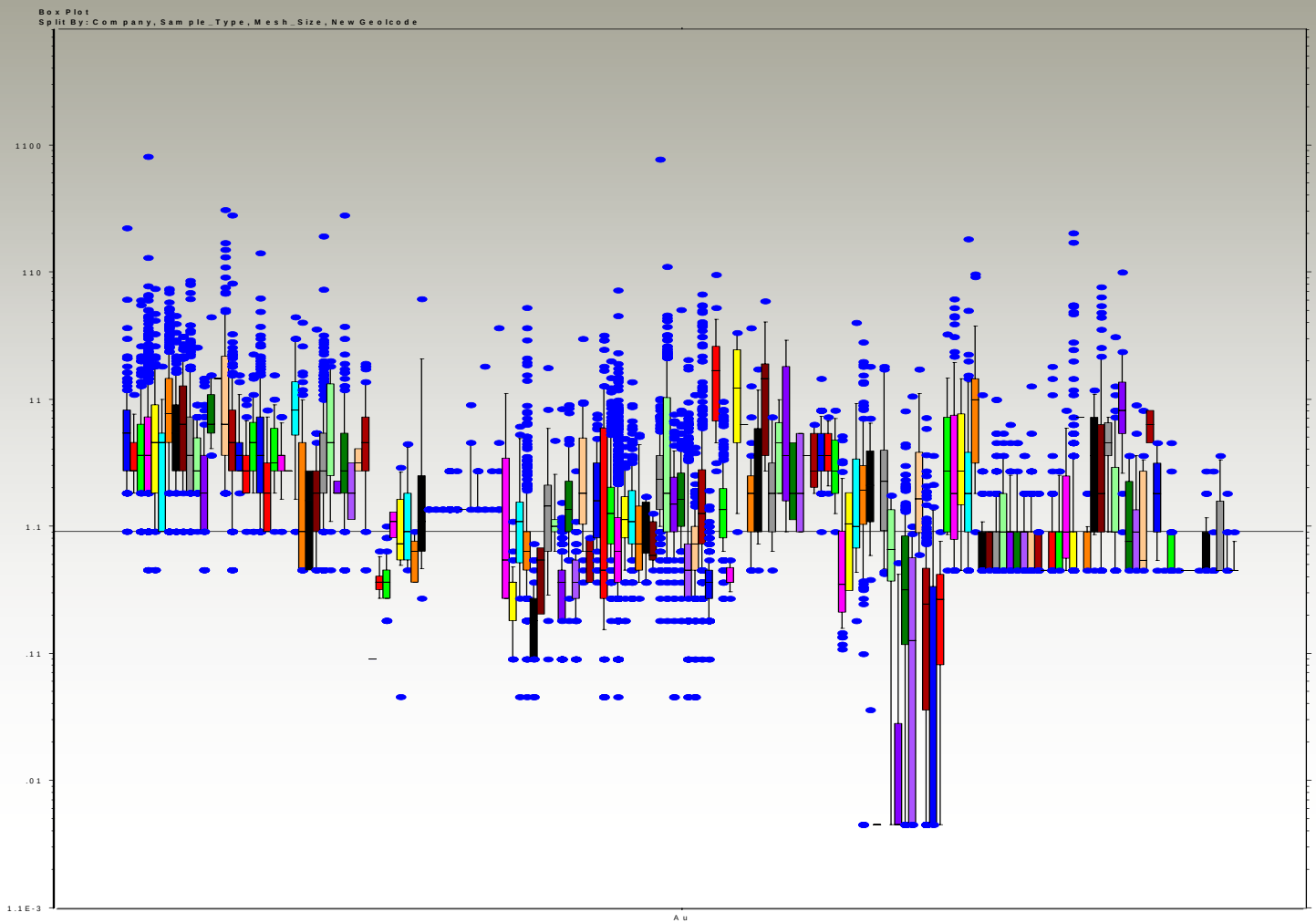
Raw Data

Laboratory, Method and Mesh Size



