

# FINING A NEEDLE IN A HAYSTACK: PERFORMANCE EVALUATION OF PORTABLE XRF INSTRUMENTS FROM THREE MANUFACTURERS



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27<sup>th</sup> IAGS: Tucson, Arizona  
21<sup>st</sup> April 2015

# Introduction

- Following the discovery of the Nova-Bollinger deposit in July 2012 by Sirius Resources the Fraser Range region has become one of Australia's most sought after exploration districts.
- Despite being located just 250km east of Kalgoorlie, very little exploration has been undertaken in the area, due to the presence of sand cover and poor infrastructure.
- A number of small-cap ASX-listed companies have accelerated their exploration program in the region to test a base metals camp theory.
- Approximately 75% of these companies utilise handheld XRF instruments.
- Is pXRF a “fit for purpose” technique?
- Which manufacturer's instrument are “fit for purpose”



# THE HAYSTACK

Fraser Range  
Western Australia



# Western Australia



Fraser Range  
Province

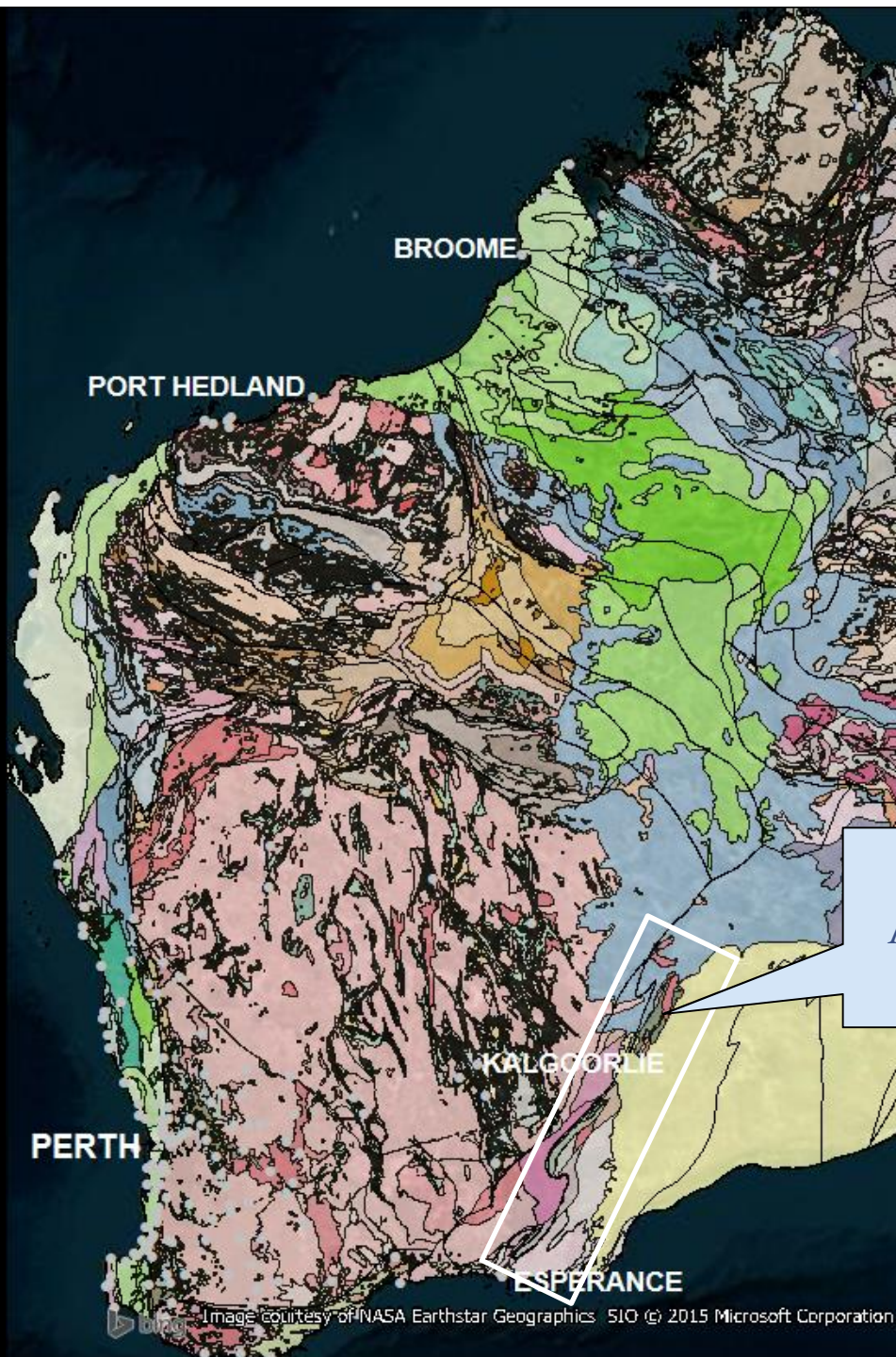


Image courtesy of NASA Earthstar Geographics SIO (c) 2015 Microsoft Corporation

Bing image



# Geology

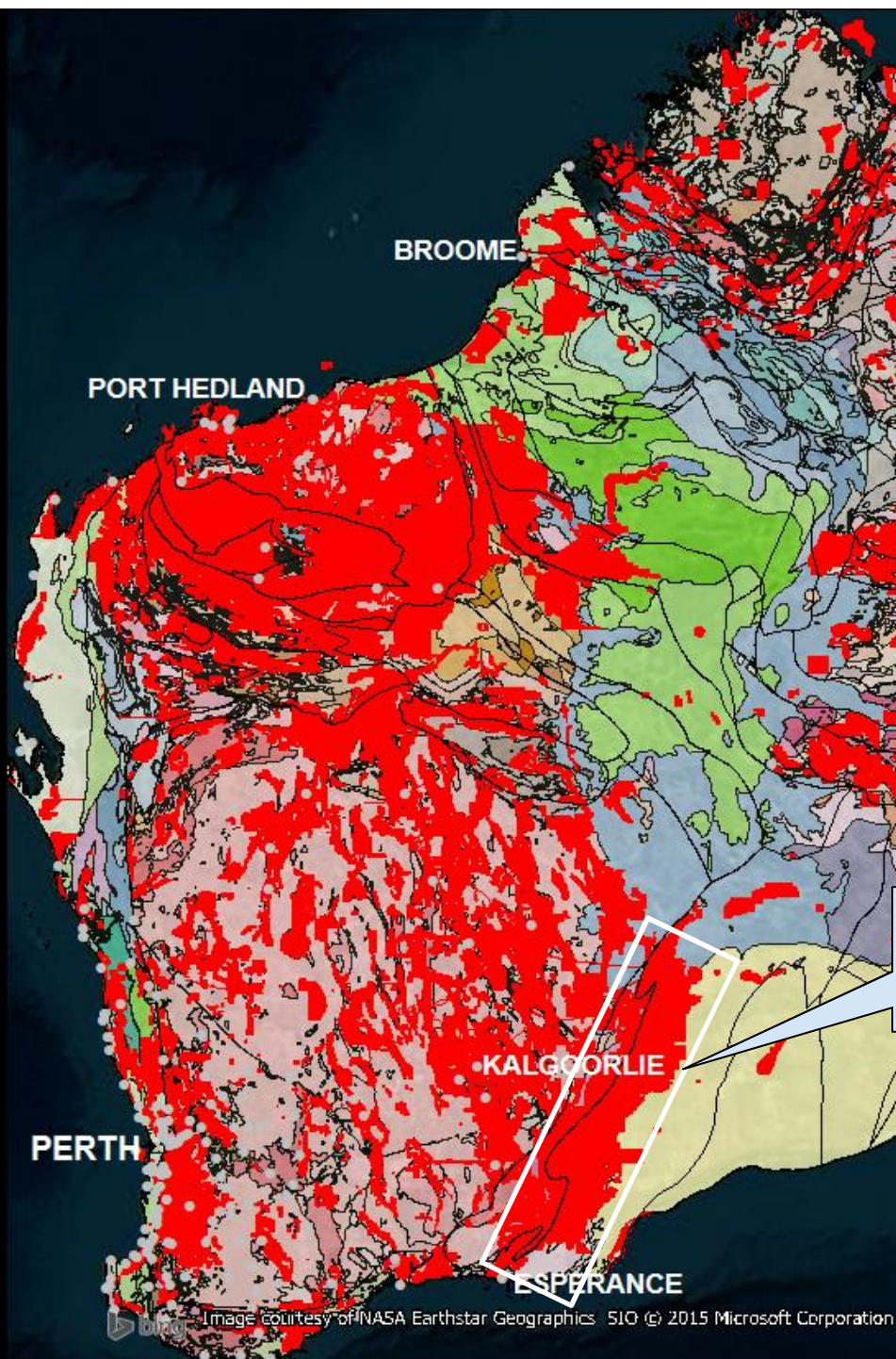


Fraser Range  
Archean / Proterozoic  
Tectonic Boundary





# Tenements



Fraser Range  
Intensely Pegged

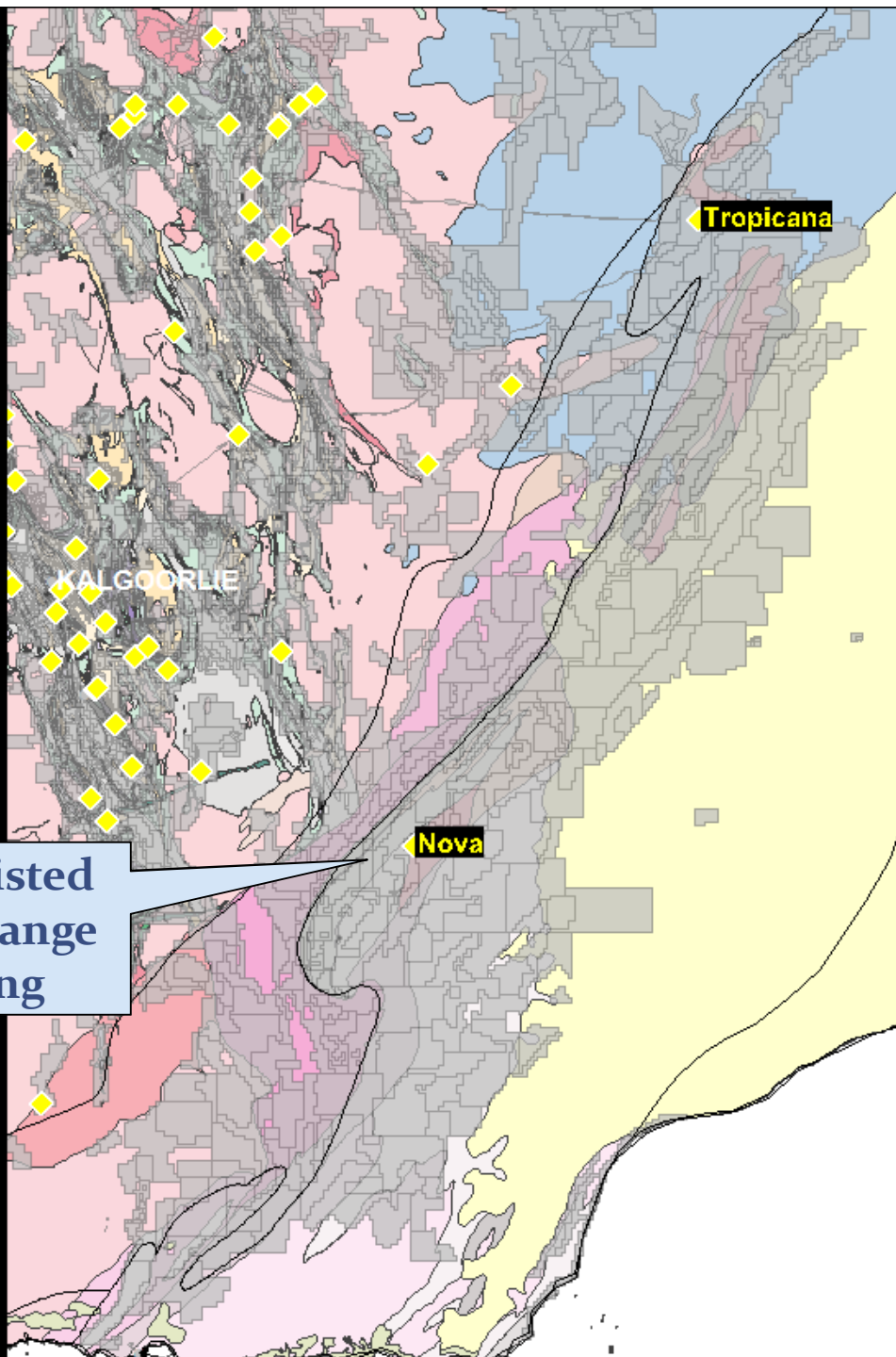
Image courtesy of NASA Earthstar Geographics SIO © 2015 Microsoft Corporation

GSWA data



# The Needle(s)

# Fraser Range Projects



12 small-cap ASX-listed  
dominate Fraser Range  
tenement holding



**GOLD**  
Tropicana in ground  
value: **US\$9B**

116.8Mt @ 2.06 g/t for 7.72 M oz  
December 2013

**NICKEL**  
Nova in ground  
value: **US\$4B**

10.2Mt at 2.4% Ni, 1.0% Cu and  
0.08% Co March 2013

GSWA data



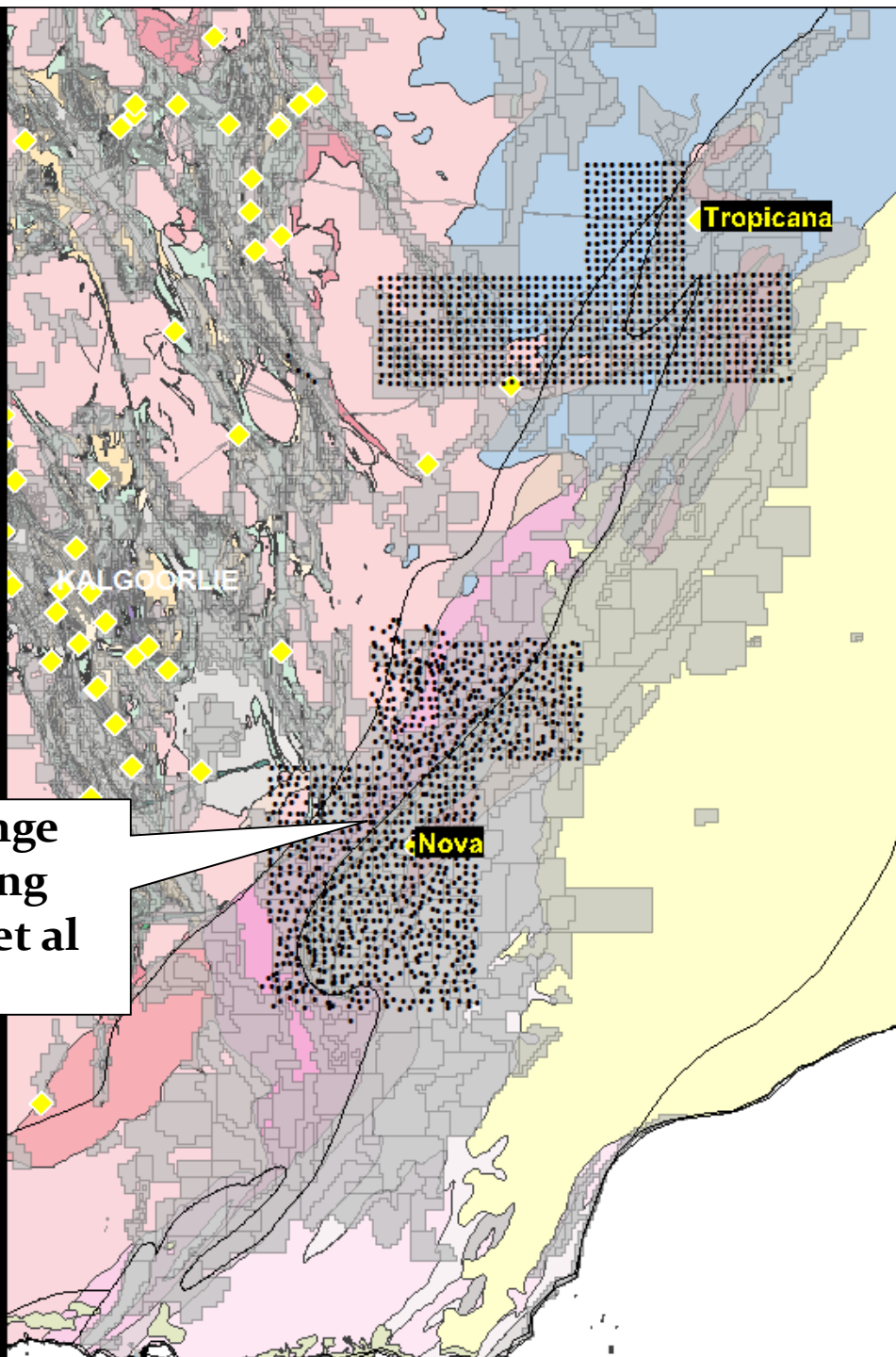
# Key Explorers & Exploration Stage

Of the 12 companies 9 key explorers are using handheld pXRF instruments as an exploration tool (75%)

Company name	Stock code	Surface evaluation (i.e. soil geochem sampling)	Sub-surface evaluation (i.e. downhole EM)	RC drilling	Assays received from RC drilling	Diamond core drilling	Assays received from Diamond Core Drilling
		✓				✓ (prelim. 6 holes from surface)	✓ (prelim. 6 holes from surface)
Boadicea Resources Ltd	BOA	✓		✓			
Buxton Resources Ltd	BUX	✓	✓	✓			
		✓	✓	✓			
		✓	Downhole and ground EM commenced	✓	✓	✓ (4 holes at depth)	Only received assays for one hole
Matsa Resources Ltd	MAT	✓	EM underway	✓	✓		
		✓	EM underway	✓	✓		
		✓					
		✓	✓				
		✓	✓				
		✓	✓	✓	✓		
		✓	EM underway	✓	✓		



