



TECH TALK SERIES

# Indicator Minerals for Nickel Exploration

with Dr Louise Schoneveld &  
Dr Margaux Le Vaillant



Thursday 5 June 2025

5:00pm - 6:00pm

Long Neck Brewery Function Space



TECH TALK SERIES

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**Dr Louise Schoneveld**  
Senior Research Scientist  
CSIRO



**Dr Margaux Le Vaillant**  
Senior Research Scientist  
CSIRO



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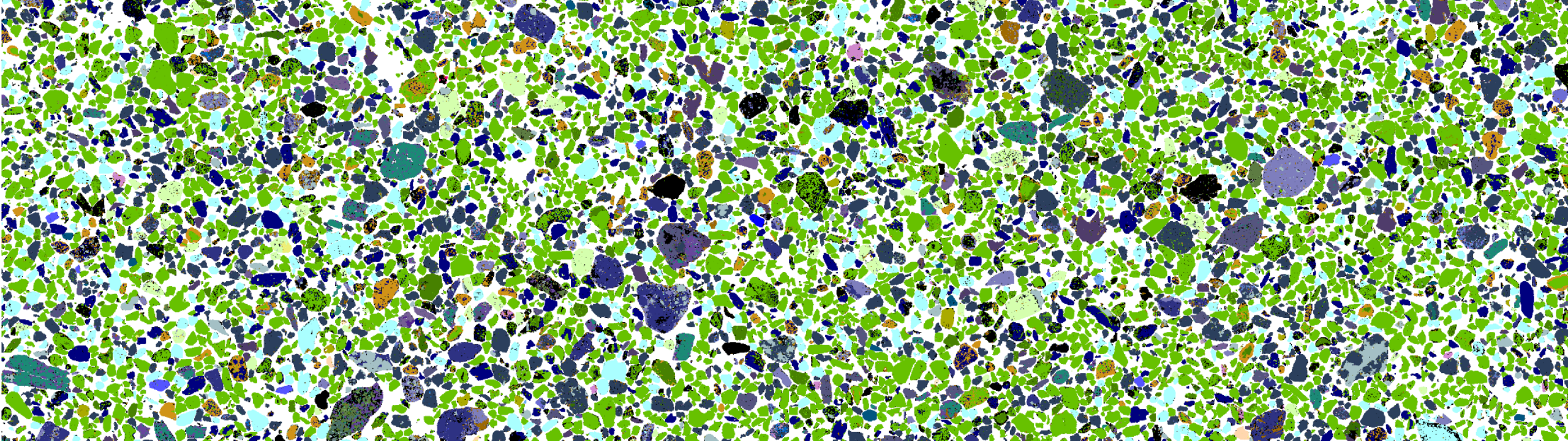


I would like to begin by acknowledging the Whadjuk people of the Noongar nation as the Traditional Owners of the land/s that we're meeting on today and pay my respect to their Elders past and present.

'Eternal Wisdom, Infinite Innovation'  
artwork by Rachael Sarra, working with Gilimbaa.