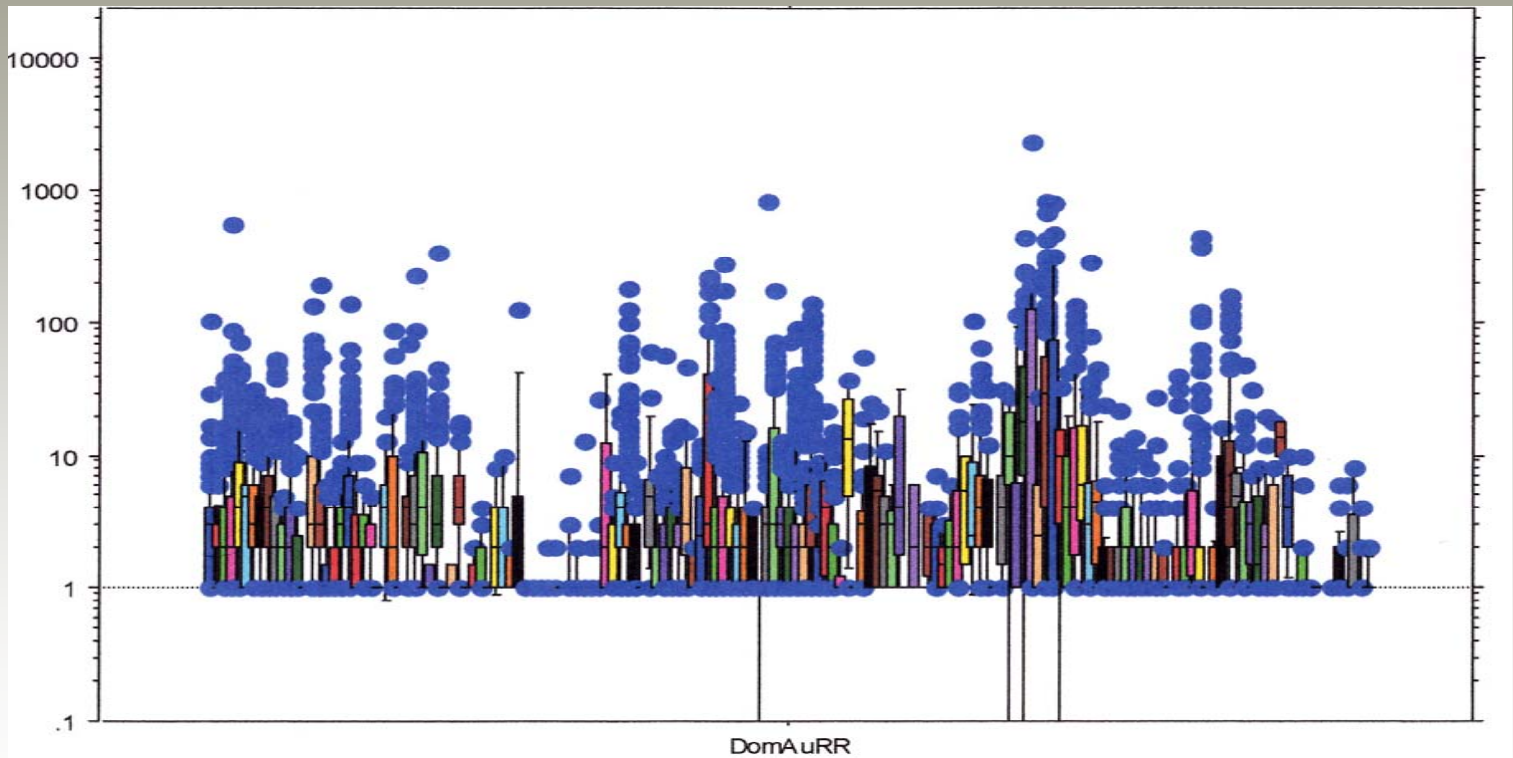
Quantification: Normalisation by Response Ratios