# Fraser Range GSWA samples



GSWA Fraser Range  
Regolith sampling  
program (Morris et al  
2000)





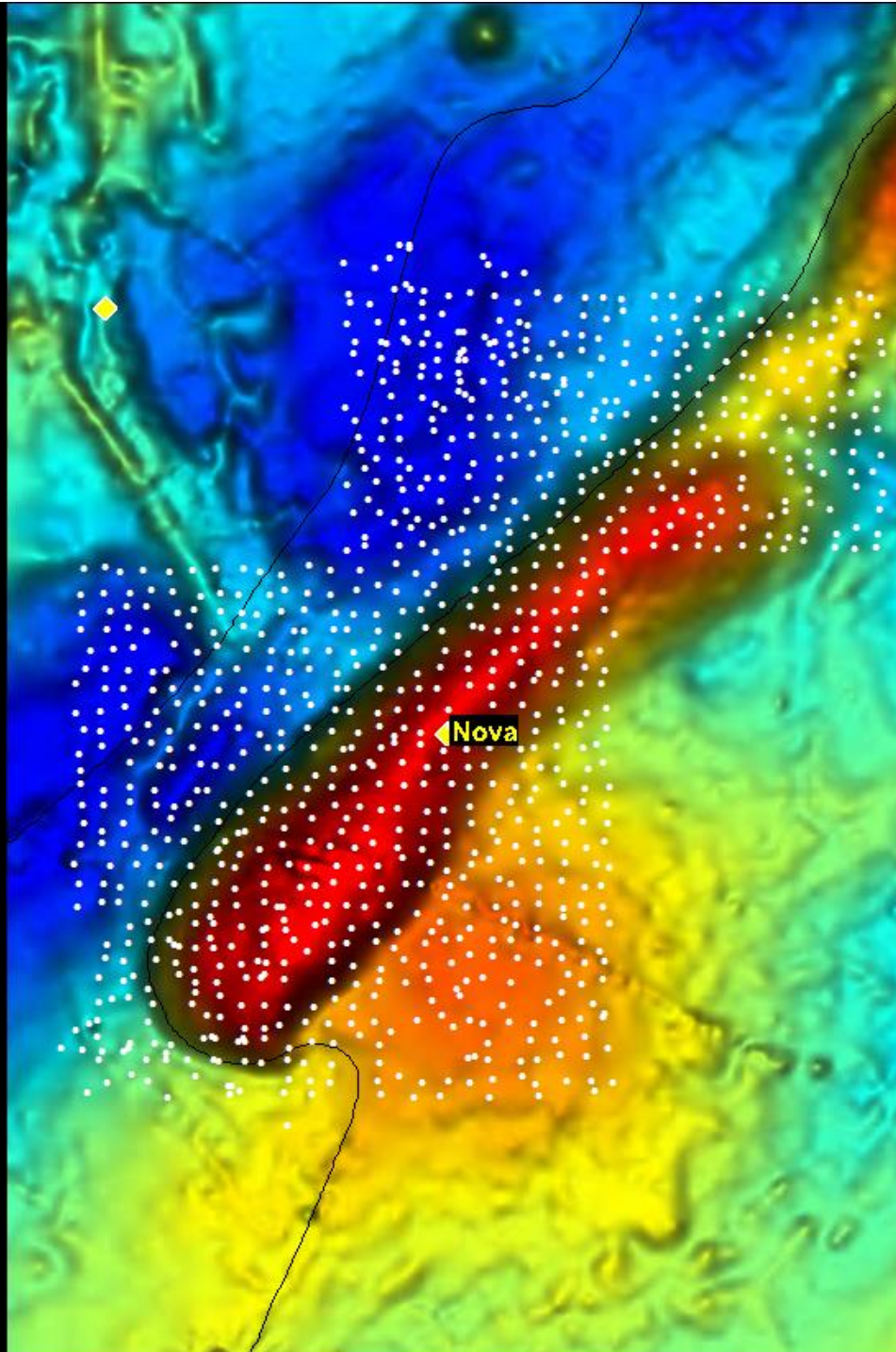
# Fraser Range GSWA samples

Used GSWA  
Fraser Range  
Samples

Surface regolith  
samples

Collected on  
~4km x 4km grid

All samples have  
commercial  
laboratory assays

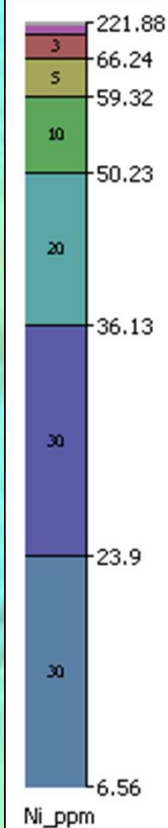
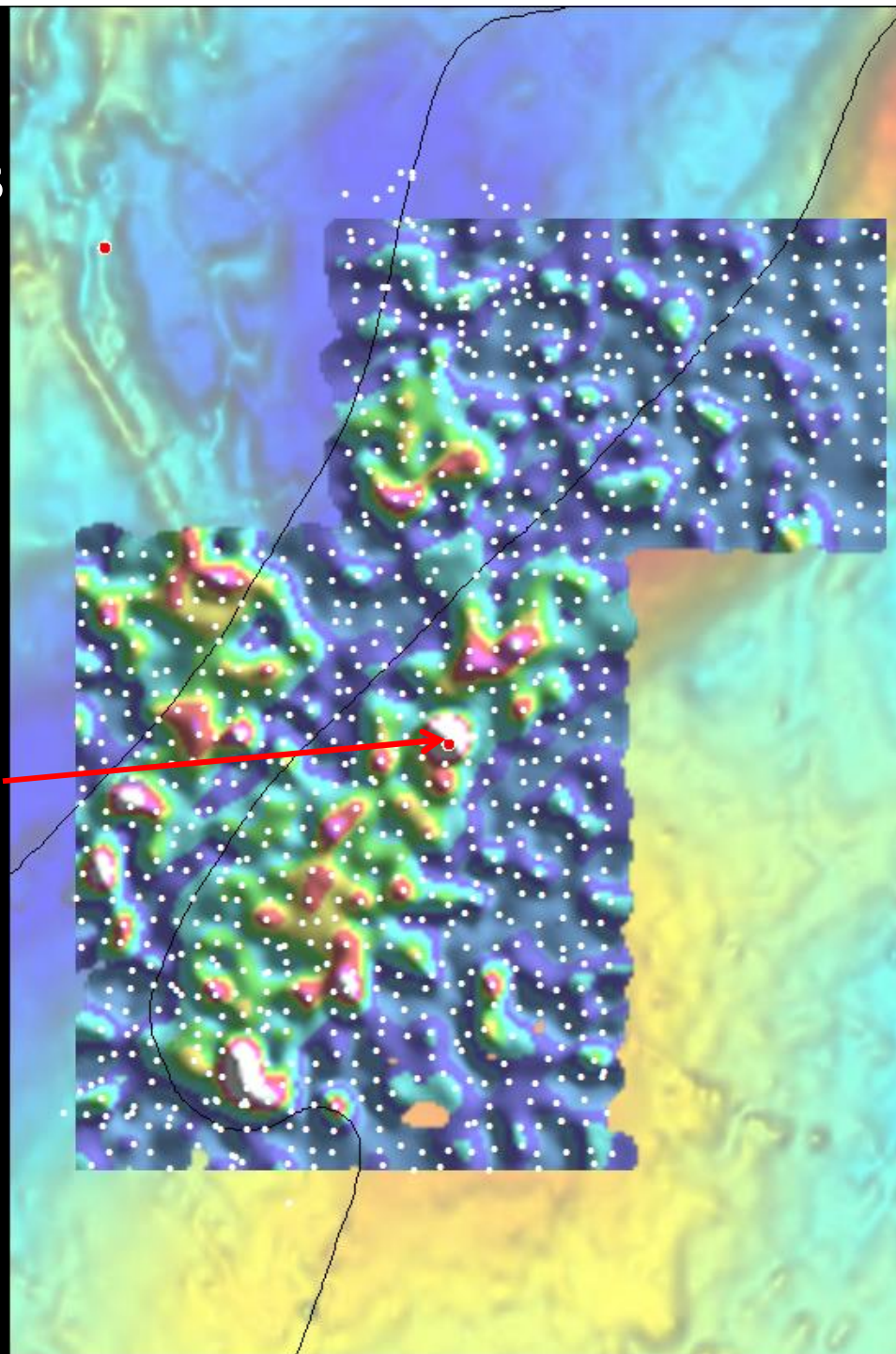


# Fraser Range GSWA samples

Sample 163201  
collected within 1.2  
km of Nova  
containing

- " **271 ppm Ni**
- " 90 ppm Cu
- " 594 ppm Cr

This is the needle in  
the haystack sample



# Ni

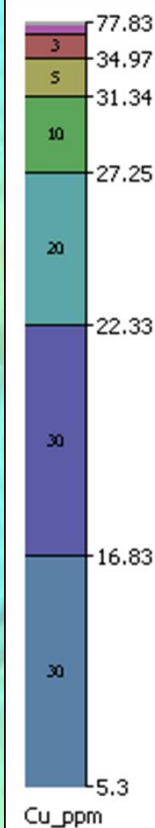
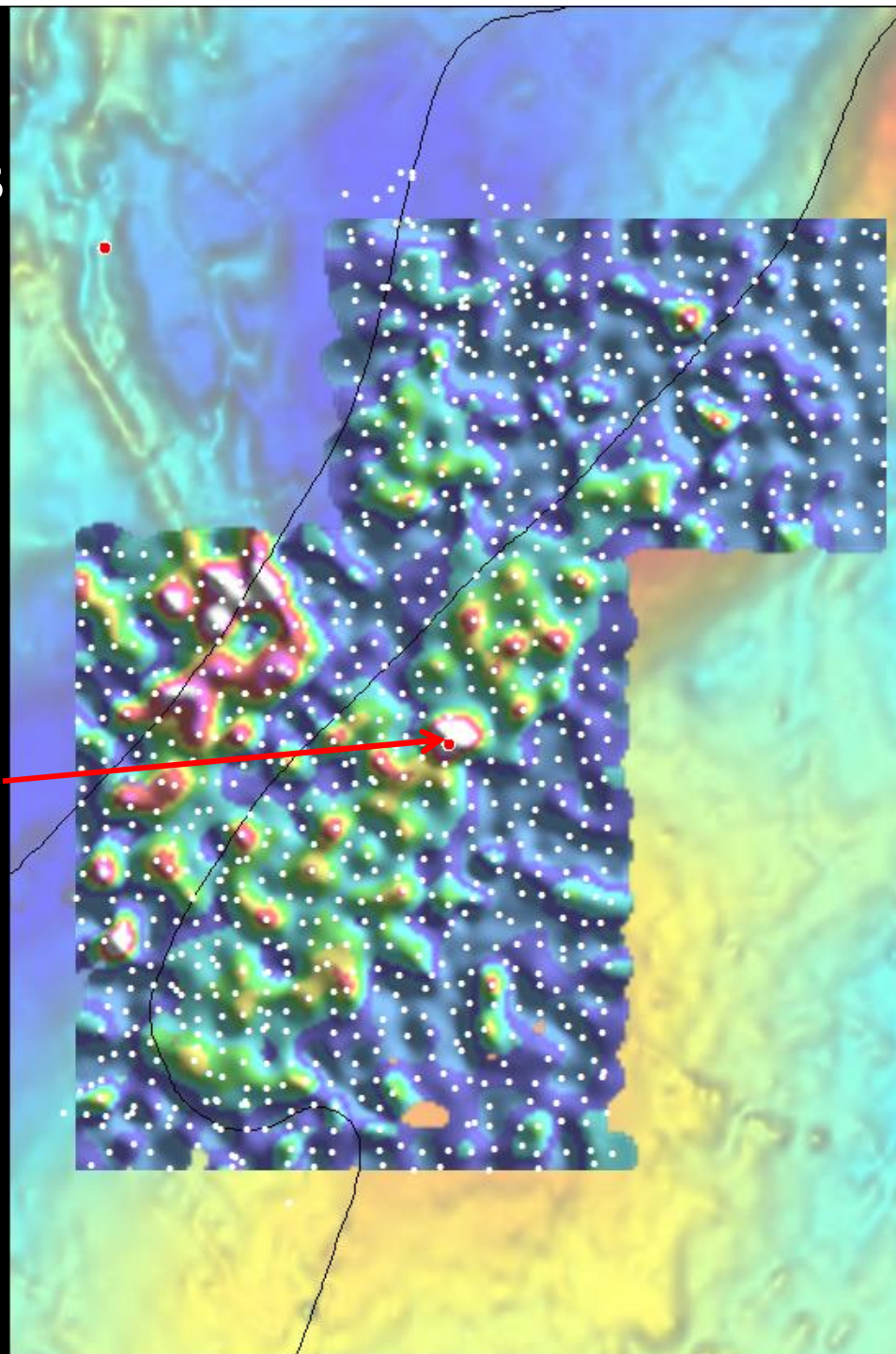
GSWA data



# Fraser Range GSWA samples

Sample 163201  
collected within 1.2  
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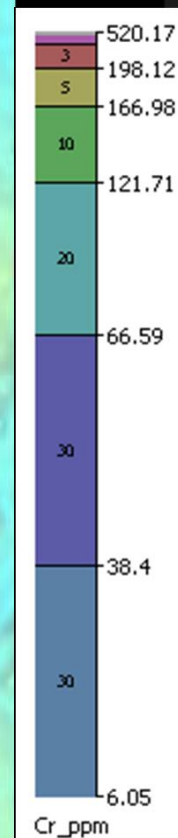
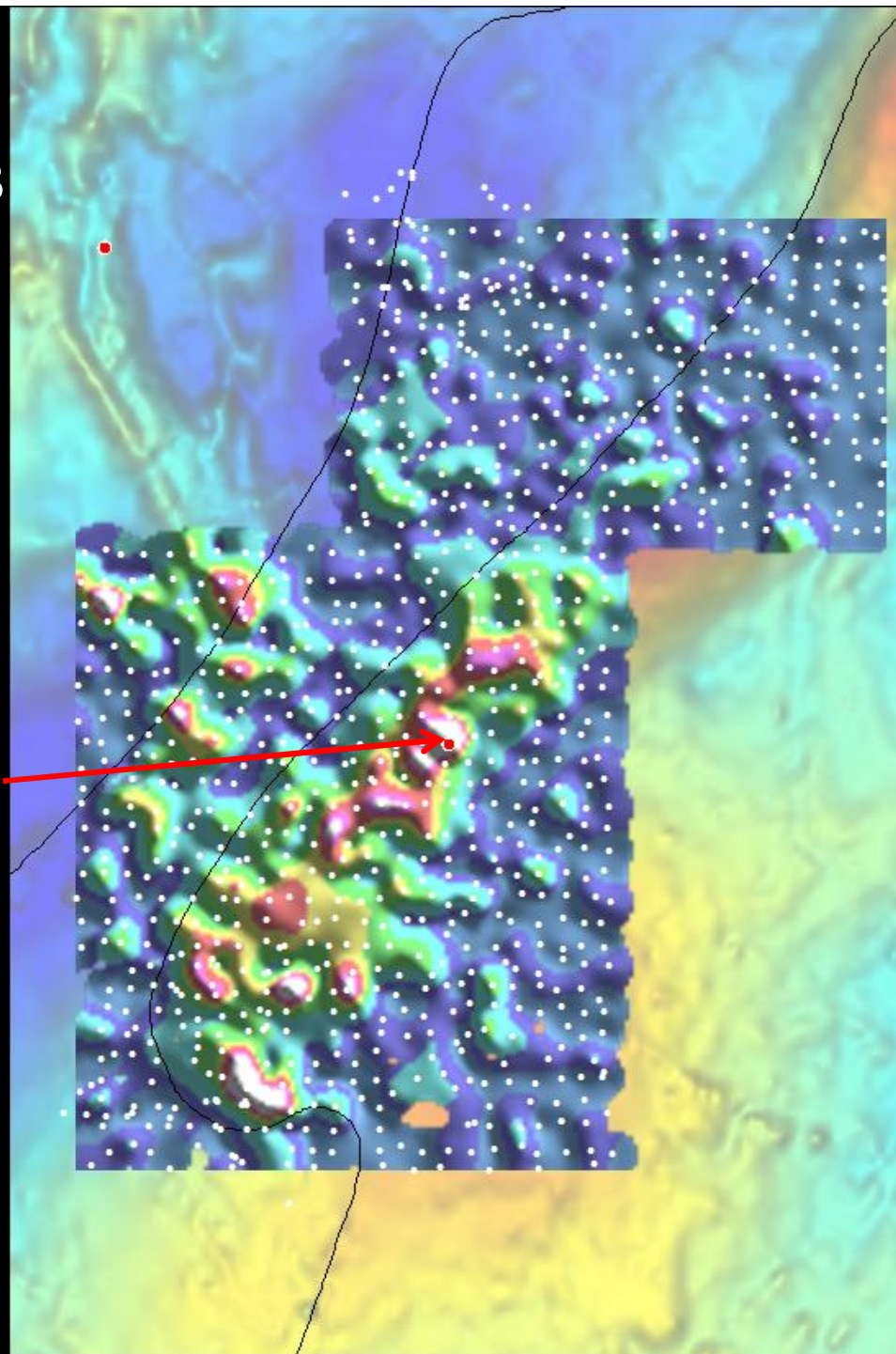
Cu

GSWA data

# Fraser Range GSWA samples

Sample 163201  
collected within 1.2  
km of Nova  
containing  
" 271 ppm Ni  
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" **594 ppm Cr**