Australia's National Science Agency



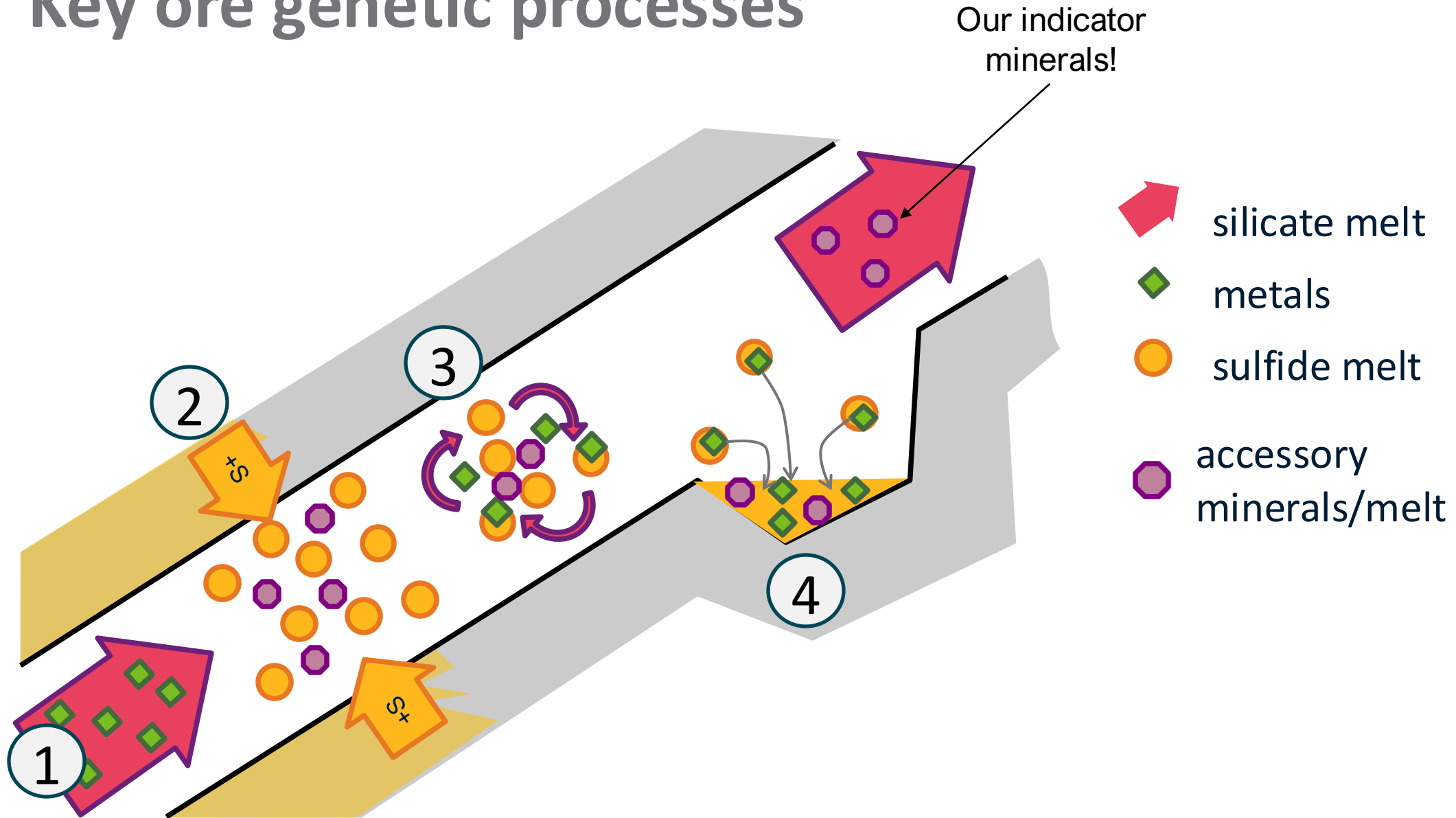


# Indicator Minerals for Nickel Sulfide Exploration – M10426

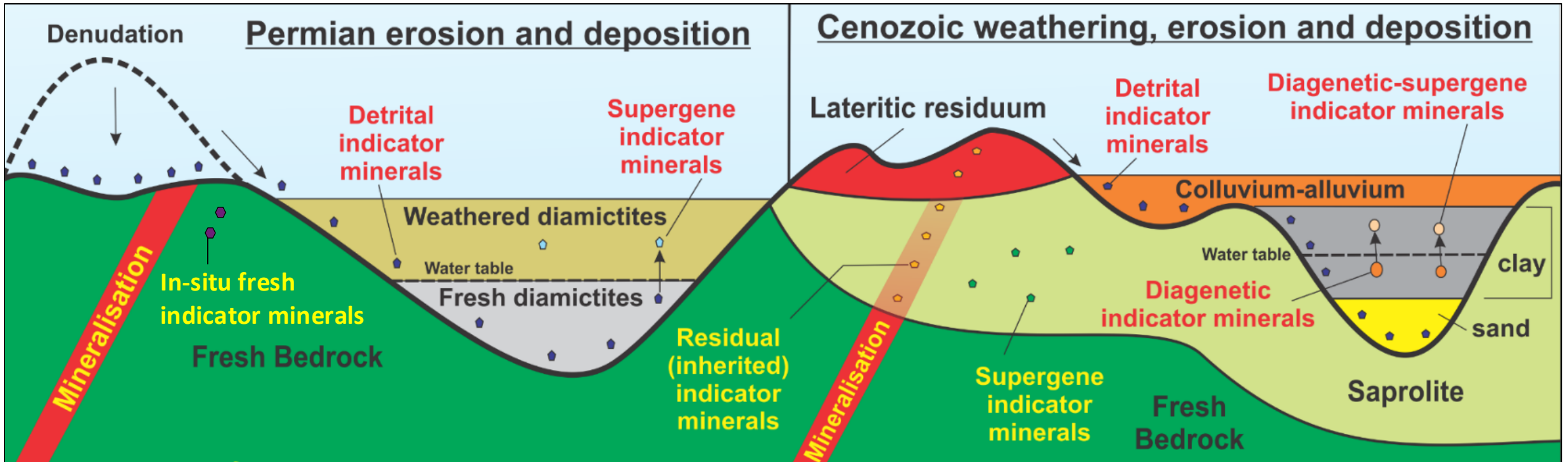
**Louise Schoneveld & Margaux Le Vaillant**

& Morgan Williams, Walid Salama, Catherine Spaggiari, Steve Barnes, Coralie Siegel, Siyu Hu, Renee Birchall, Raphael Baumgartner, Tina Shelton, Michael Verrall, and Jacob Walmsley.

# Key ore genetic processes



# Indicator minerals sampling for exploration



Modified from Walid Salama

## Types of indicator minerals in the Australian landscape used in this study

1. **In situ:** Fresh or partially altered minerals present within the host intrusion
2. **Detrital:** Physical weathering of the host intrusion and potential transport of the minerals. Minerals are found ex-situ
3. **Residual:** Stable minerals inherited from the primary mineralisation (such as sulfides), found in-situ in the weathering profile.

# Indicator Minerals for Nickel Exploration

## Project Overview

### Project Number

M10426

### Program Area

[Find more viable resources](#)

### Project Theme

Mineral Systems

### Total Grant Value

\$\$1,469,677

### MRIWA Contribution

\$\$354,914

### Project Period

2022 - 2024

## The Challenge

Western Australia is highly prospective for valuable Nickel resources, but most undiscovered ore lies deep below the surface, hidden from detection. High-grade nickel bodies represent only small targets within potentially mineralised regions, and traditional technology used in exploring for them is both expensive and may miss important clues to mineralisation.

## Research Contact

Louise Schoneveld –

[louise.schoneveld@csiro.au](mailto:louise.schoneveld@csiro.au)

Margaux Le Vaillant –

[Margaux.LeVaillant@csiro.au](mailto:Margaux.LeVaillant@csiro.au)