All of the above and Regolith

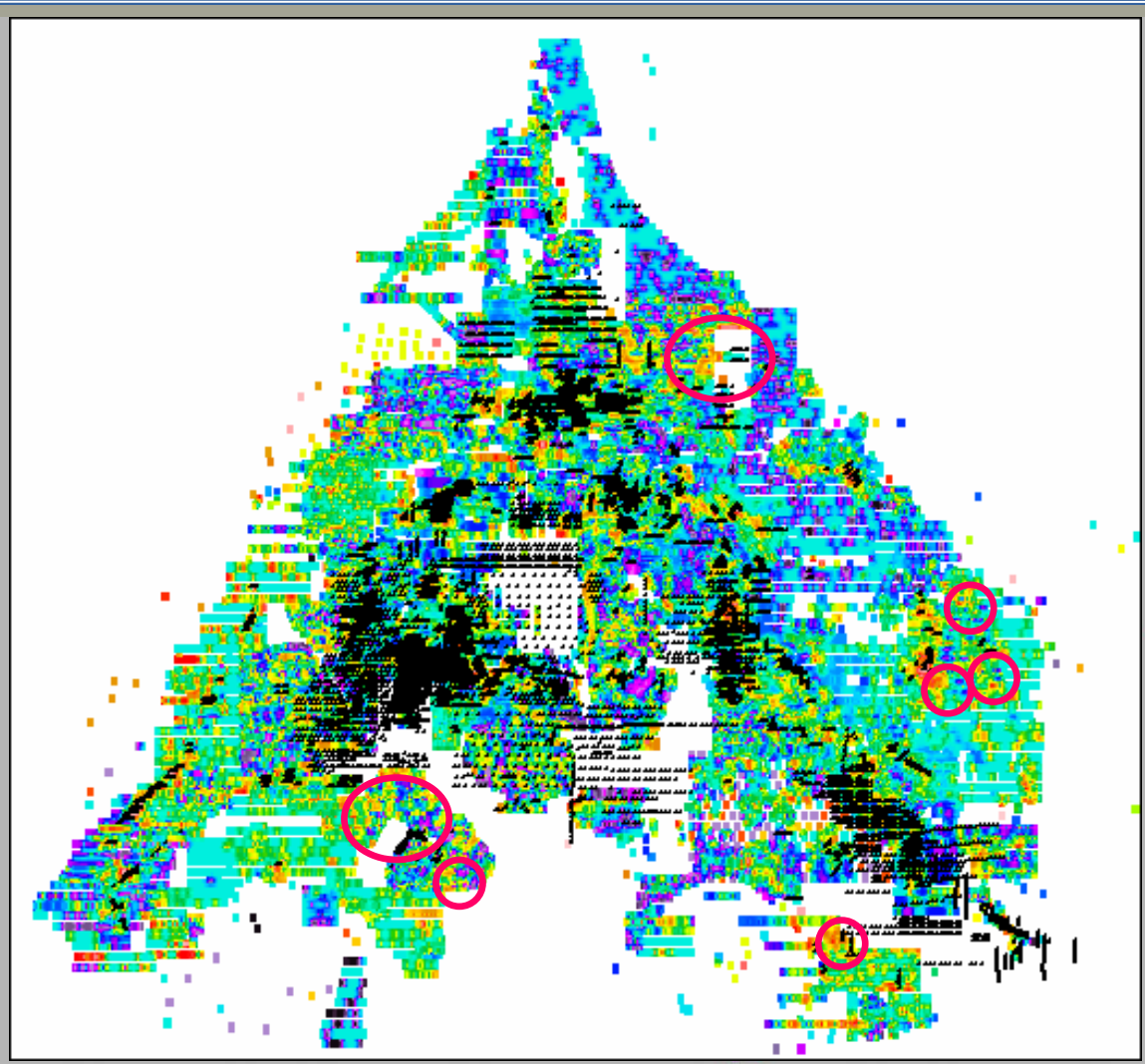


Quantification: Normalisation by Response Ratios

A Level Playing Field



Surface Geochemistry: Normalised Data



Quantification: The Test

Compare the capability of methods to locate bedrock mineralisation without generating false or displaced anomalism:

Compared the results of surface geochemistry and results of drilling by comparing:

normalised Response Ratios

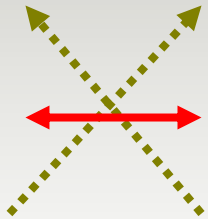
against the

“Sum of Gram Metre” values from drilling.