This is the needle in  
the haystack sample




## Cr

GSWA data



# Instruments Evaluated

Manufacturers		
pXRF instrument		
Report abbreviation		
Anode		
Tube voltage ( $kV_{max}$ )		
Tube power ( $\mu A_{max}$ )		
Resolution (eV)		
Detector area		
Power source used	Generic Li-ion batteries	Niton Li-ion batteries
Element range	Mg (Z12) and greater	
Application /modes used	Soil/Geochem	
Windows	Propylene3	

For pXRF analysis GSWA samples placed in plastic cup with Mylar film

# Evaluation Grid



**GSWA Data  
(raw)**



**Bruker Data  
(geochem app)**



**Thermo Niton Data  
(soil mode)**

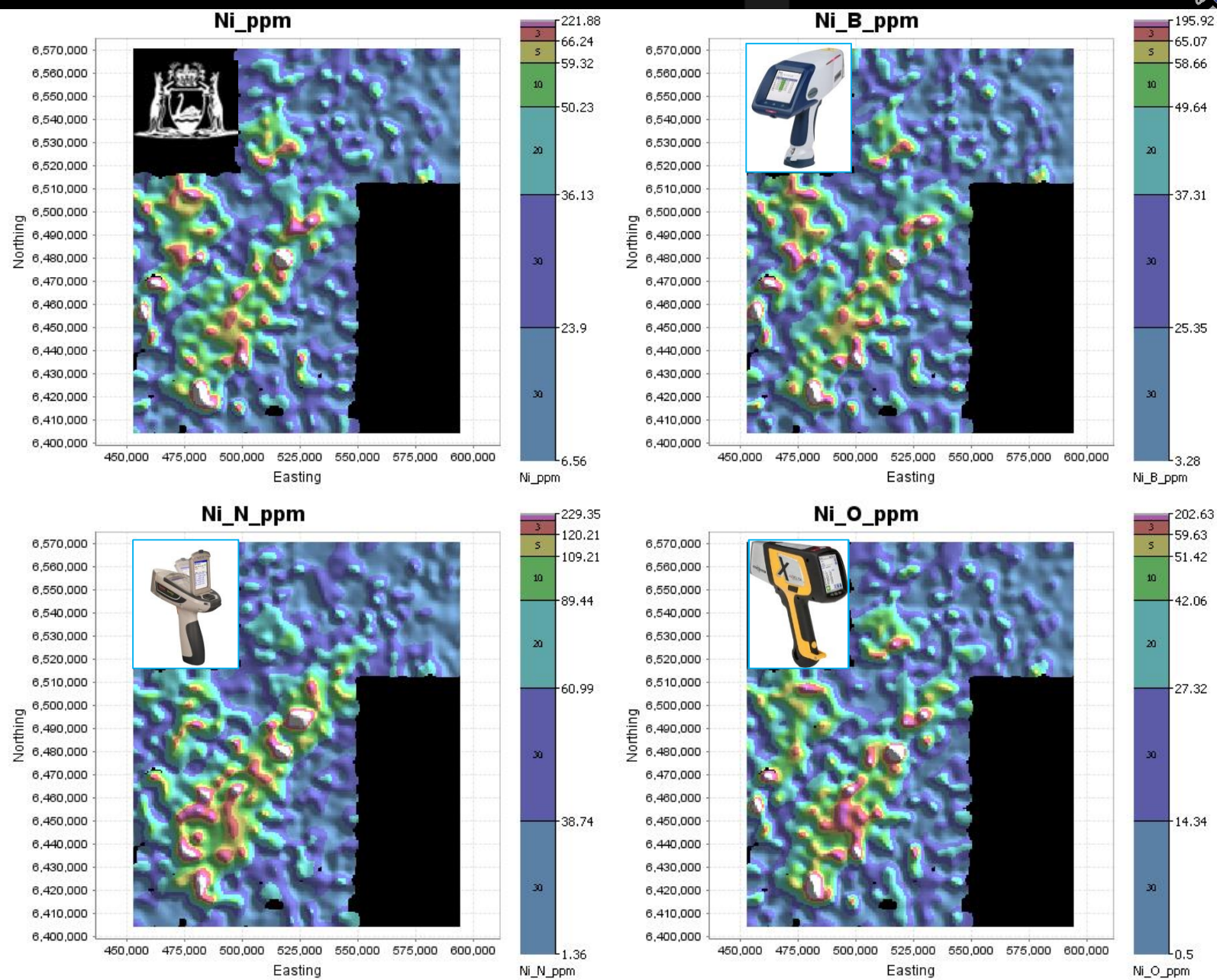


**Olympus Innov-X  
Data (soil/geochem)**

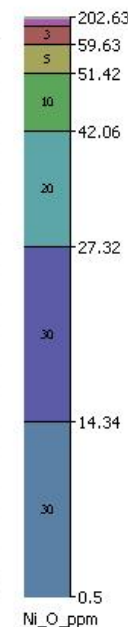
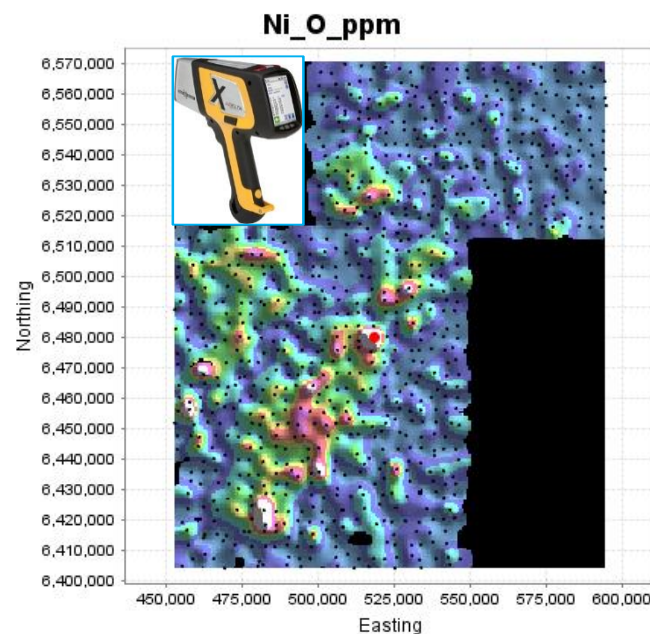
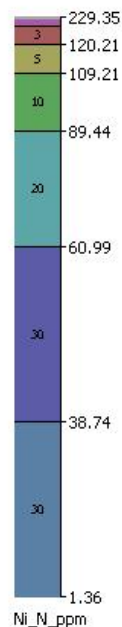
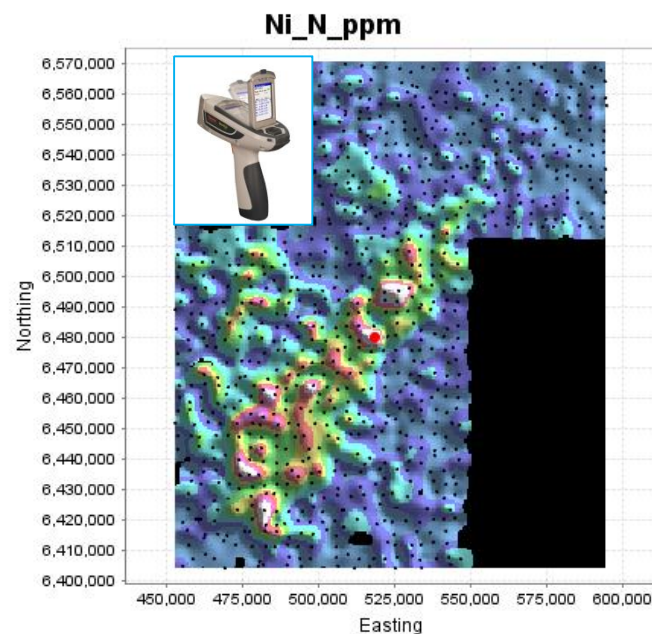
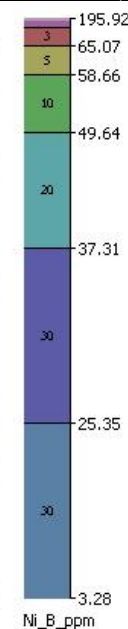
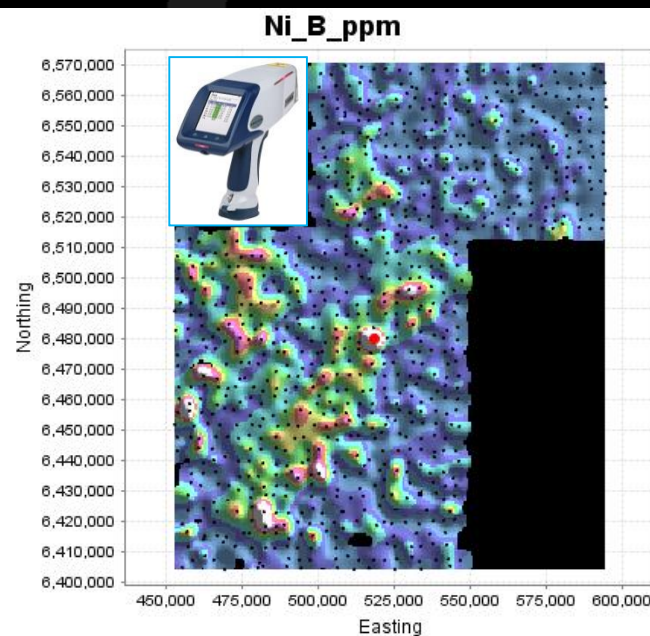
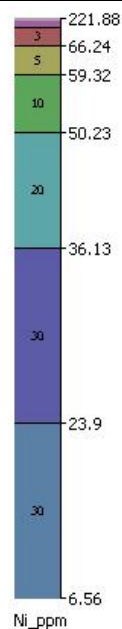
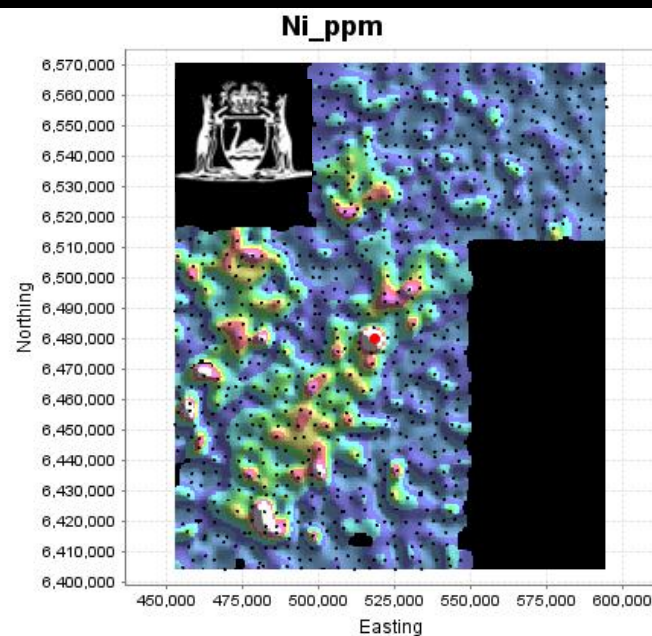




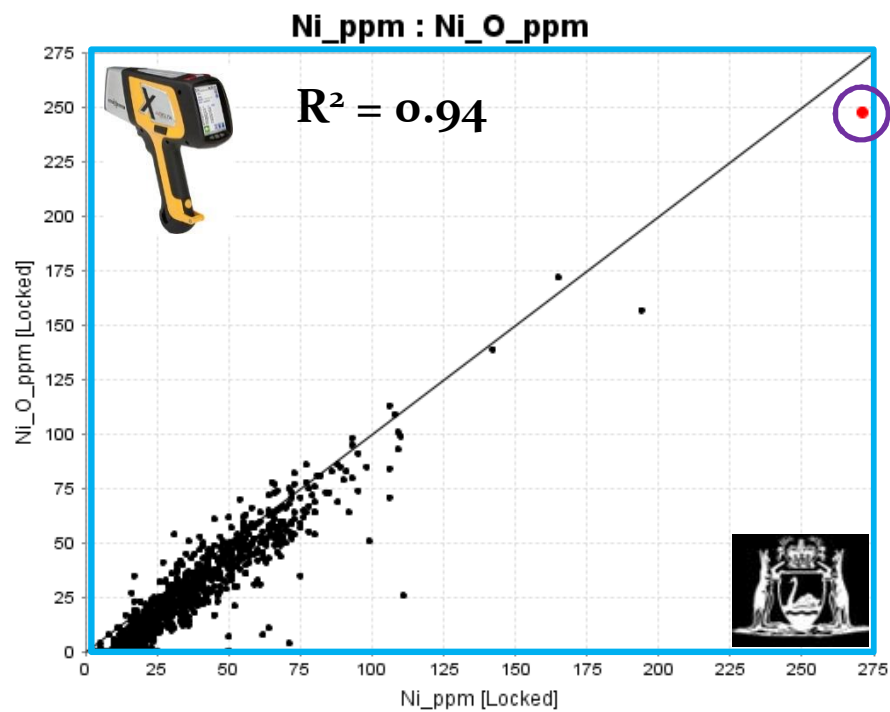
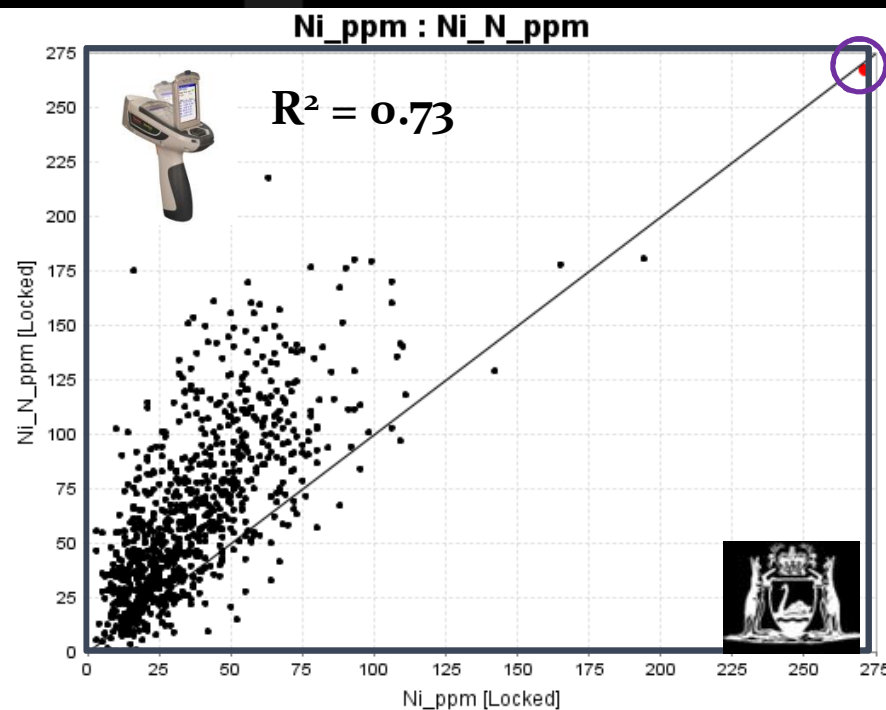
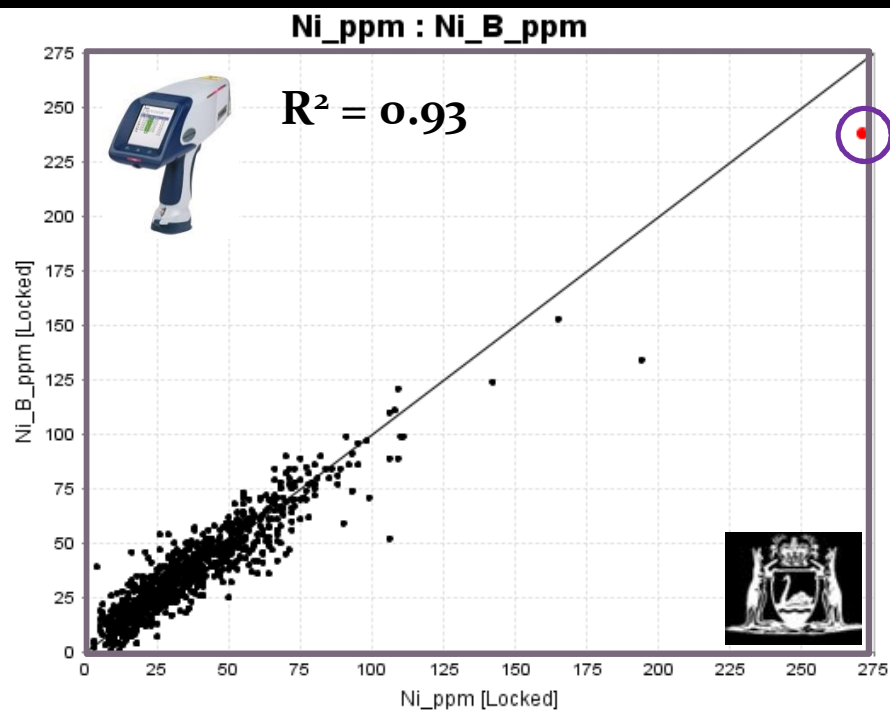
# Nickel Response