# The Research Team

 10 Research scientists with a wide range of expertise

**Project Lead**



**Louise Schoneveld**

Case Studies – Emu Lake and Highway

**Project Lead**



**Margaux Le Vaillant**

Case Studies – Carr Boyd and Widgiemooltha Dome



**Walid Salama**

Regolith Expertise  
Case Study – Seahorse



**Coralie Siegel**

Case Studies –  
Cathedrals belt and Coates



**Morgan Williams**

Machine Learning Expertise



**Siyu (Shirley) Hu**

Case Study – Gabanintha



**Renee Birchall**

Case Study – Western Gawler



**Raphael Baumgartner**

Case Study – Carlingup Range



**Catherine Spaggiari**

Geological Background Expertise



**Steve Barnes**

Nickel Sulfide Expertise



# The Project

 12 detailed case studies + additional CSIRO samples

## Komatiitic Ni

Emu Lake  
Carlingup Range  
Widgiemooltha  
Black Swan  
Forrestania

## Lateritic Ni

Goongarrie Region

## Layered intrusions

Coobina  
Gabanintha/Lady Alma  
Coates

## Barren

West Musgrave Province  
Plato  
Hart Dolerite

## Greenfield Exploration

Seahorse

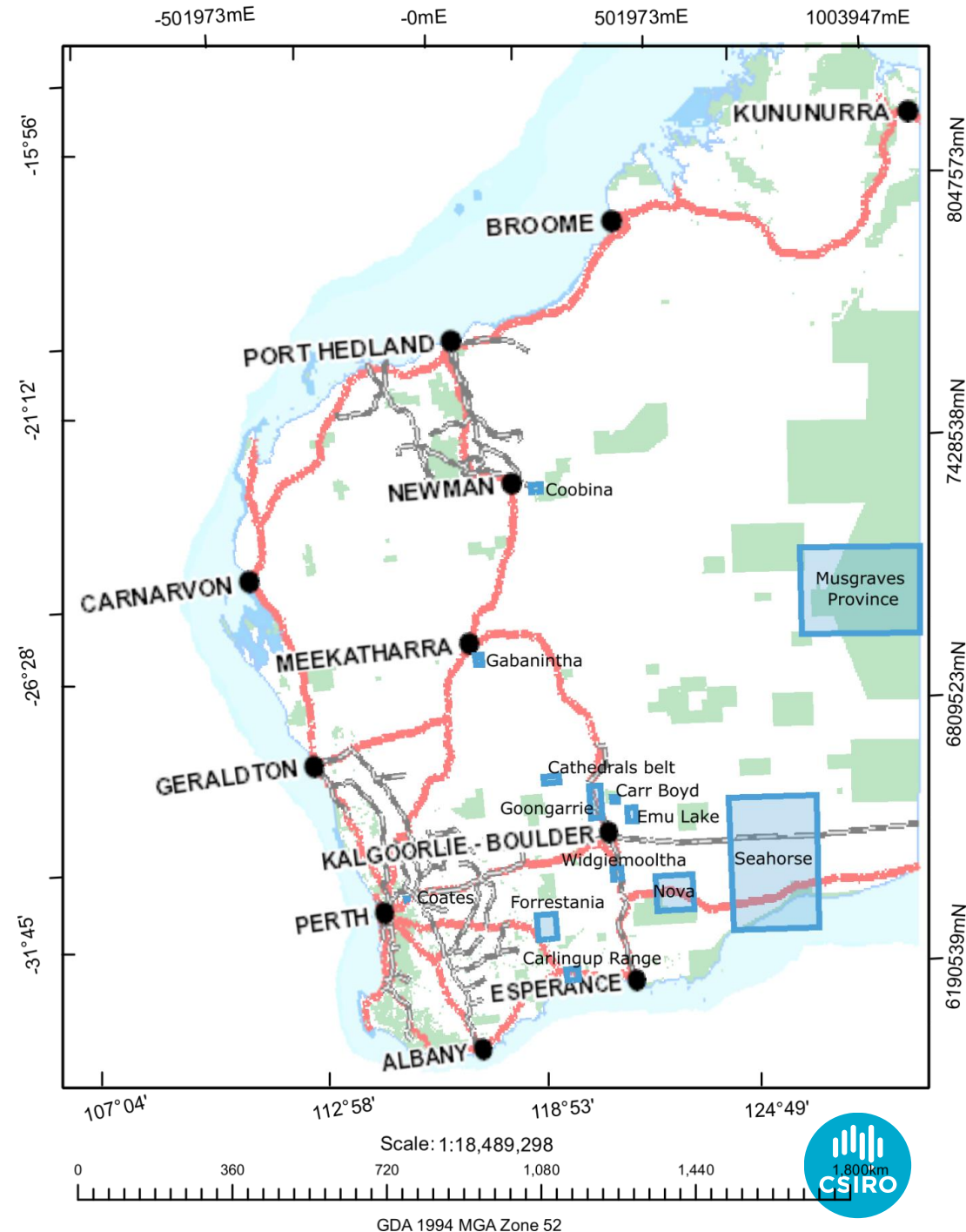
## Intrusion Hosted Ni

Carr Boyd  
Cathedrals belt  
Western Gawler

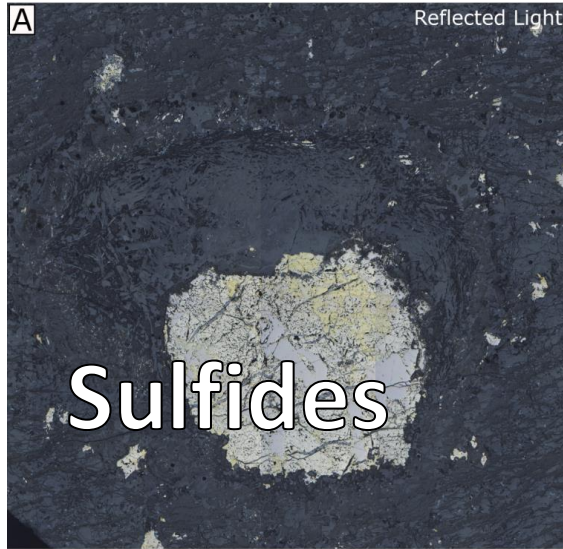
## Global Ni deposits

Nova-Bollinger  
Norilsk-Talnakh  
Frazenda Mirabella  
Kabanga  
Sakatti  
Kevitsa  
Kotalahti  
Curaçá Valley  
Savannah