SOGM equates to the mass of mineralisation

Quantification: The Test

SOGM		Response Ratios	
0 - 5 g*m	barren to weak	1 - 10	barren to weak
5 - 20 g*m	moderate	10 - 20	moderate
>20 g*m	strong	20 - 50	strong
>50 g*m	very strong	>50	very strong

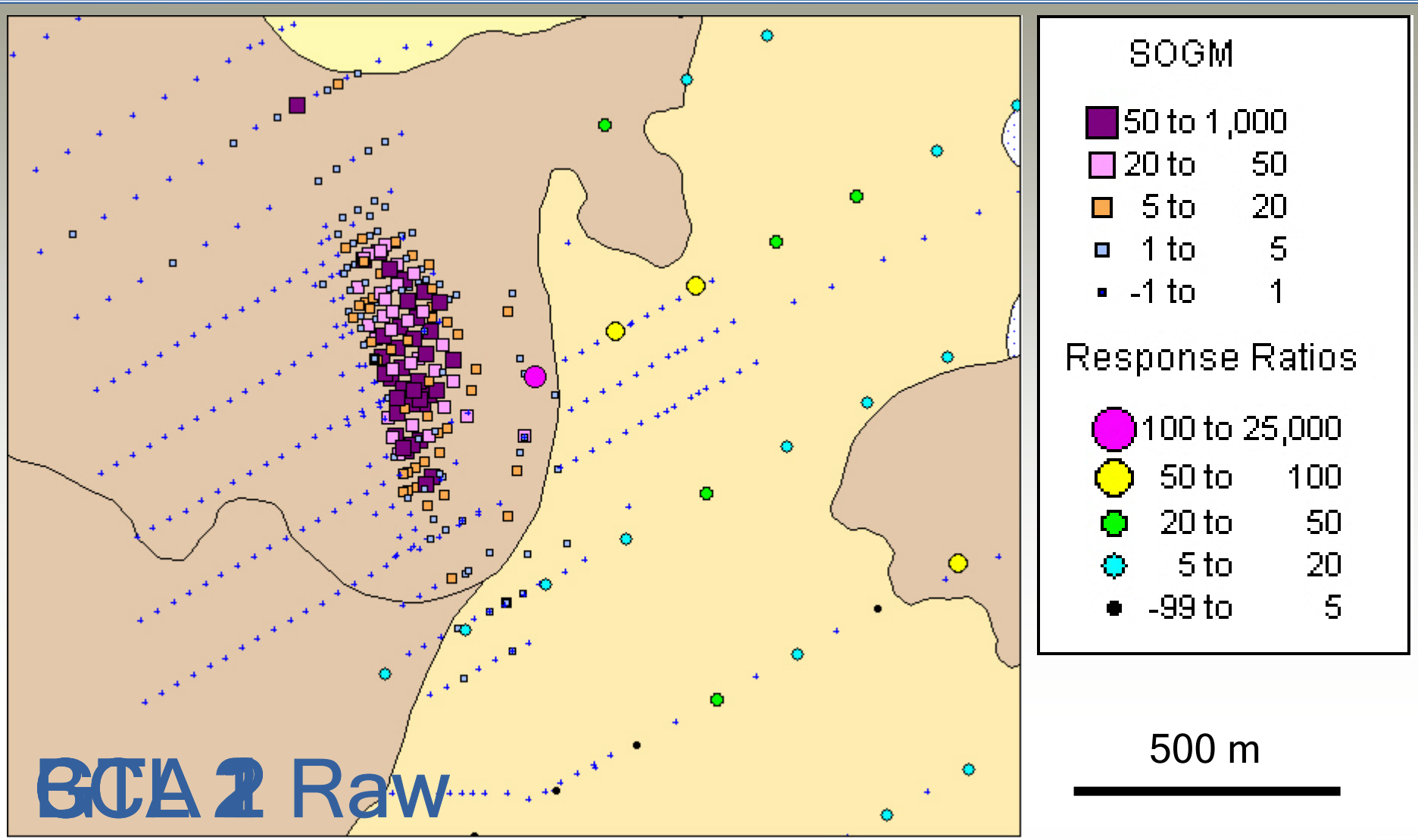


FAIL

SUCCESS

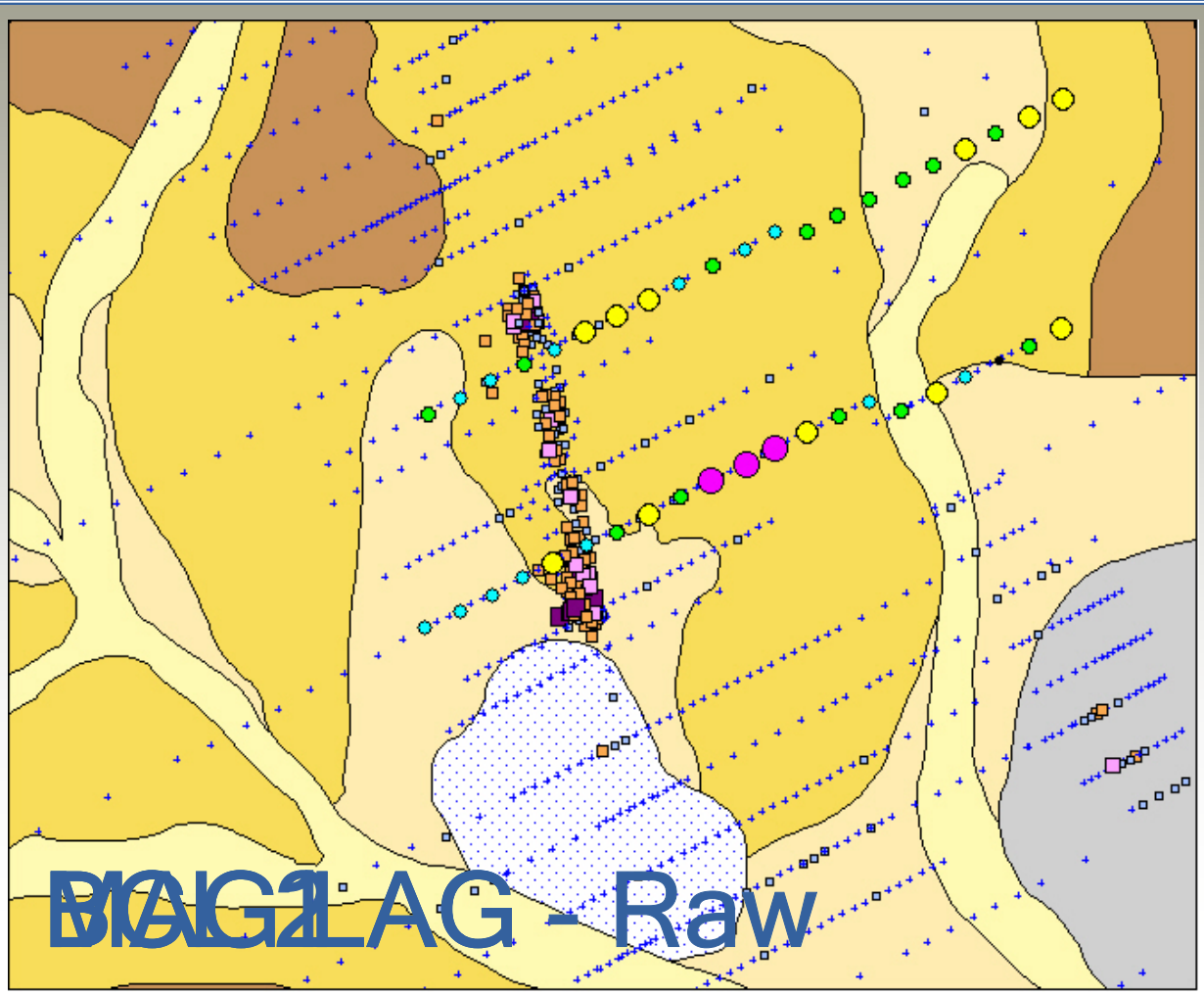