# Nickel Response (Needle)

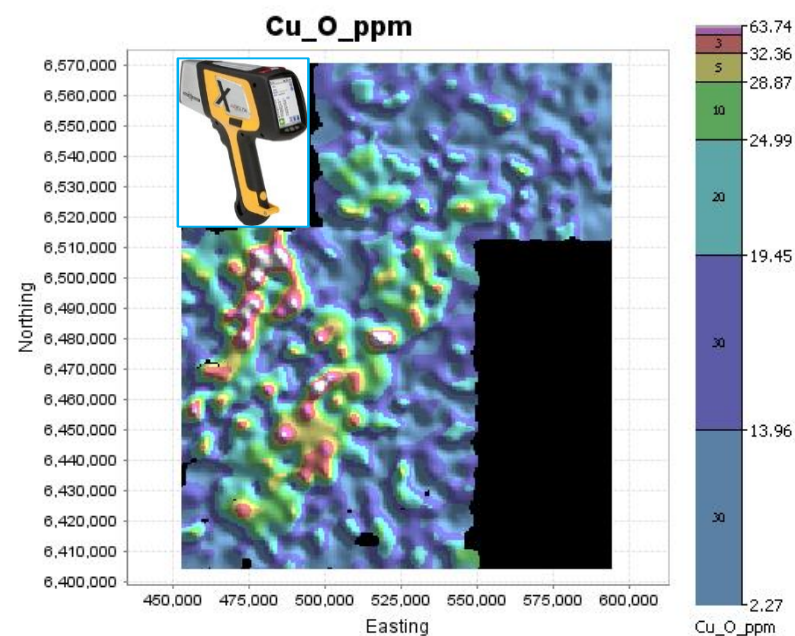
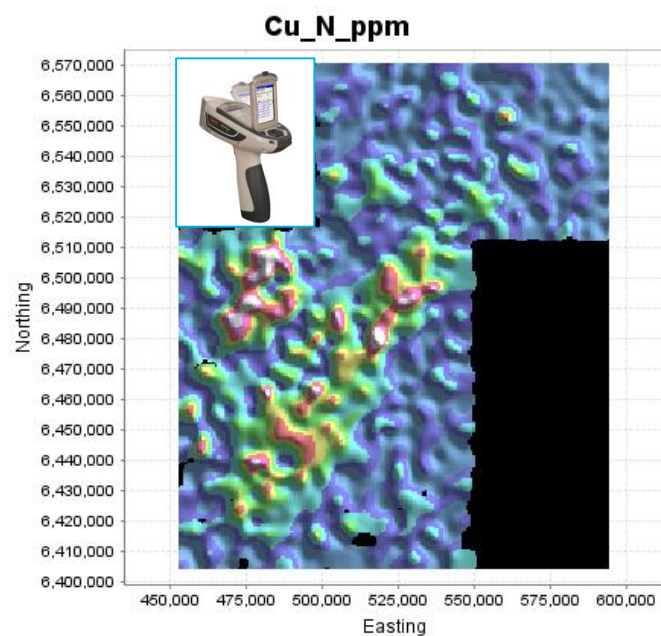
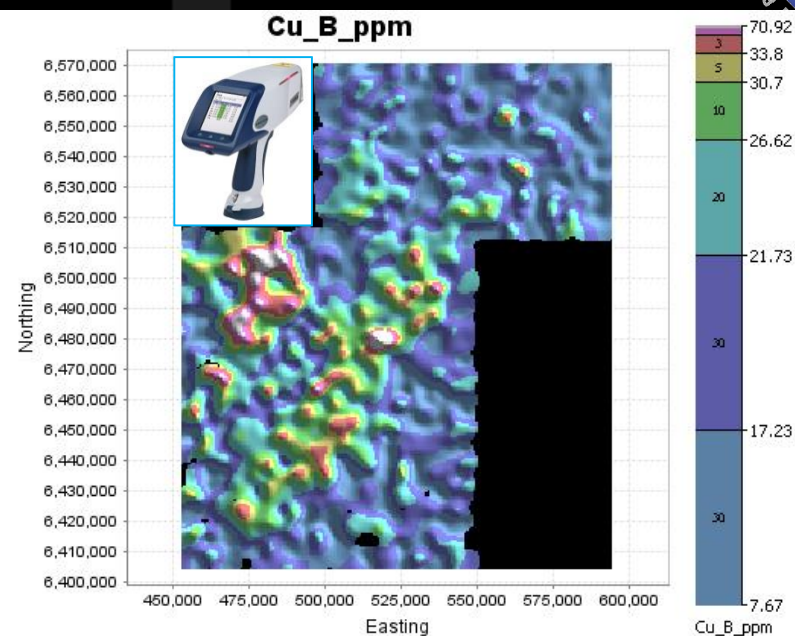
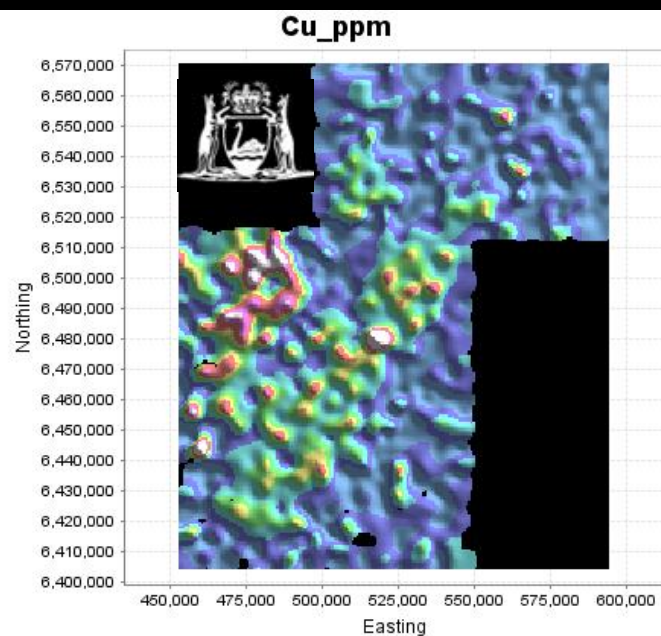






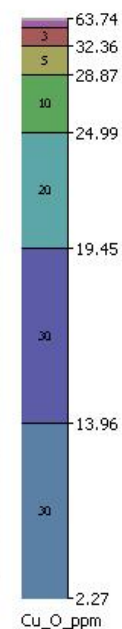
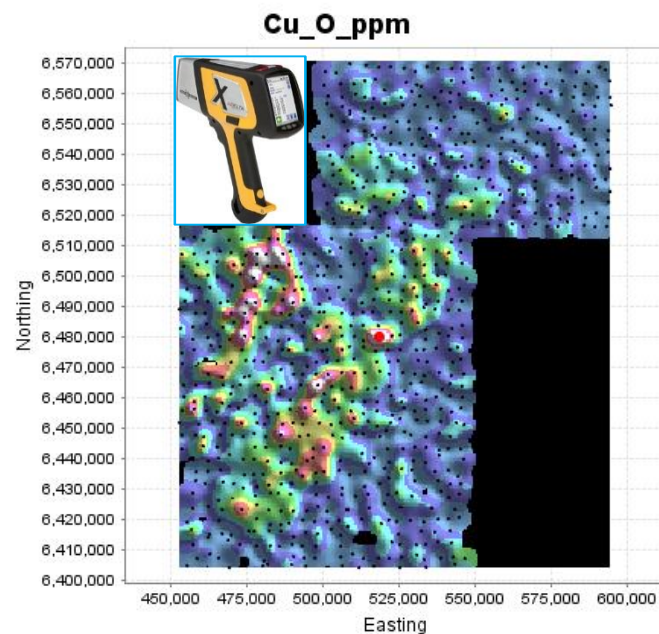
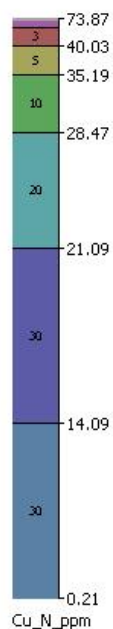
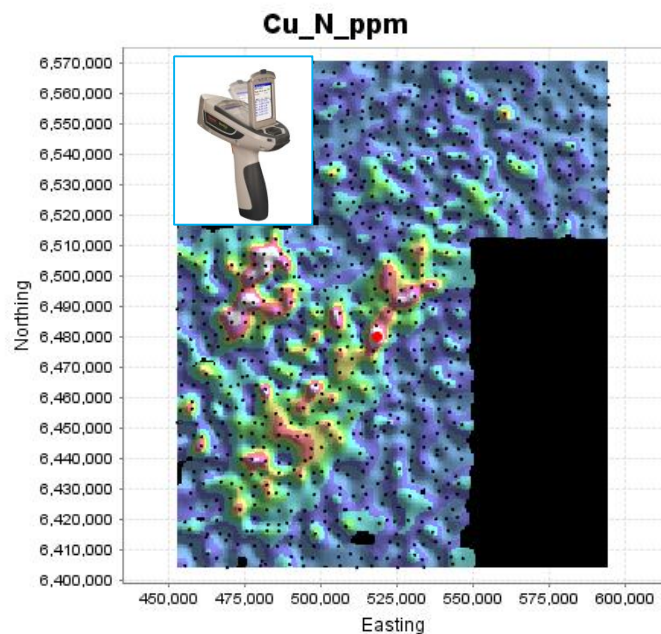
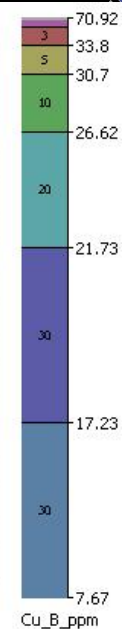
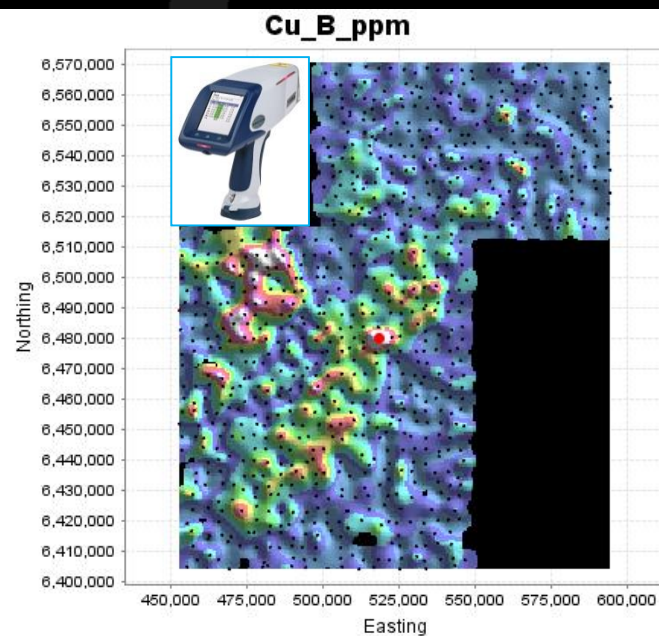
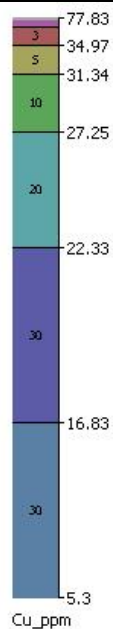
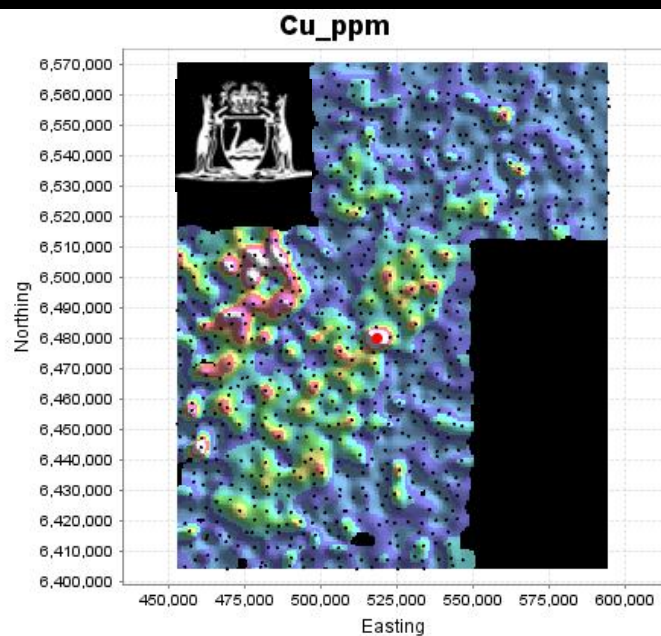
	Ni_ppm	Ni_B_ppm	Ni_N_ppm	Ni_O_ppm
Min	3	1	0.055	0.5
Max	271	238	267.56	248
Mean	35.48	35.84	60.69	26.52
Sdev	23.58	22.22	38.84	24.23
RSD	66.48	62.00	64.00	91.38

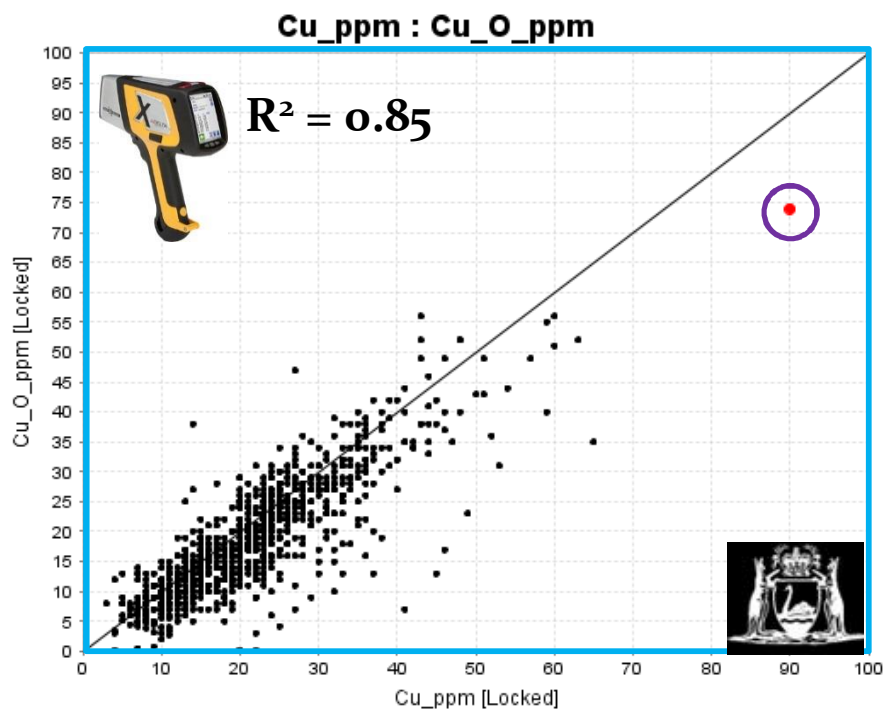
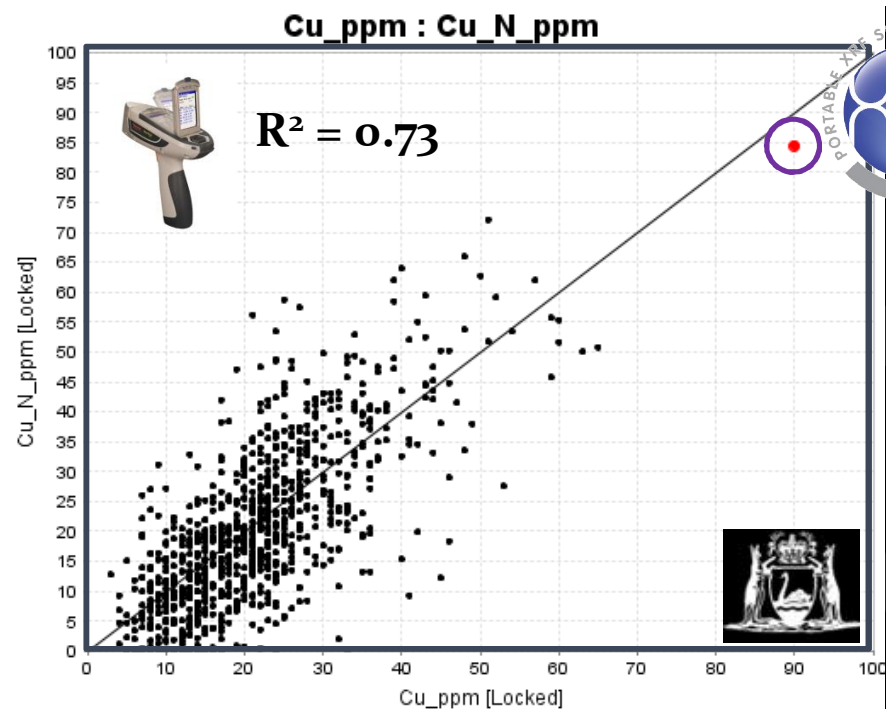
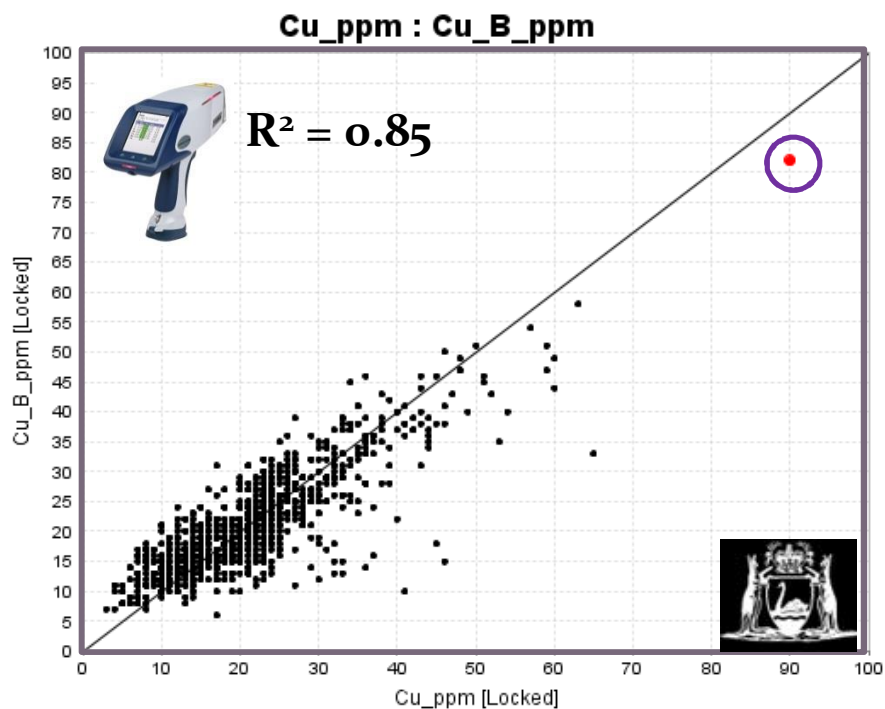
# Copper Response