**1150 samples**



# The Minerals

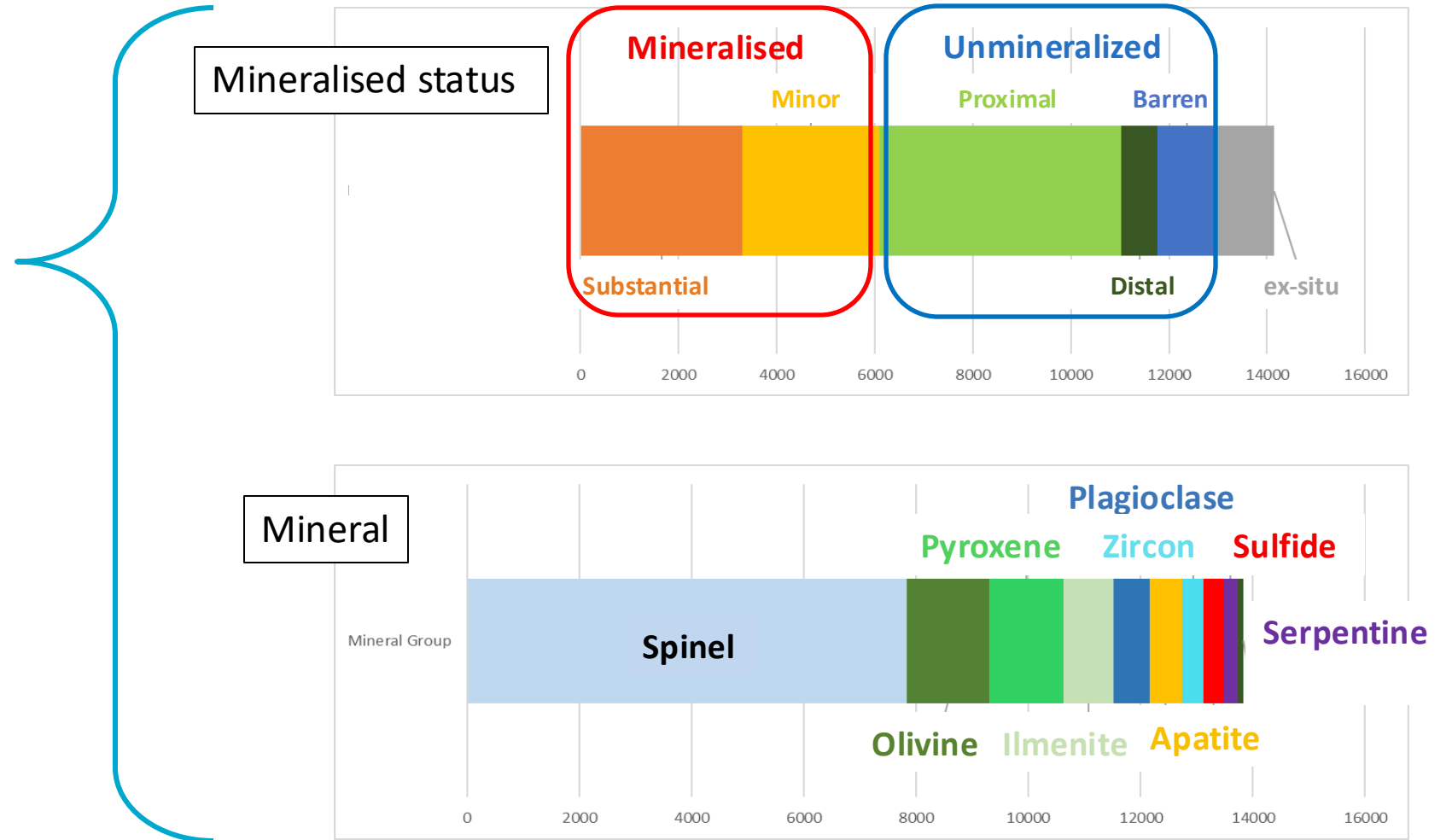


# The Database

- >100,000 TIMA grain analyses
- >18,800 LA-ICP-MS analyses

Collected from  
860+ Samples of Basement  
290+ Heavy Mineral  
Concentrates

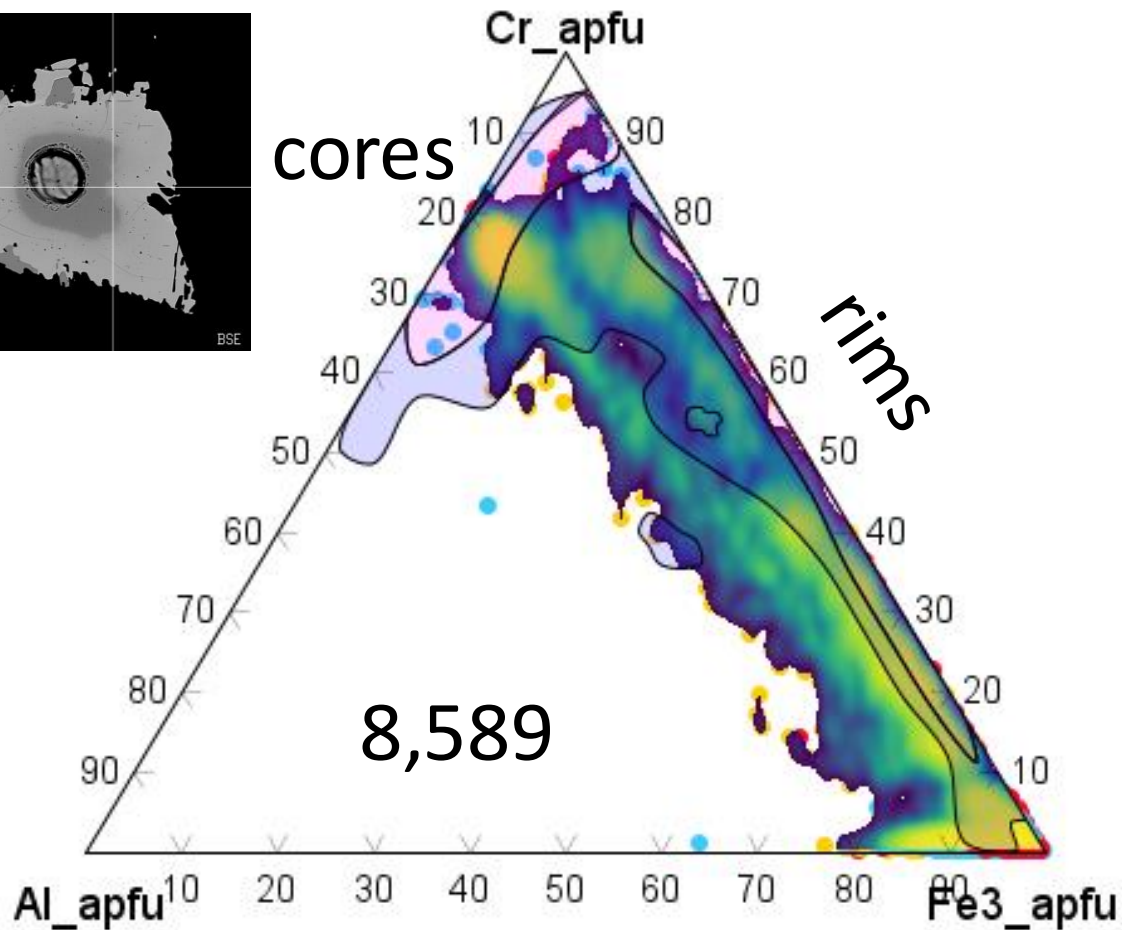
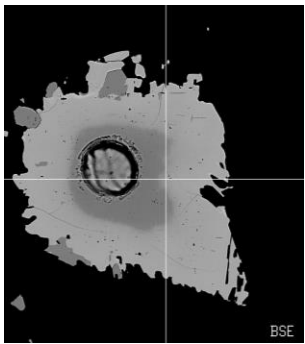
→ A large, robust and consistent database  
→ perfect for Machine Learning (ML) Models