The Orchestration

Mine: SOGM



BCIA 2 Raw

Resource: SOGM



SOGM

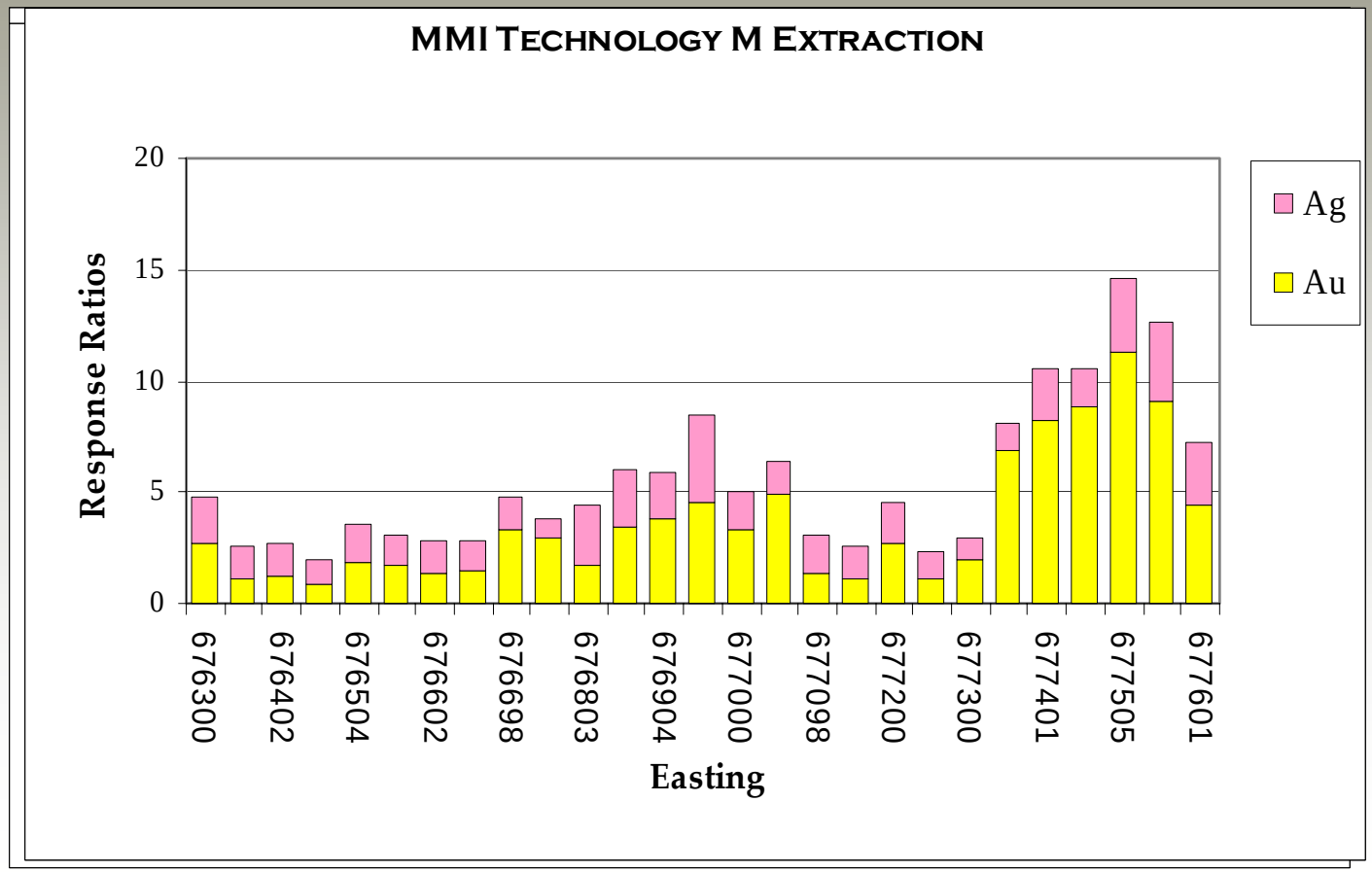
50 to 1,000
20 to 50
5 to 20
1 to 5
-1 to 1