# Copper Response (Needle)

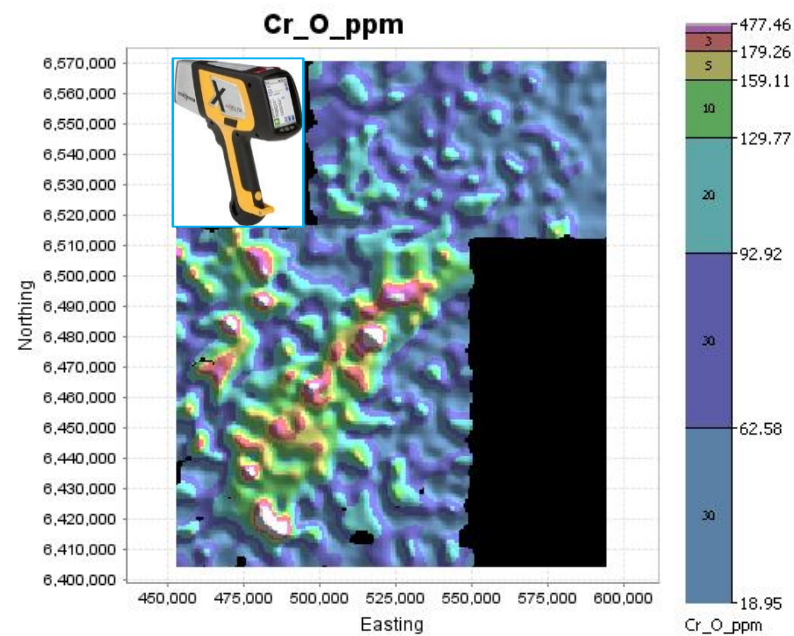
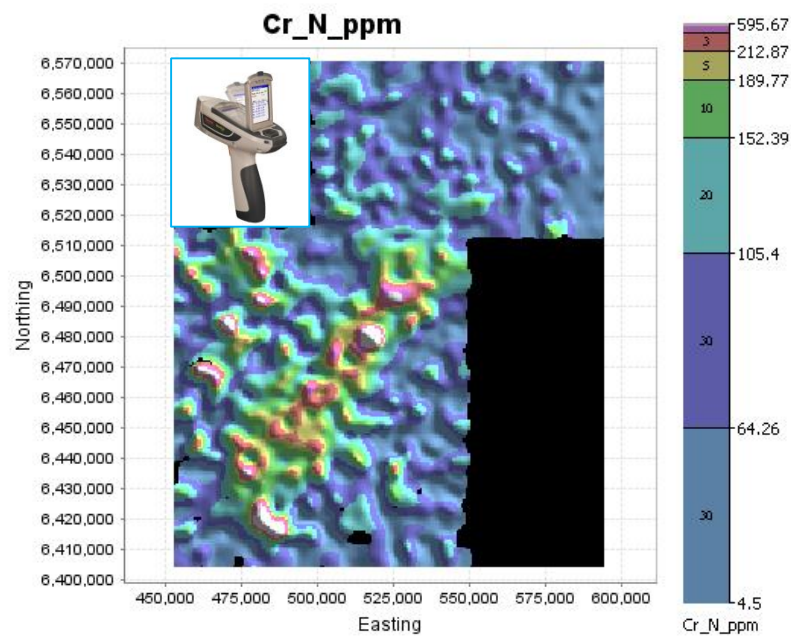
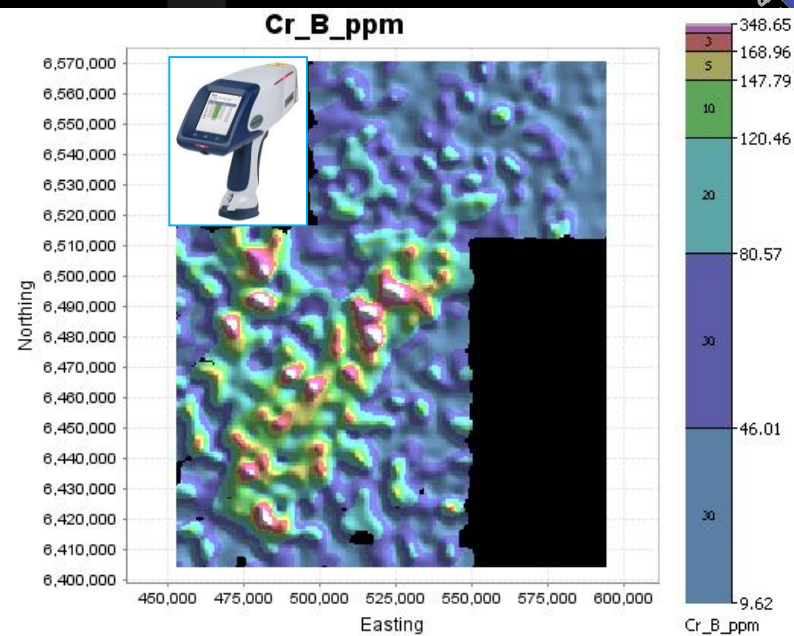
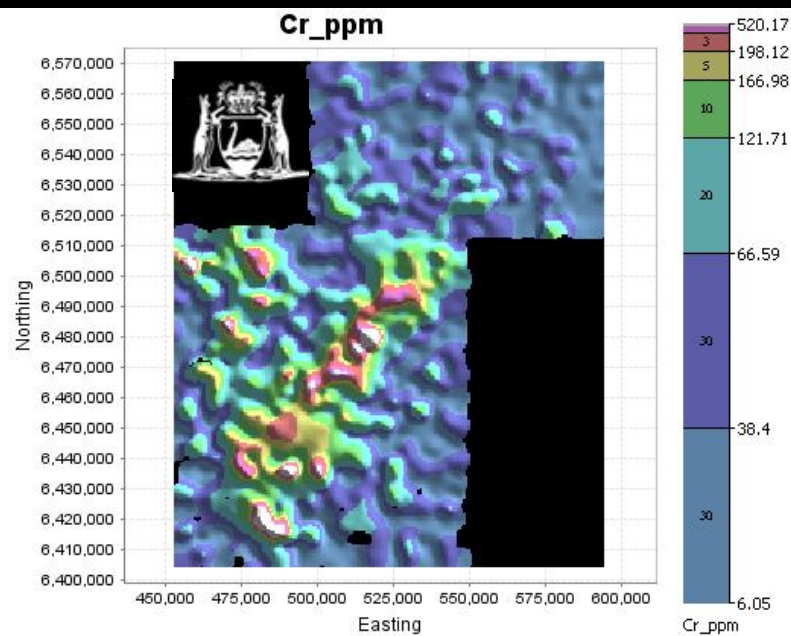




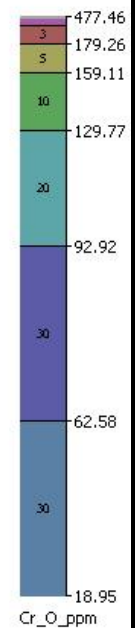
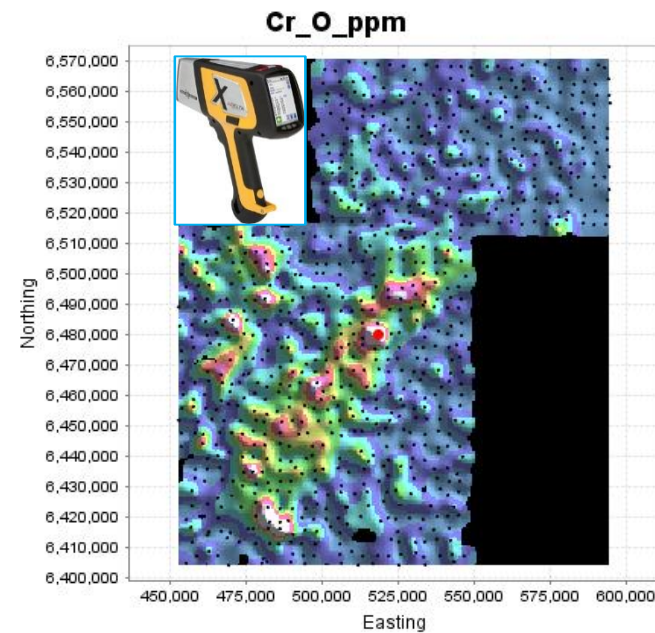
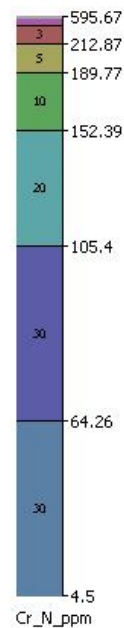
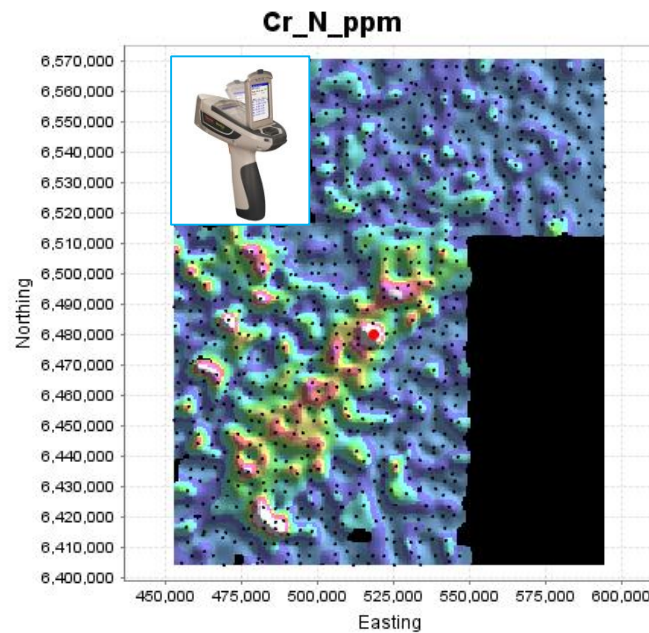
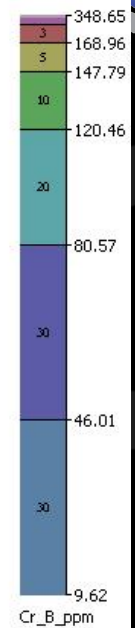
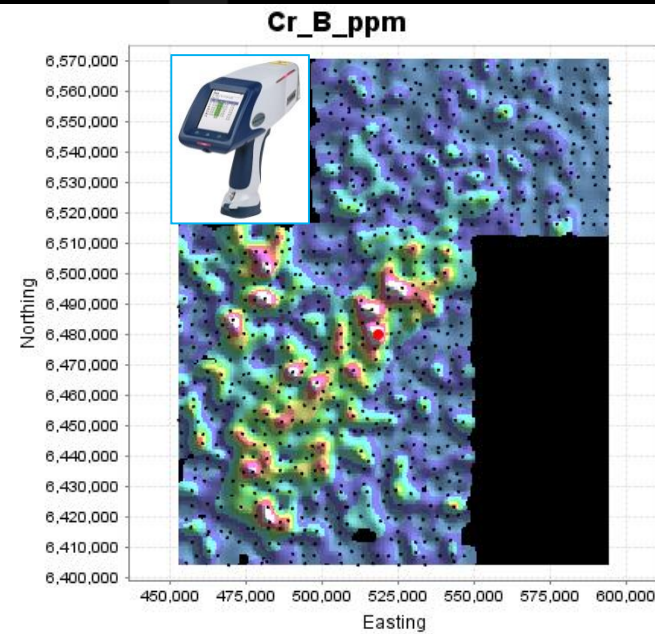
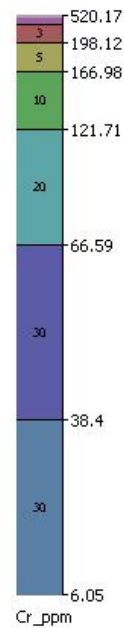
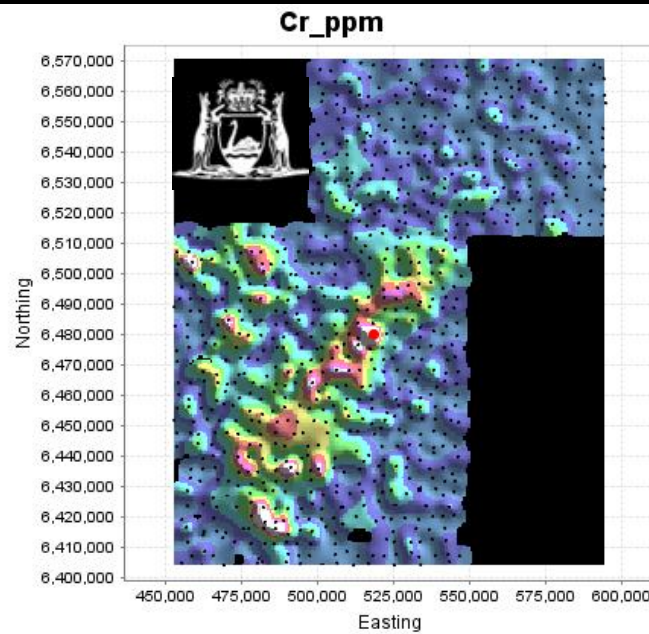
	Cu_ppm	Cu_B_ppm	Cu_N_ppm	Cu_O_ppm
Min	3	6	0.02	0.15
Max	90	82	84.5	74
Mean	21.37	21.43	20.49	18.73
Sdev	10.14	8.63	13.44	9.71
RSD	47.44	40.28	65.59	51.85



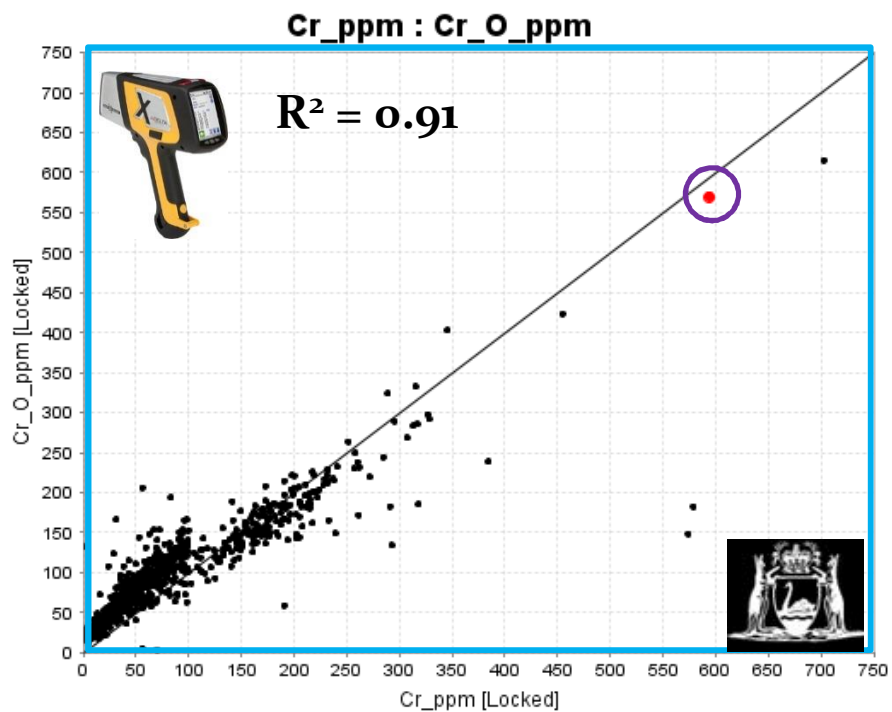
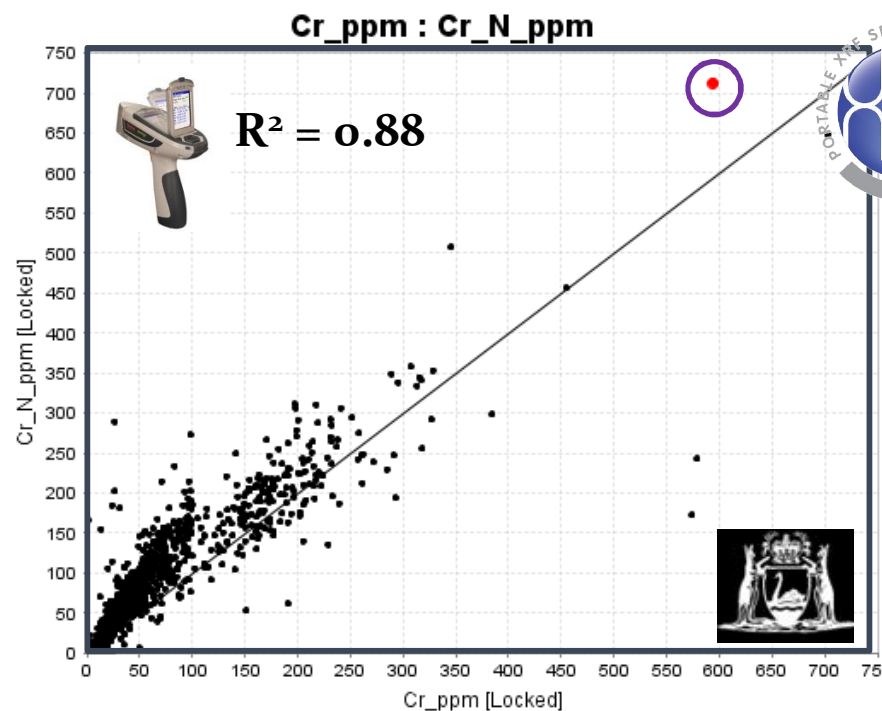
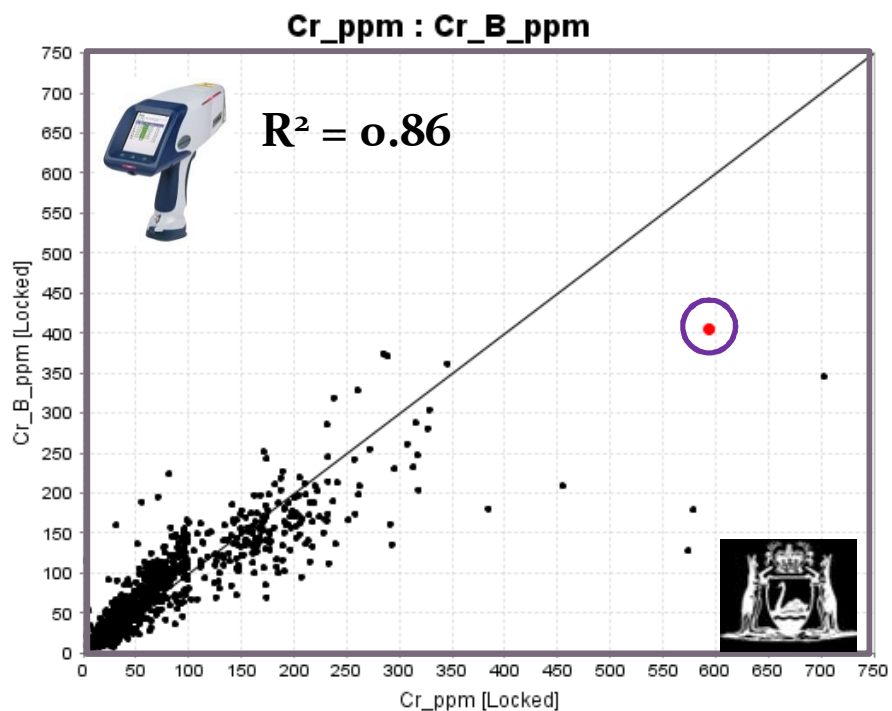
# Chrome Response