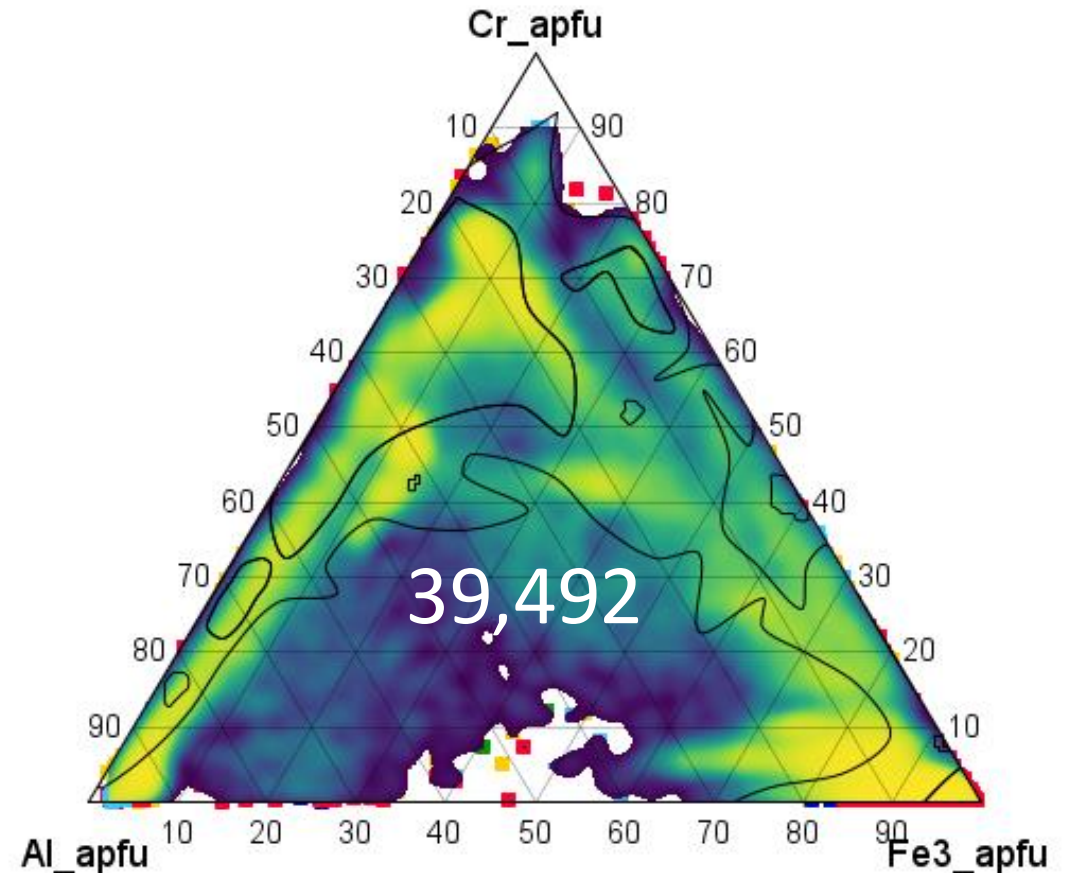
# Spinel

Major elements give a good indicator of host rock

## Barnes and Roeder - Komatiite



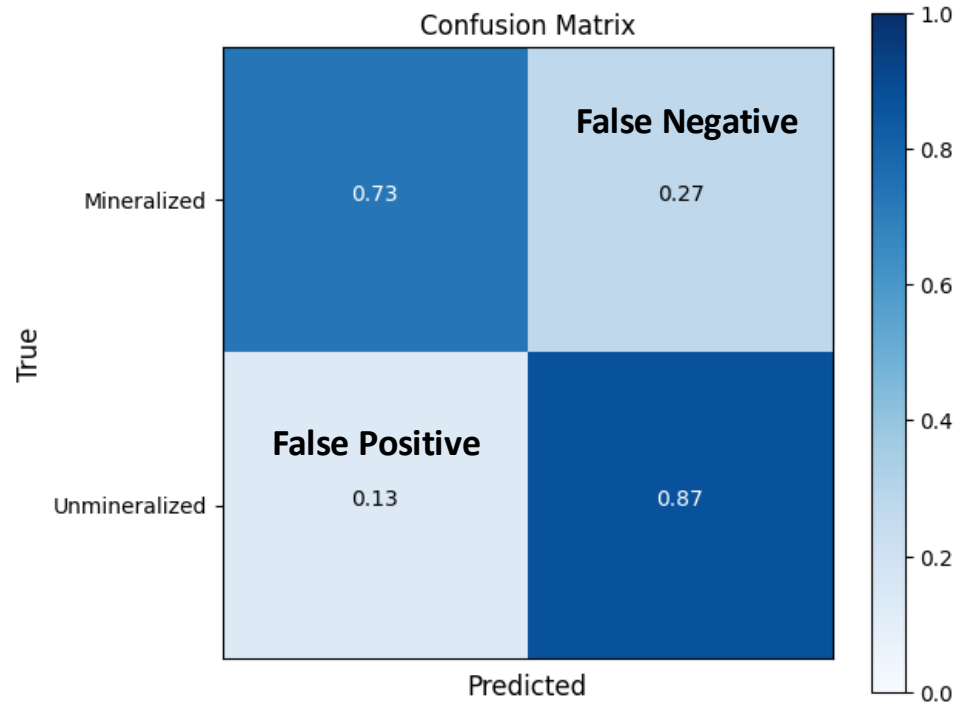
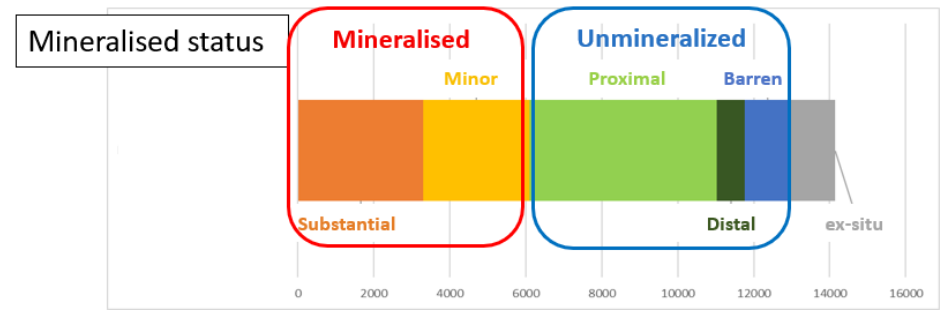
## Barnes and Roeder 2001 - Layered Intrusions