Response Ratios

100 to 25,000
50 to 100
20 to 50
5 to 20
-99 to 5

500 m

Prospect: 2 g*m and 5 g*m



2 g*m

5 g*m

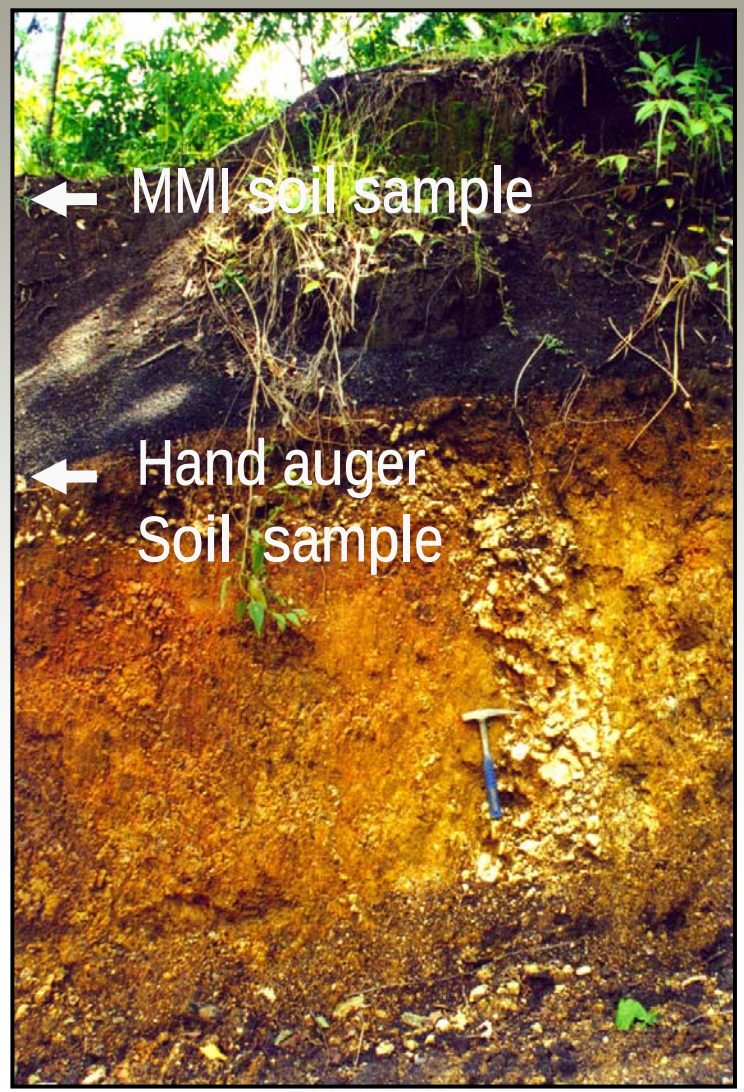
Orchestration: Success Rates

METHOD	Aqua Regia + AAS/GTA	BMA Lab BCL 1%CN	XRA Lab BCL ?%CN	GNS Lab BCL 0.1%CN	MagLag Conc.HCL	MMI M Extraction
Detection Limit	1 to 3 ppb	0.1 ppb	0.1 ppb	0.1 ppb	0.5 ppb	0.1 ppb
PASS at Barren Sites (Sterilises ground correctly)	1 / 25	1 / 14	0 / 9	2 / 13	0 / 3	6 / 6
FAIL at Barren Sites (False anomalies)	24 / 25	13 / 14	9 / 9	11 / 13	3 / 3	0 / 6
PASS at Mineralised Sites (Discovery success)	2 / 2	1 / 1	1 / 2	2 / 6	3 / 4	5 / 5
FAIL at Mineralised Sites (Discovery failure)	0 / 2	0 / 1	1 / 2	4 / 6	1 / 4	0 / 5
OVERALL SUCCESS RATE	3 / 27	2 / 15	1 / 11	4 / 19	3 / 7	11 / 11
	11%	**13%**	**9%**	**21%**	**43%**	**100%**