# Chrome Response (Needle)



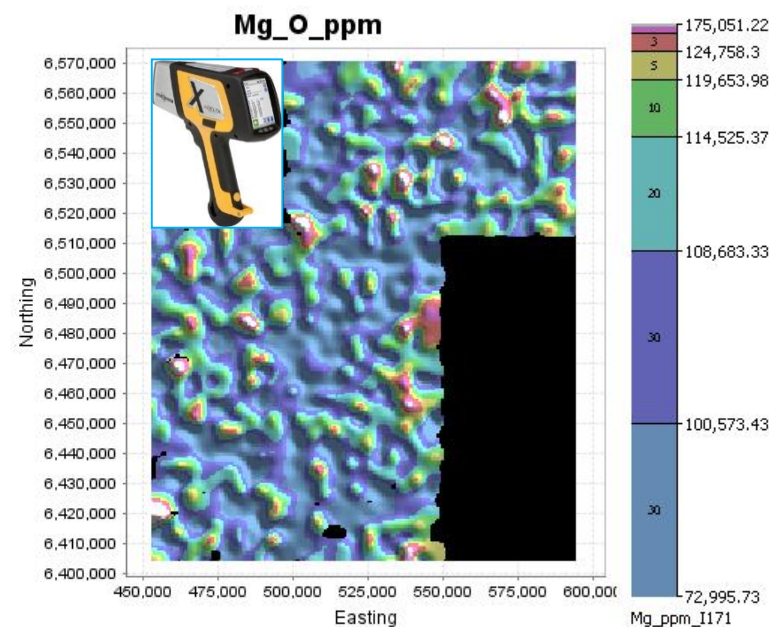
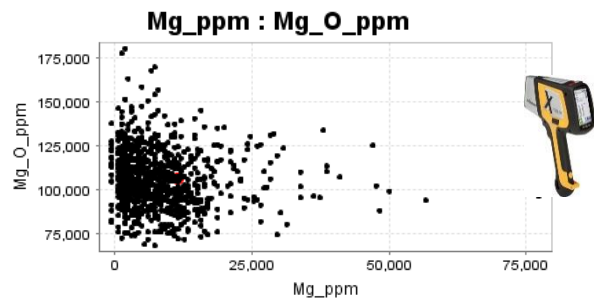
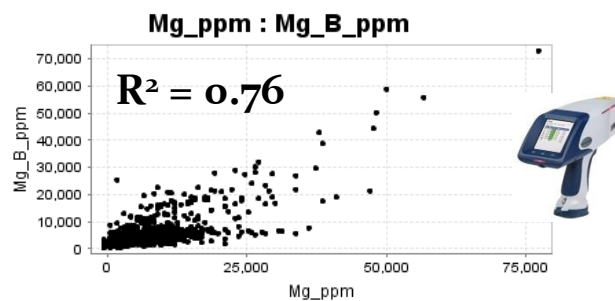
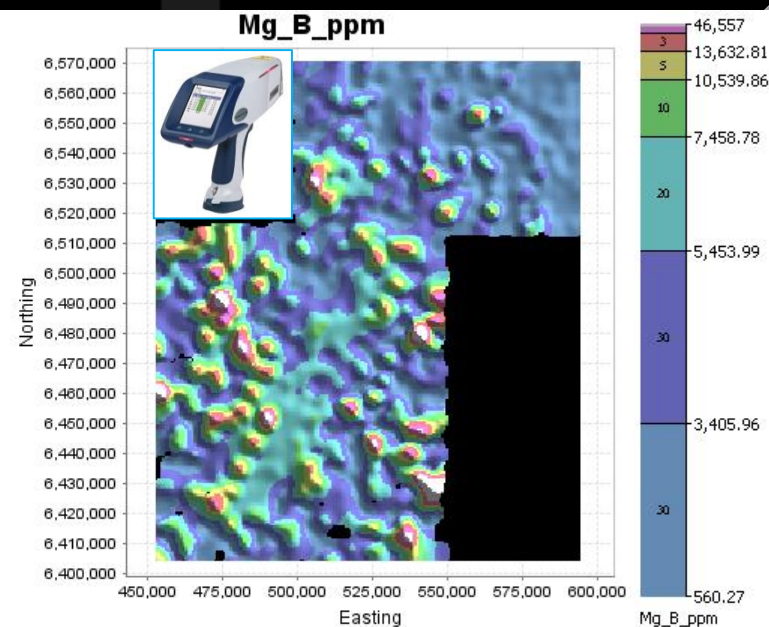
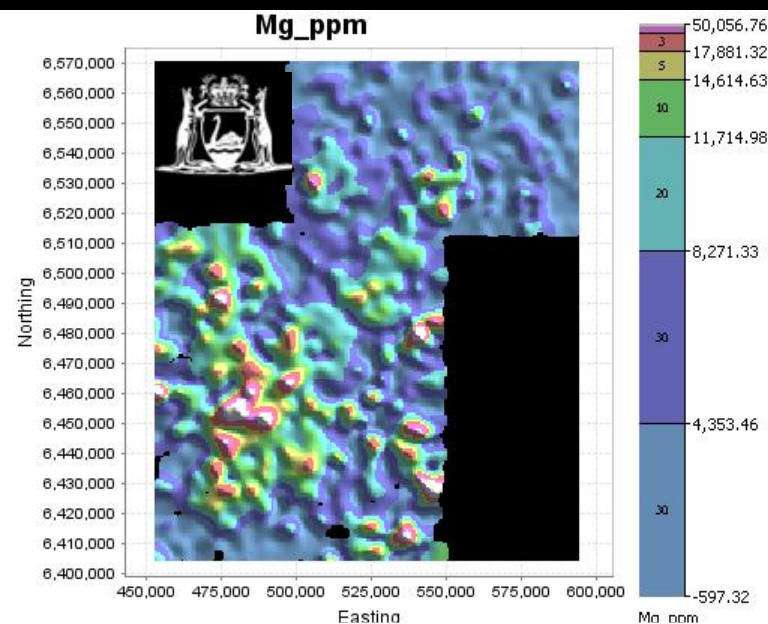




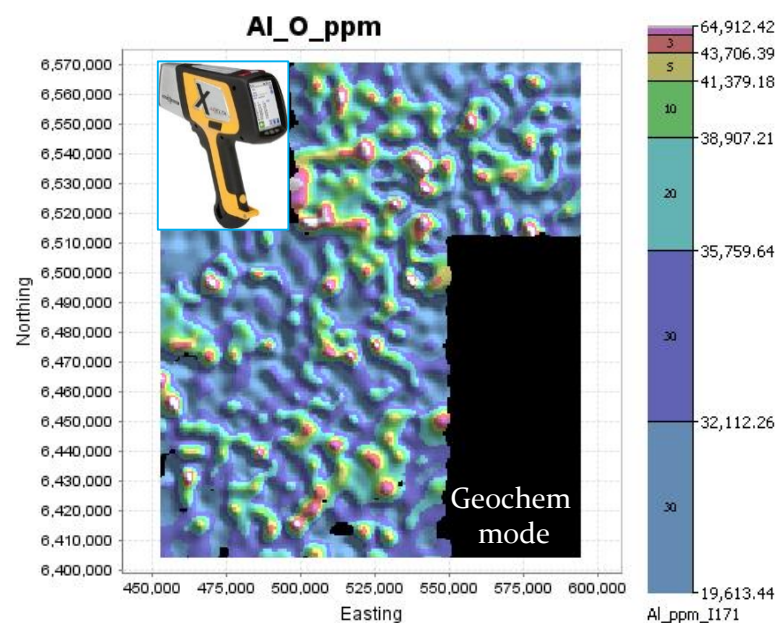
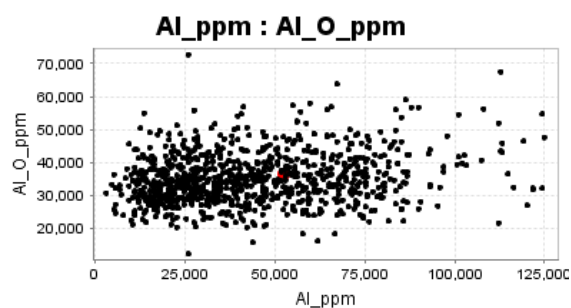
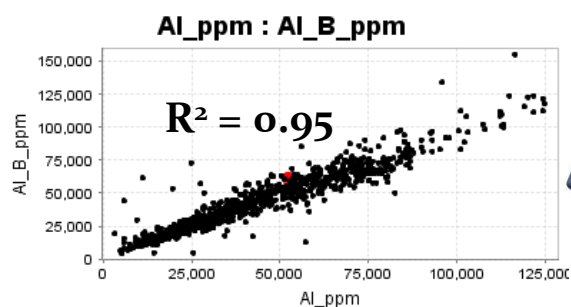
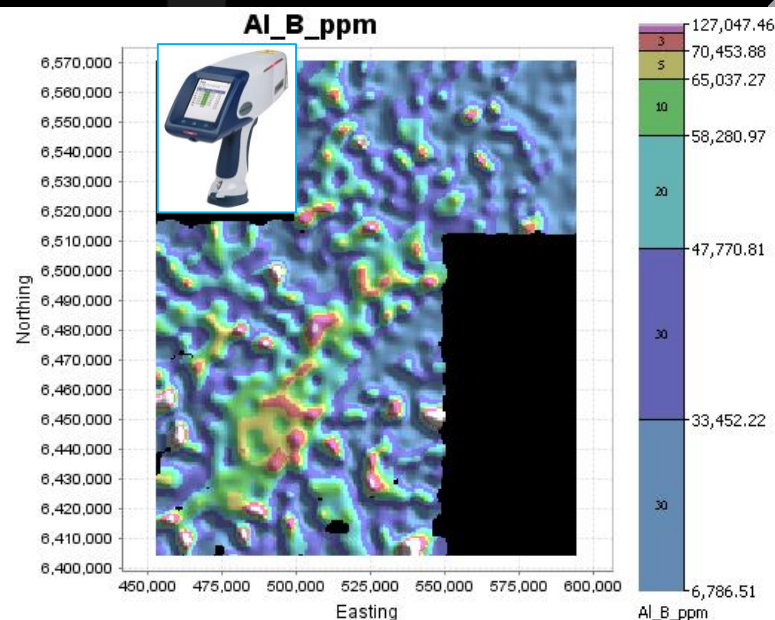
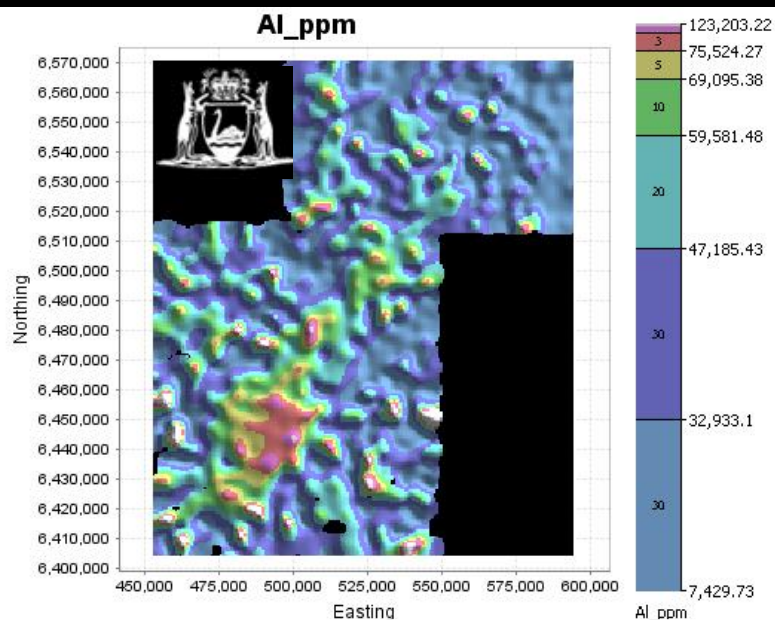
	Cr_ppm	Cr_B_ppm	Cr_N_ppm	Cr_O_ppm
Min	1	5	0.09	3
Max	703	405	712.68	615
Mean	77.19	79.19	103.62	92.73
Sdev	75.94	60.91	78.60	61.02
RSD	98.38	76.92	75.85	65.81



# Magnesium Response

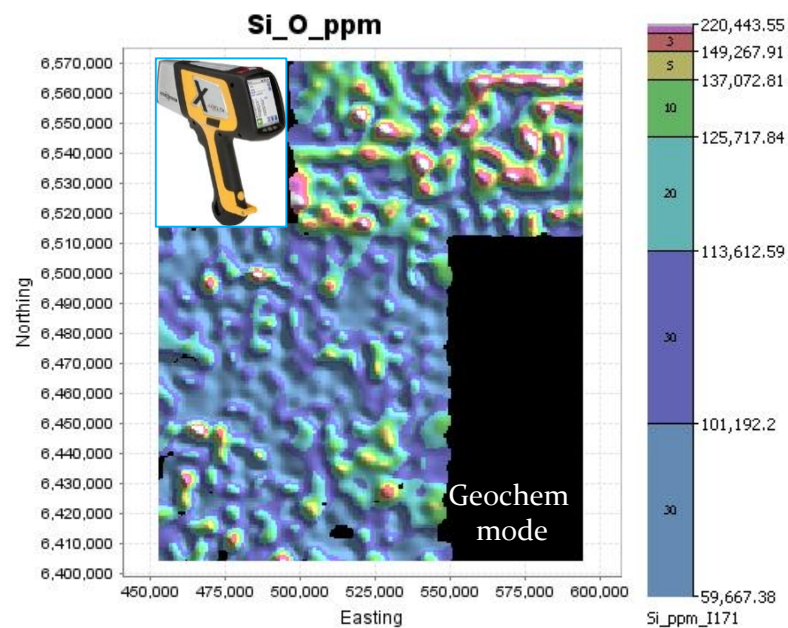
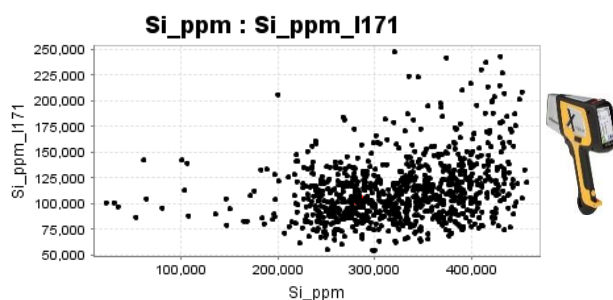
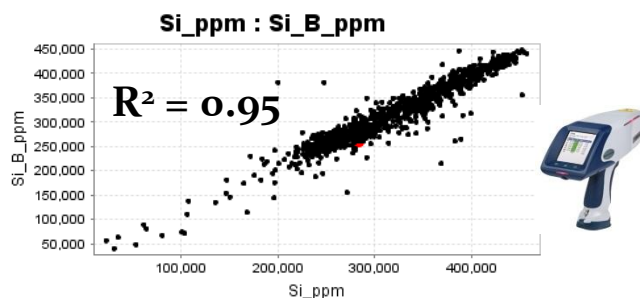
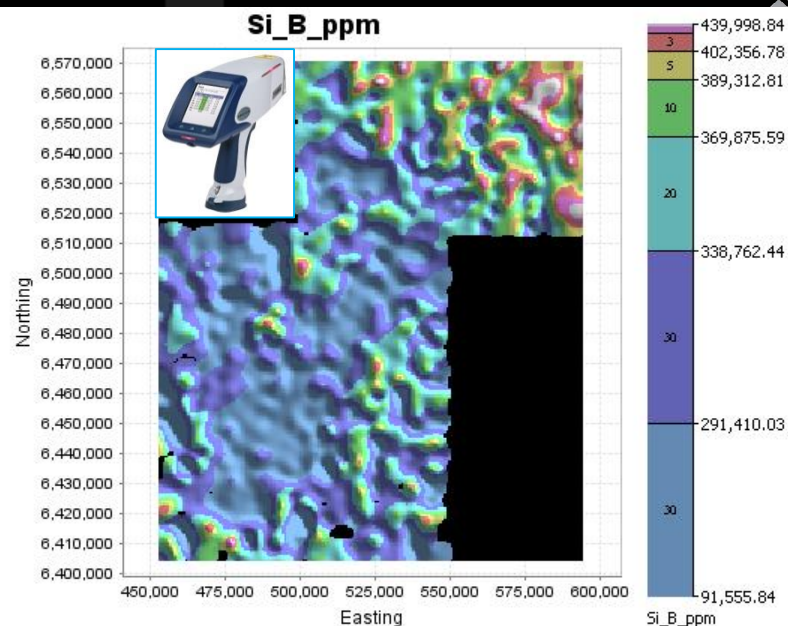
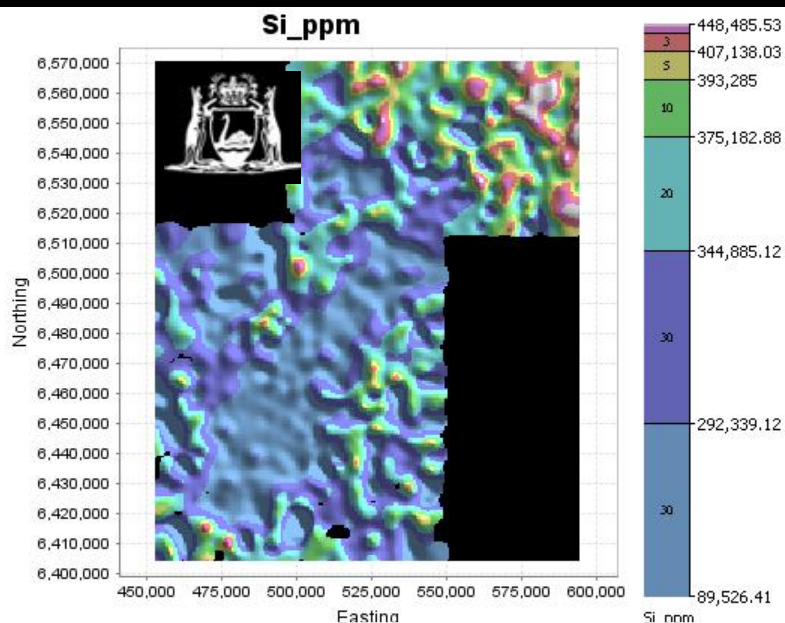