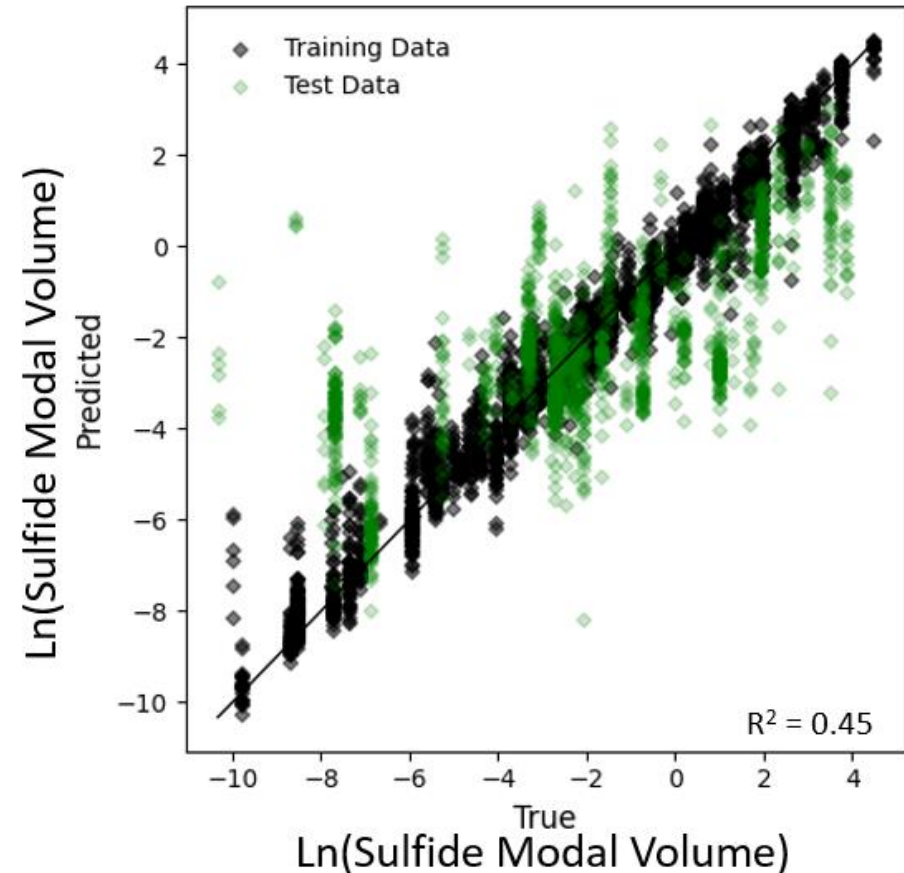
# Spinel

Trace elements (Ti, V, Ni, Co, Ga) can indicate prospectivity and even sulfide abundance