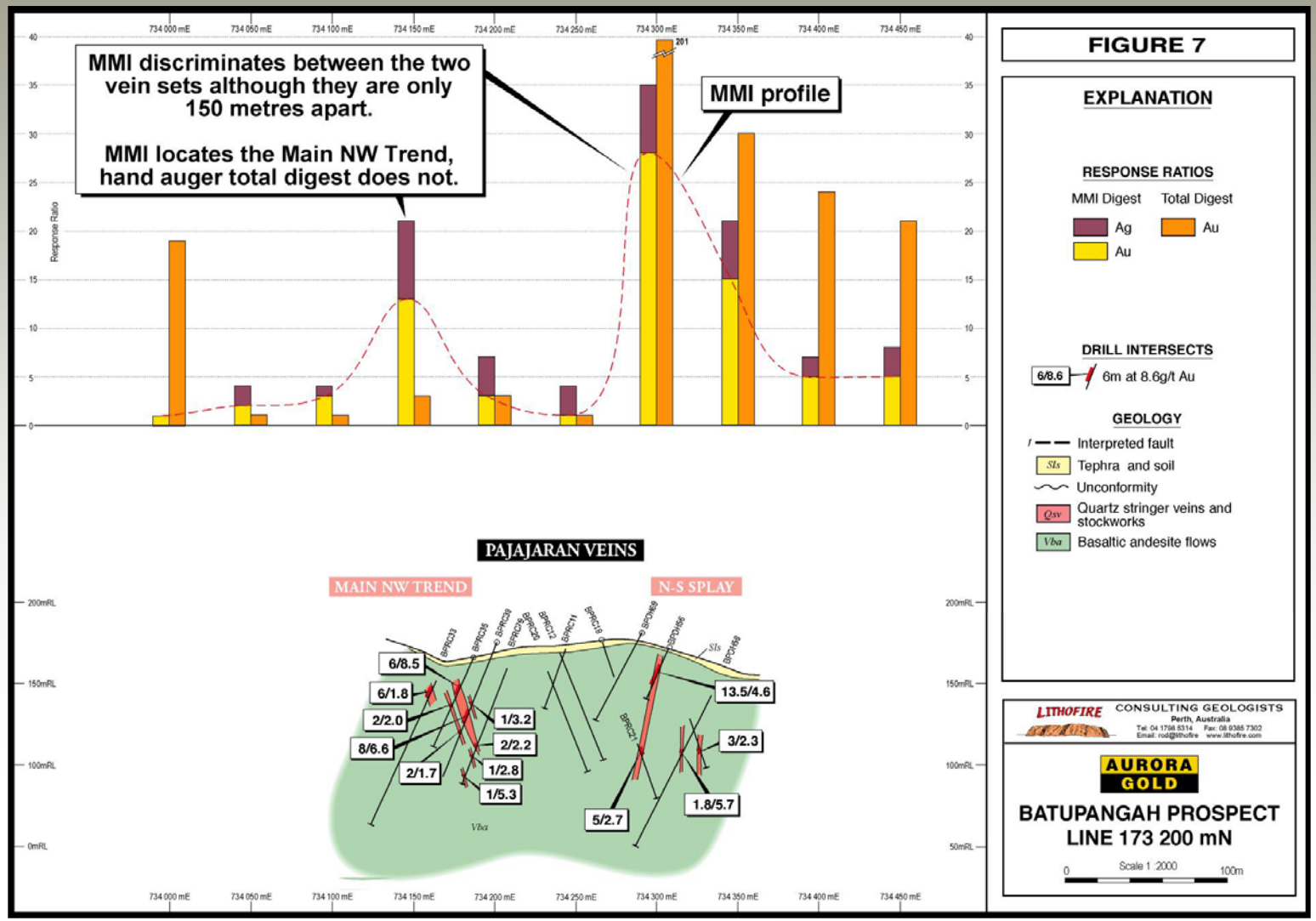
Case Study: Toka Tindung, Sulewesi

The Exploration Challenge:

Krakatoa



High Resolution Geochemistry



Success Rates: Hand Auger Total Digest vs MMI B Digest

	Undecided Evaluations (U)	Failures by Overdrilling (F$)	Failures at Barren and Weak Prospects:	Failures at Medium and Strong Prospects	PASS	SUCCESS RATE
MMI B Digest: gold in soil	**1**	**0**	**1**	**2**	**25/28**	**90%**
Total Digest: gold in hand-augered saprolite	**2**	**5**	**1**	**3**	**18/27**	**67%**

CONCLUSIONS

- **Both techniques have high success rates;**
- **High success rate of auger is a testament to the team but is about 10 times slower and requires a larger team;**
- **Recent upward movement of ions occurs through the tephra**
- **MMI is a high resolution technique that can discriminate veins within 150 m**

Conclusions

Partial Digests offer significant improvement in Success Rates when applied with diligence: they are high resolution tools and it is important that the basics are done correctly.

MMI in particular is superior because:

- There is no nugget effect;
- It works in many different regolith environments;
- It has excellent repeatability down to 0.01 ppb Au.

If you innovate you must quantify and to quantify you must normalise.