# Aluminium Response





# Silicon Response

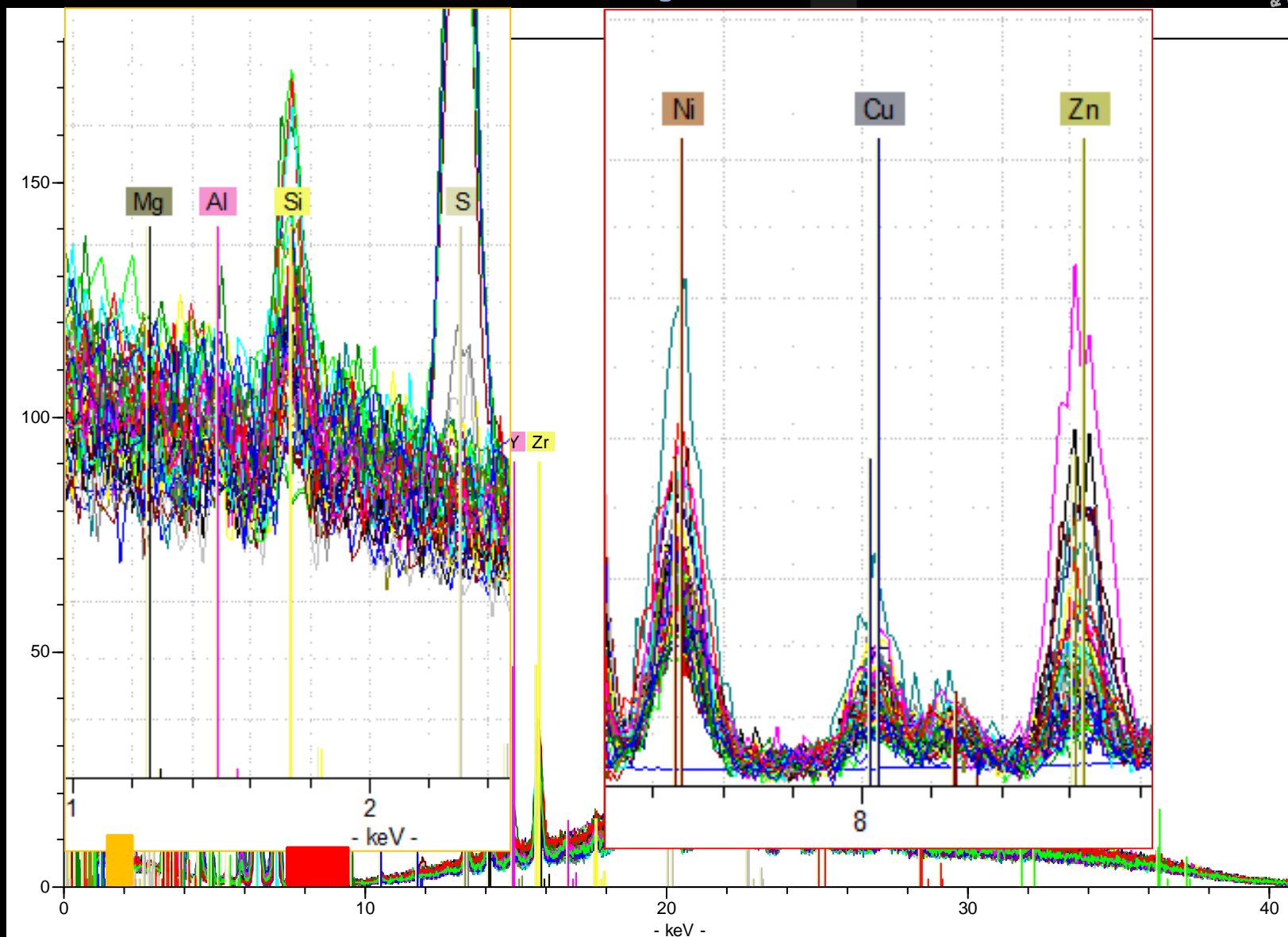




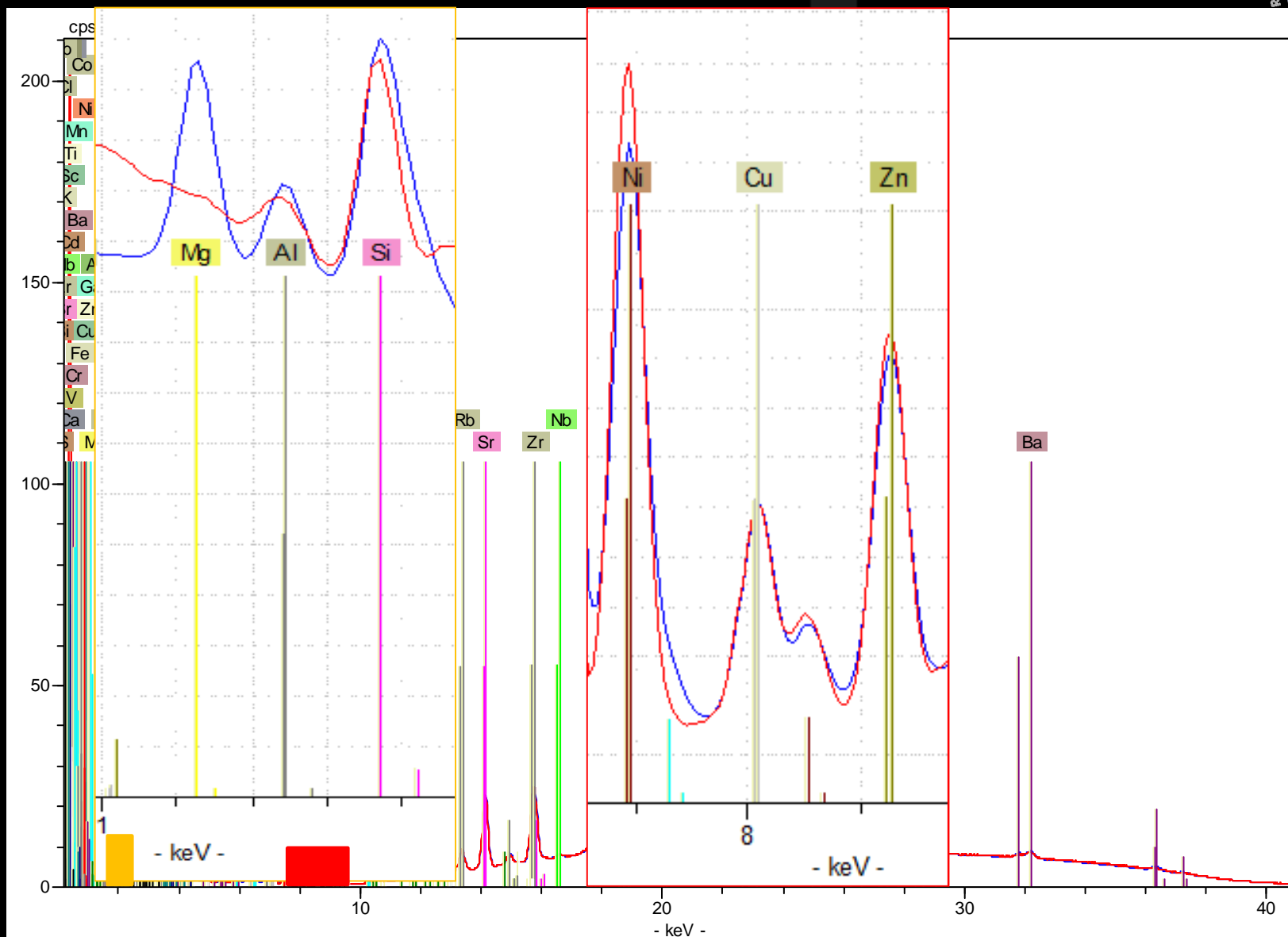


**How real are these light  
element trends and  
Concentrations?**

# Spectra for soil samples



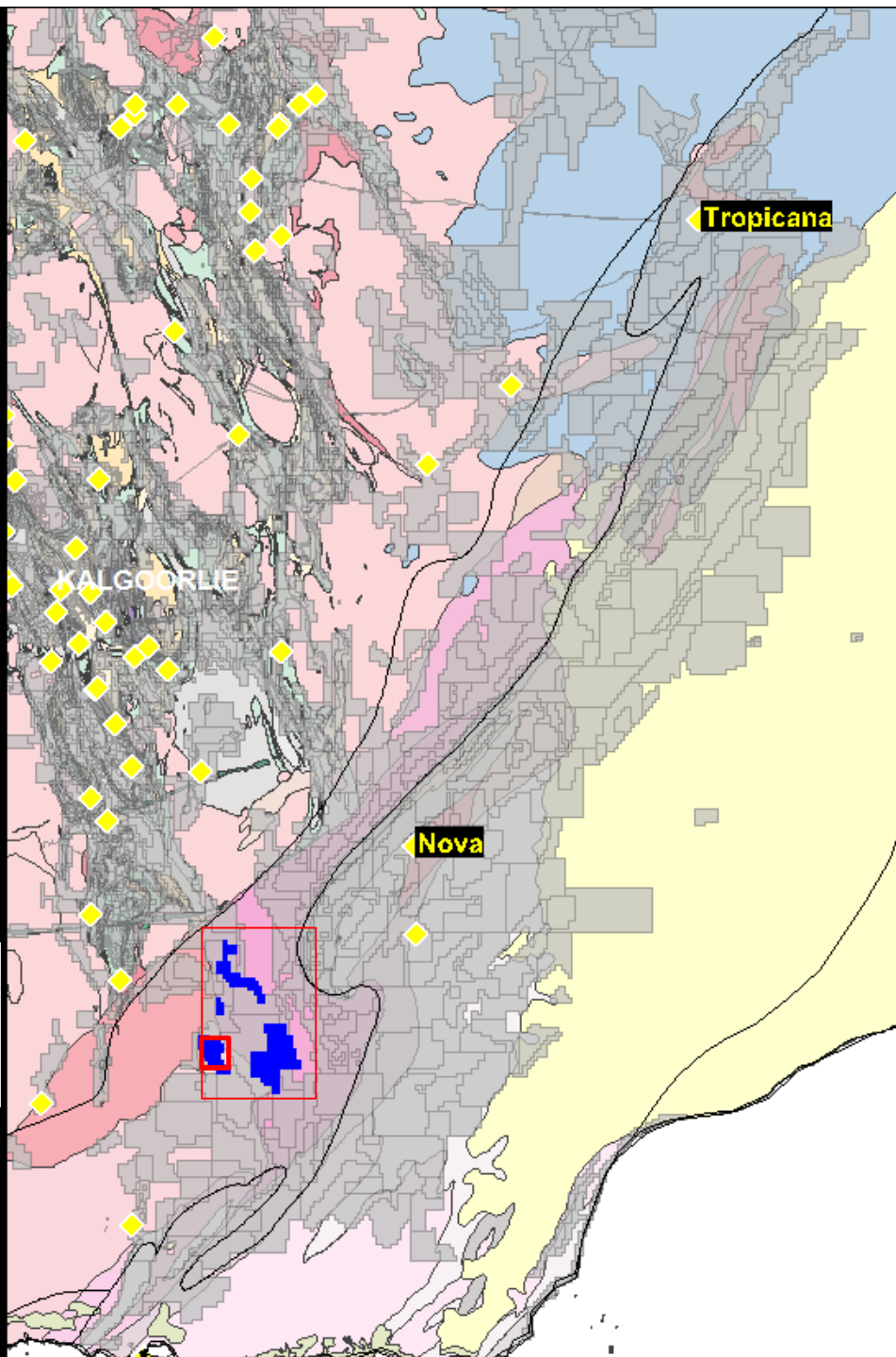
# Accumulated and deconvoluted







# Application by Explorer



**Pioneer**  
RESOURCES LIMITED

FWNi003

GSWA data



# FWNi003

Proterozoic-aged oval  
geological structure

8 kilometres in length

Tramline stratigraphy  
disrupted

Multiple internal  
magnetic bodies

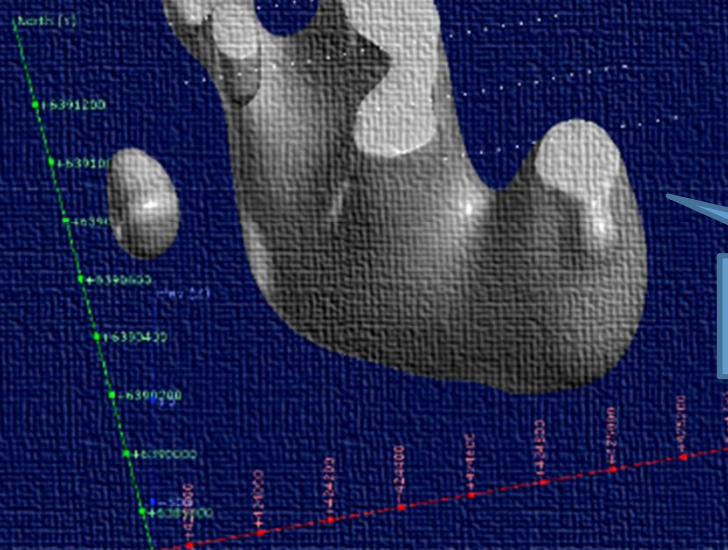
within 4 km of a major  
thrust fault



# Magnetic Inversion Model of FWNi003



leapfrog®



Magnetic Inversion  
Model

**Pioneer**  
RESOURCES LIMITED

Plunge: +56  
Azimuth: 052



0 250 500 750 1000

PIO data





## Soil Sample grid FWNi003

1706 -200  $\mu\text{m}$  soil  
samples on a 200 x  
50m grid to cover  
target area.