Ex-situ indicator mineral

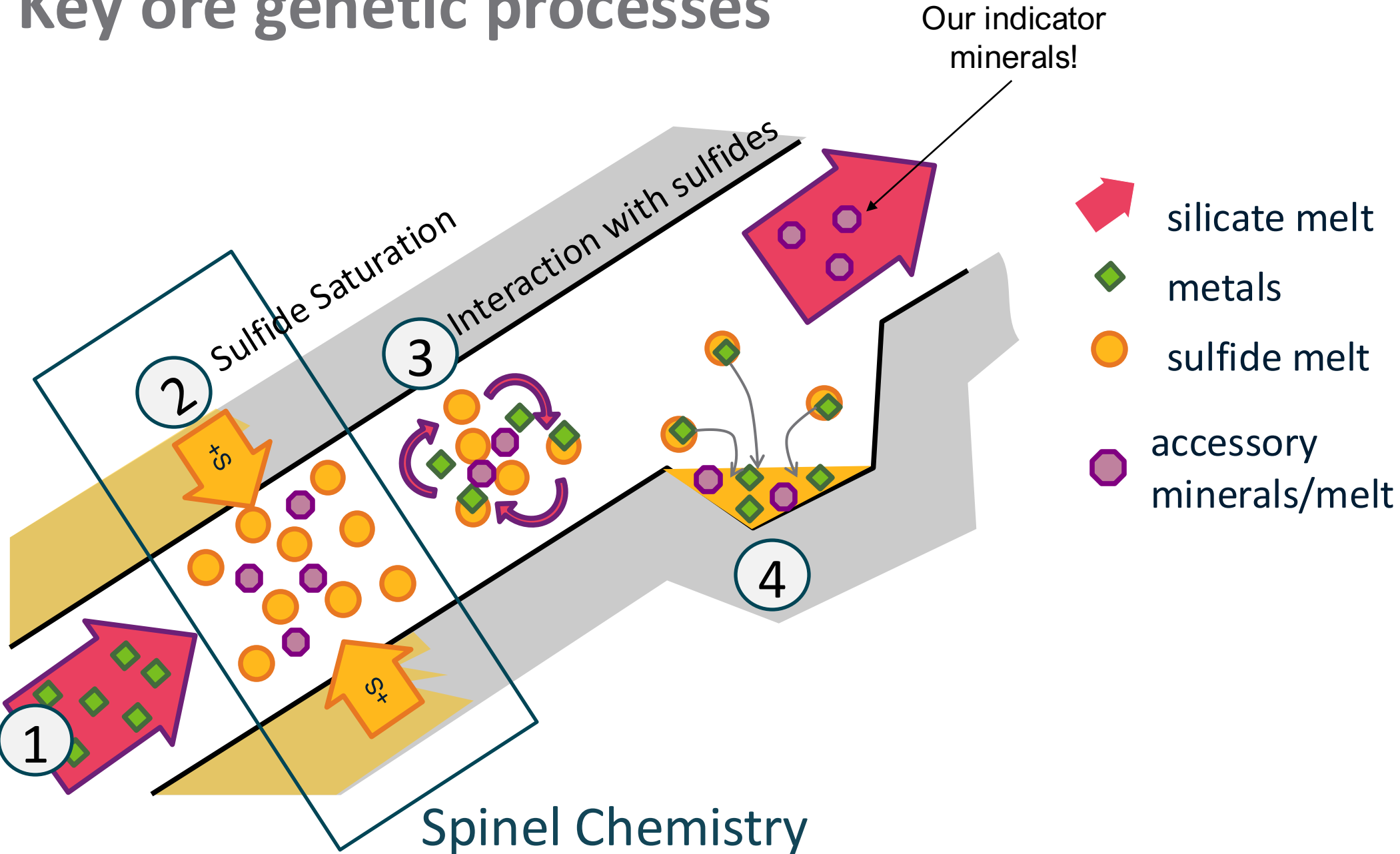


## Predicting sulfide volume

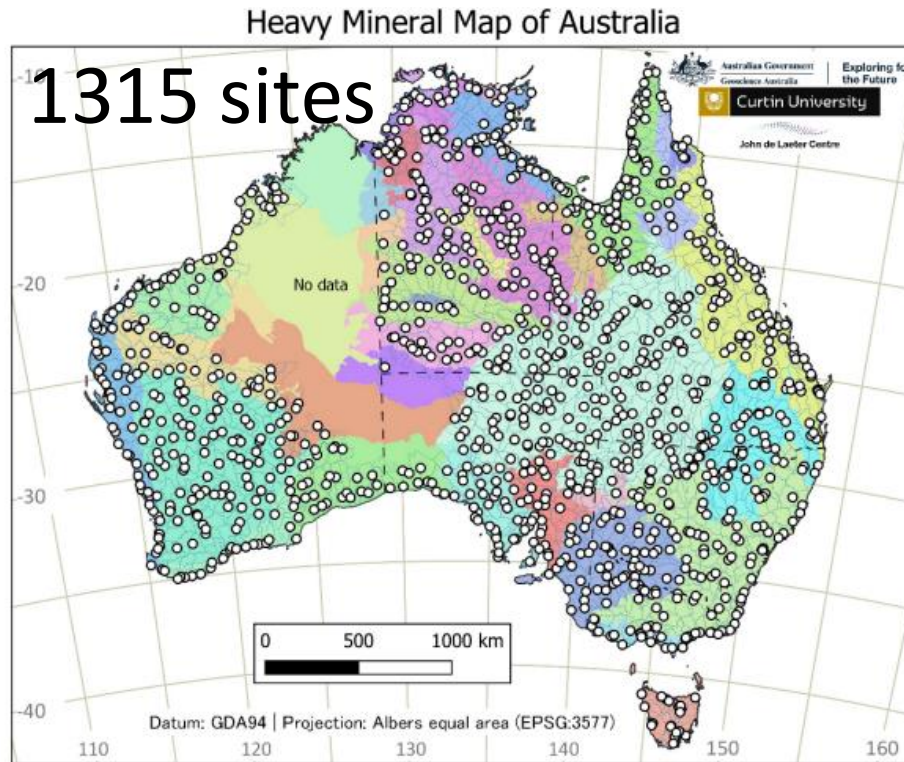


Analyses: 6621  
Samples: 246

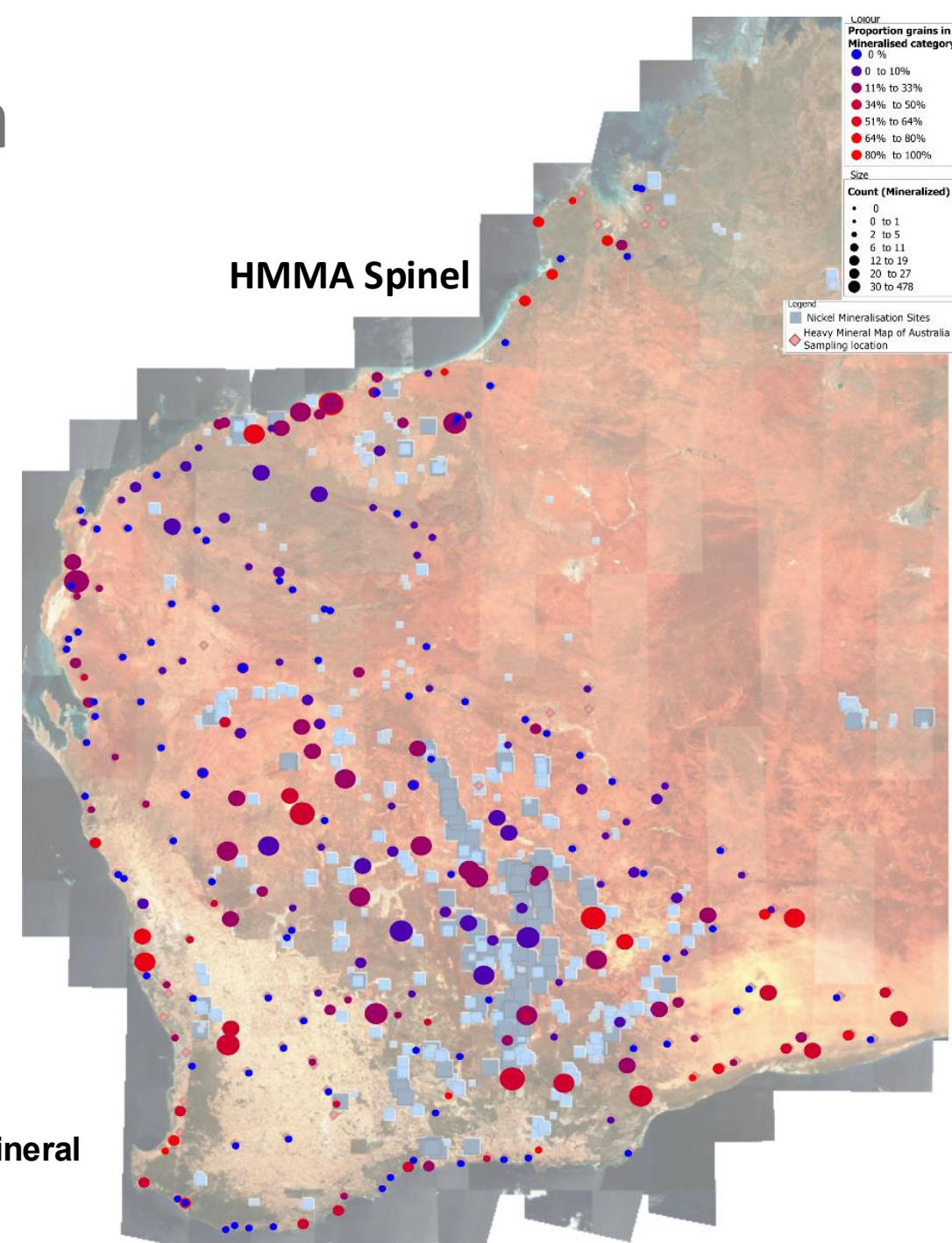
# Key ore genetic processes



# Heavy Mineral Map of Australia

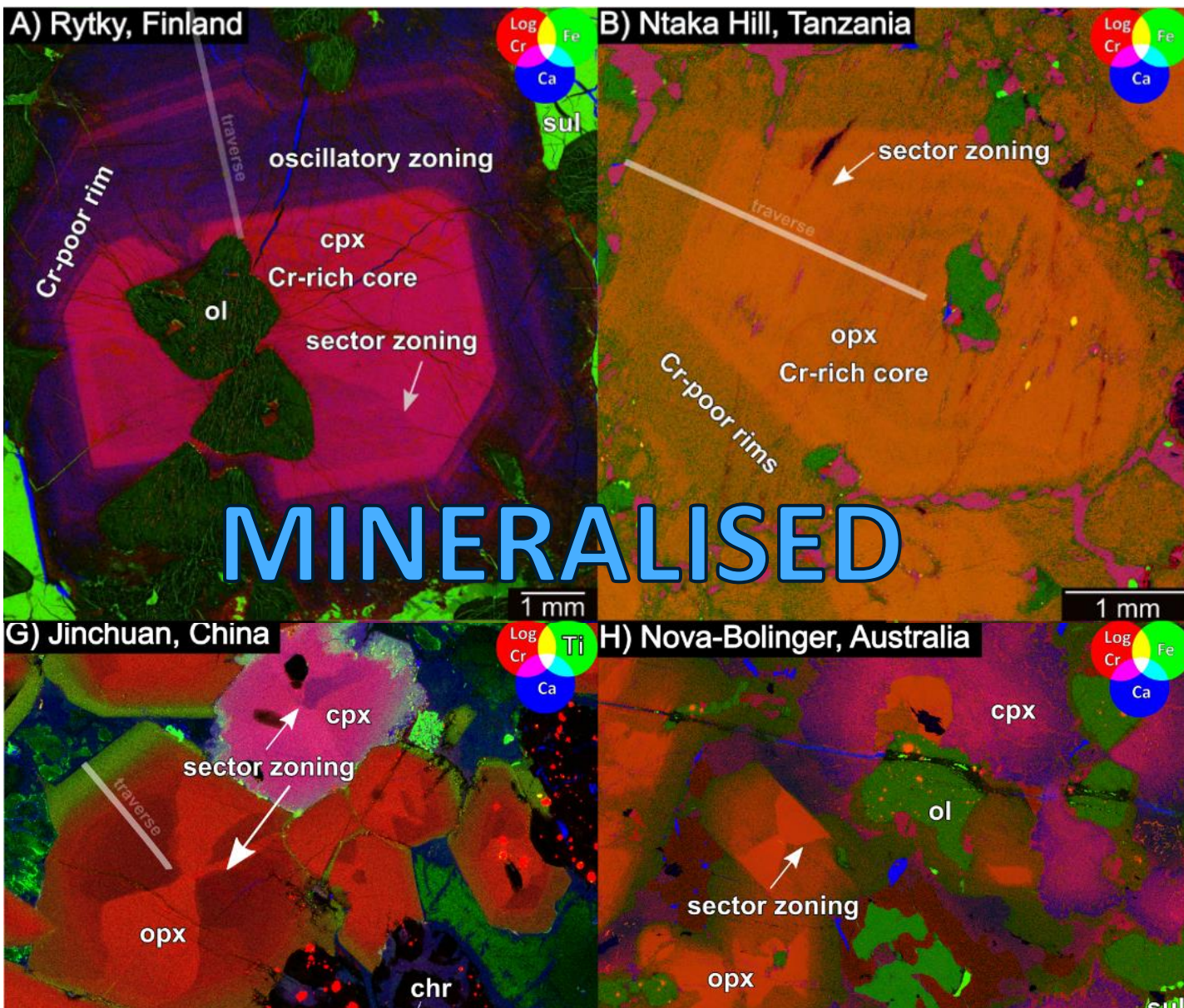