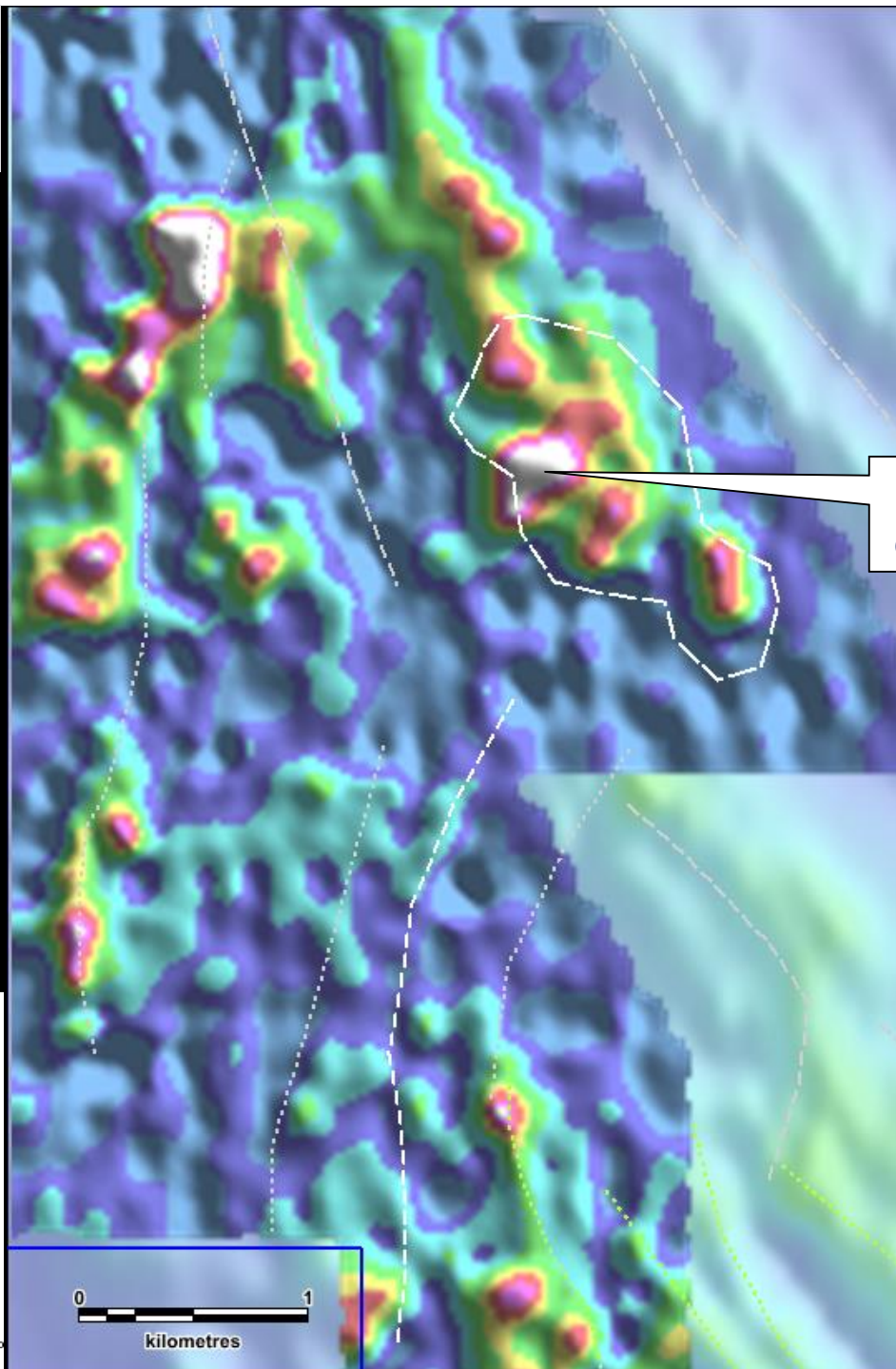
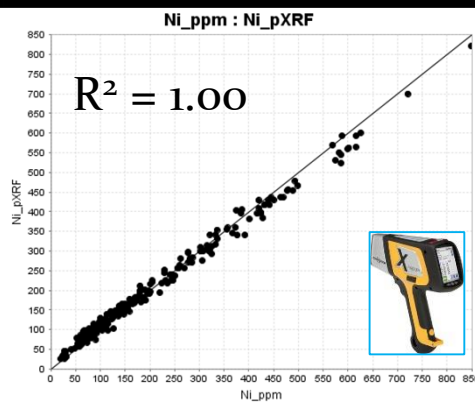
# Field Sampling in the Fraser Range



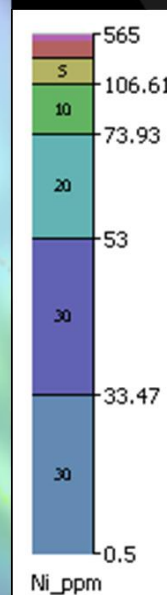


# Ni pXRF

AR vs pXRF: Check  
assay



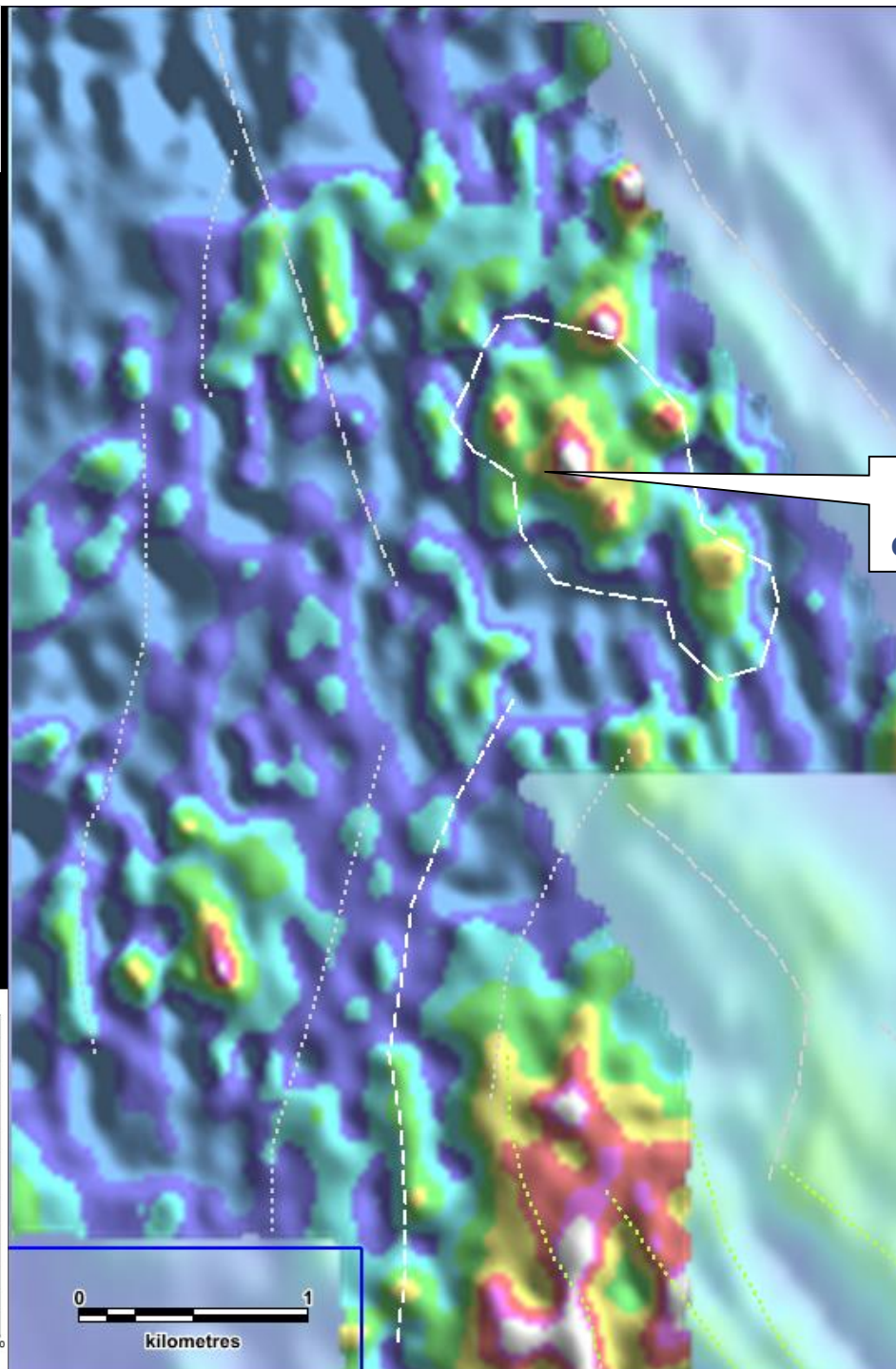
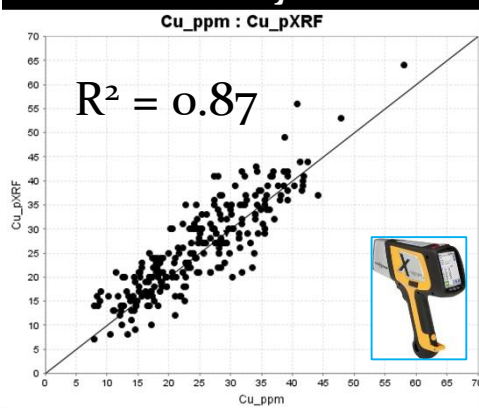
Key target area  
elevated in pXRF Ni



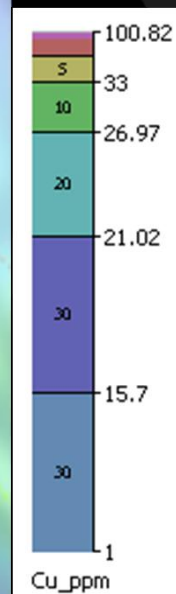
PIO data

# Cu pXRF

AR vs pXRF: Check  
assay



Key target area  
elevated in pXRF Cu

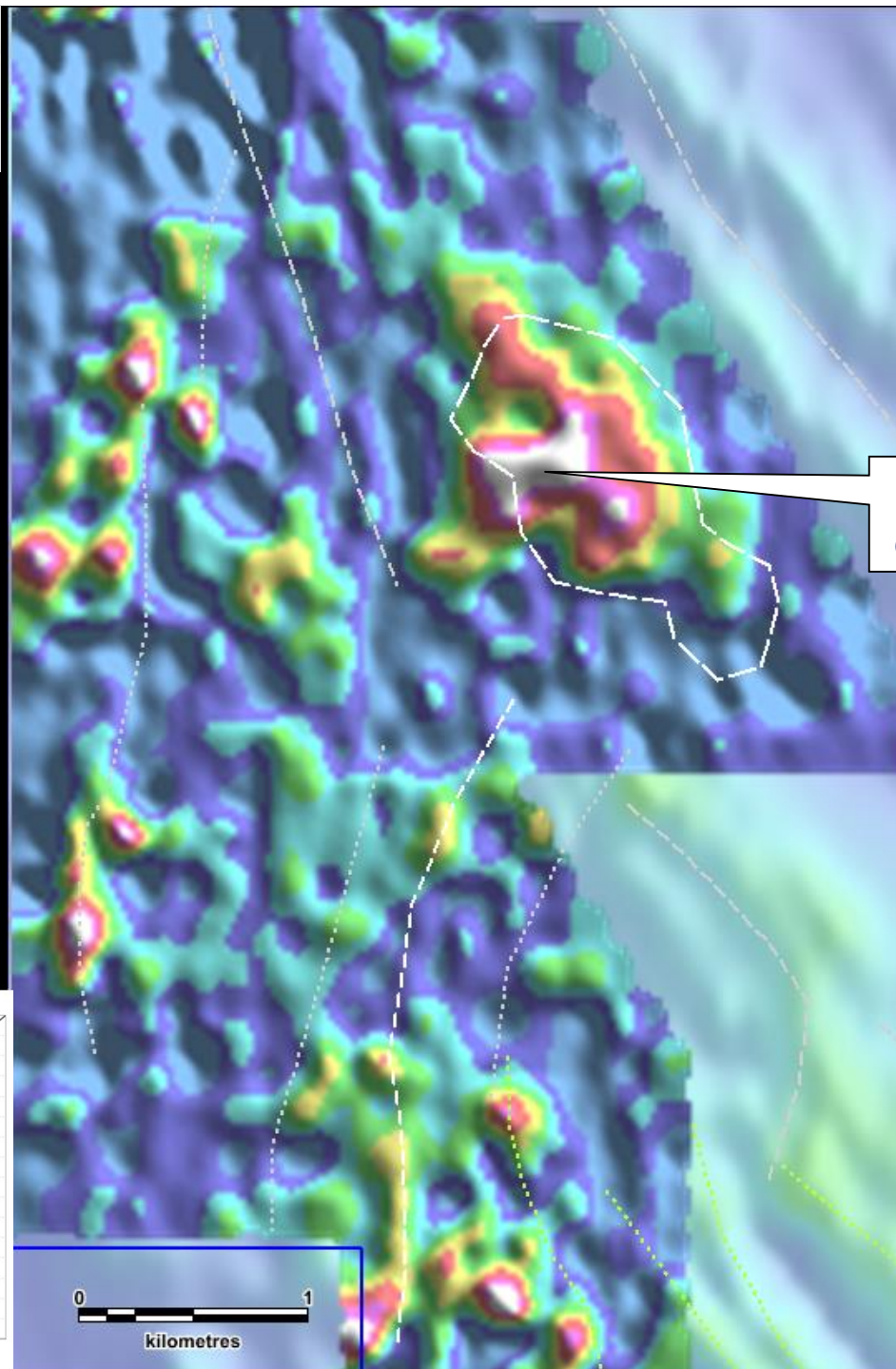
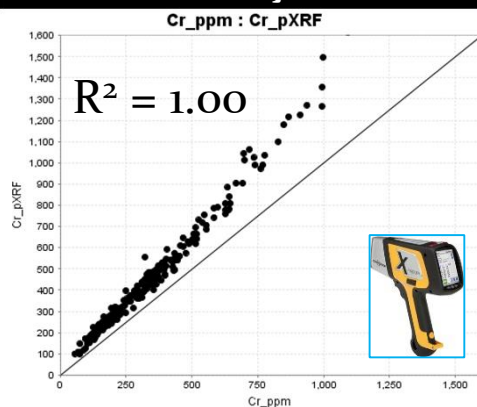


PIO data

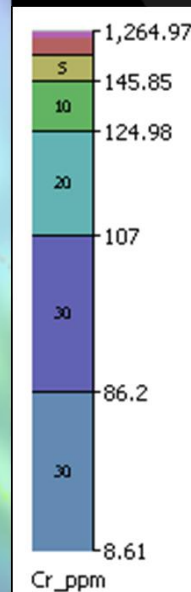


# Cr pXRF

AR vs pXRF: Check  
assay



Key target area  
elevated in pXRF Cr



PIO data



# FWNi003: pXRF Soil Geochemistry overlaying aeromagnetic data model



Lithological Indicators: Mafic or Ultramafic Rocks

Chrome outline

Nickel outline

Magnetic Inversion  
Model

Soil Geochemistry overlaying  
aeromagnetic data model



PIO data



## ASX: 13/04/2015 ASX announcement



13 April 2015

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### Exploration Update:

#### Aircore Drilling at the Fairwater Nickel Project 50% completed

- Ultramafic complex identified
- Nickel values up to 0.46% Ni, with elevated Cu, Co and PGM, returned from weathered rock in FWAC004 provides encouragement.

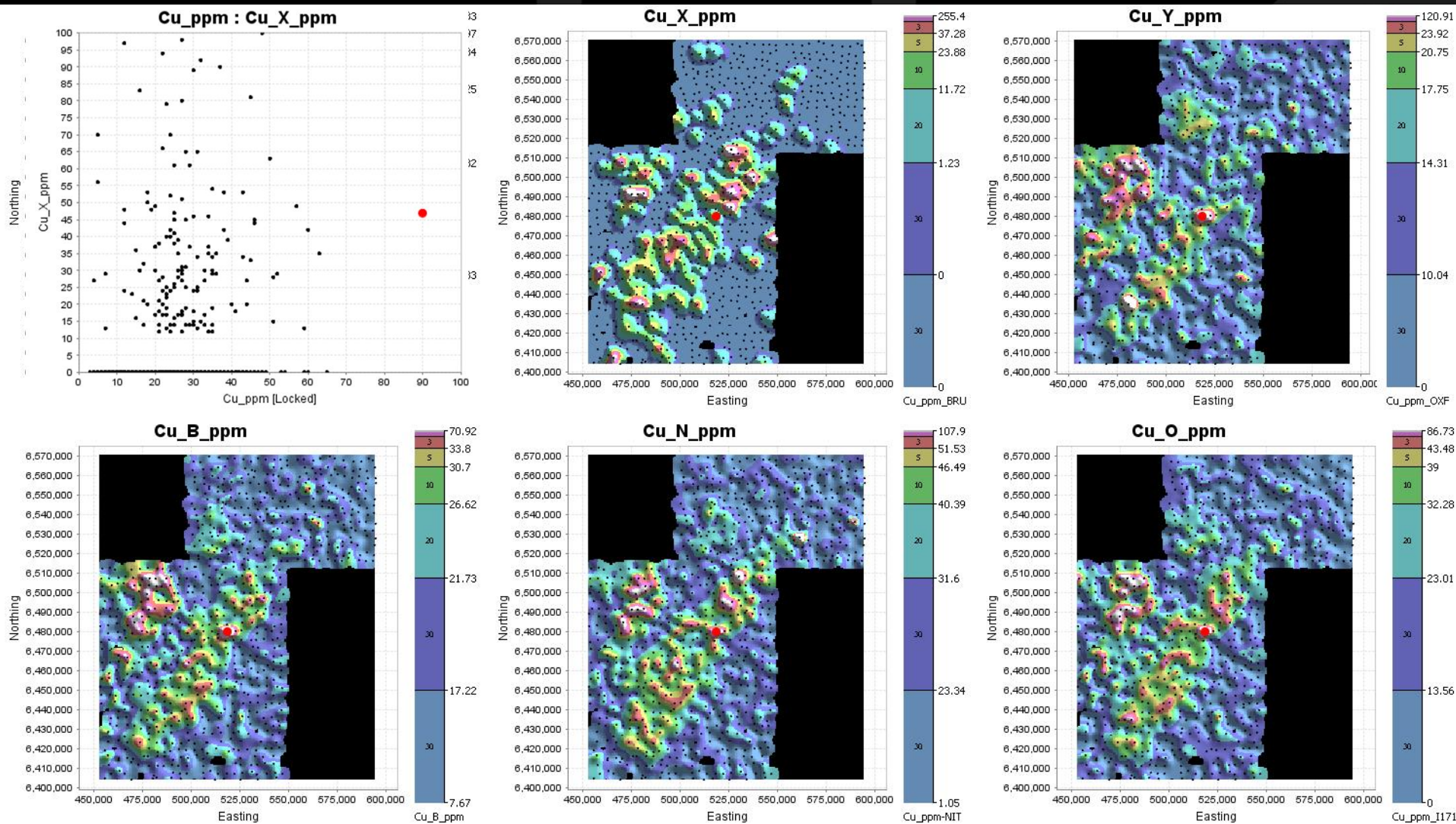


# A word of caution



# Copper Response

There are both pXRF instruments and instrument calibrations on the market that can find the haystack but not the needle!



# Conclusions



- All three manufacturers instruments (Bruker Titan 800, Thermo-Niton XL3t and Olympus Delta Premium 6000) correctly identified the the Needle-in-the-Haystack sample and generated “fit for purpose” data that replicated known geological trends.
- Bruker’s Titan 800 instrument obtained light element results for Al and Si with excellent correlation with the GSWA data.
- Through the appropriate operating and QC procedures, pXRF can play a critical role in identifying the potential next needle in the Haystack in the Fraser Range Province, WA (eg PIO).
- There are pXRF instruments and calibrations on the market that cannot find the needle in the haystack
- Acknowledgments
  - GSWA for access to Fraser Range Regolith Samples Set
  - Pioneer Resources for permission to use pXRF data