 TESCAN® Integrated Mineral Analyzer (TIMA)

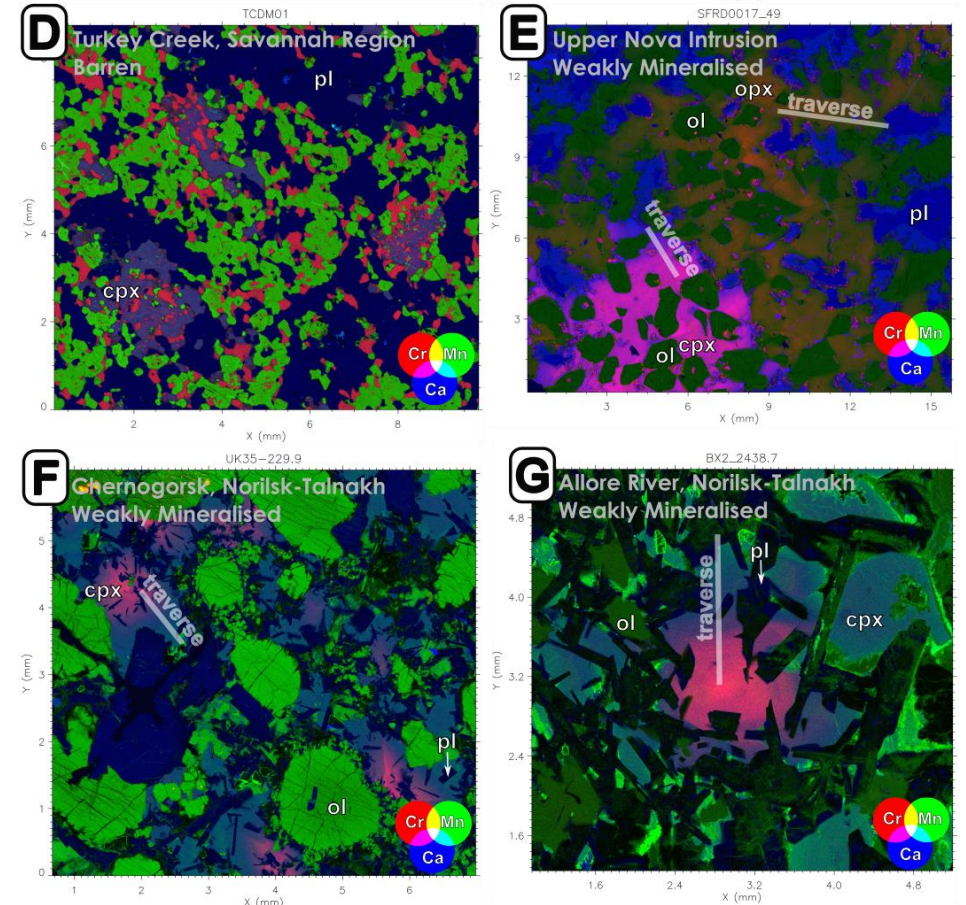


de Caritat, P., Walker, A.T., Bastrakov, E., Main, P., McInnes, B.I.A. 2023. **The Heavy Mineral Map of Australia Project**. Final Data Release. National Dataset and Atlas. GA Record 2023/42. Geoscience Australia. [DOI:10.26186/148916](https://doi.org/10.26186/148916).

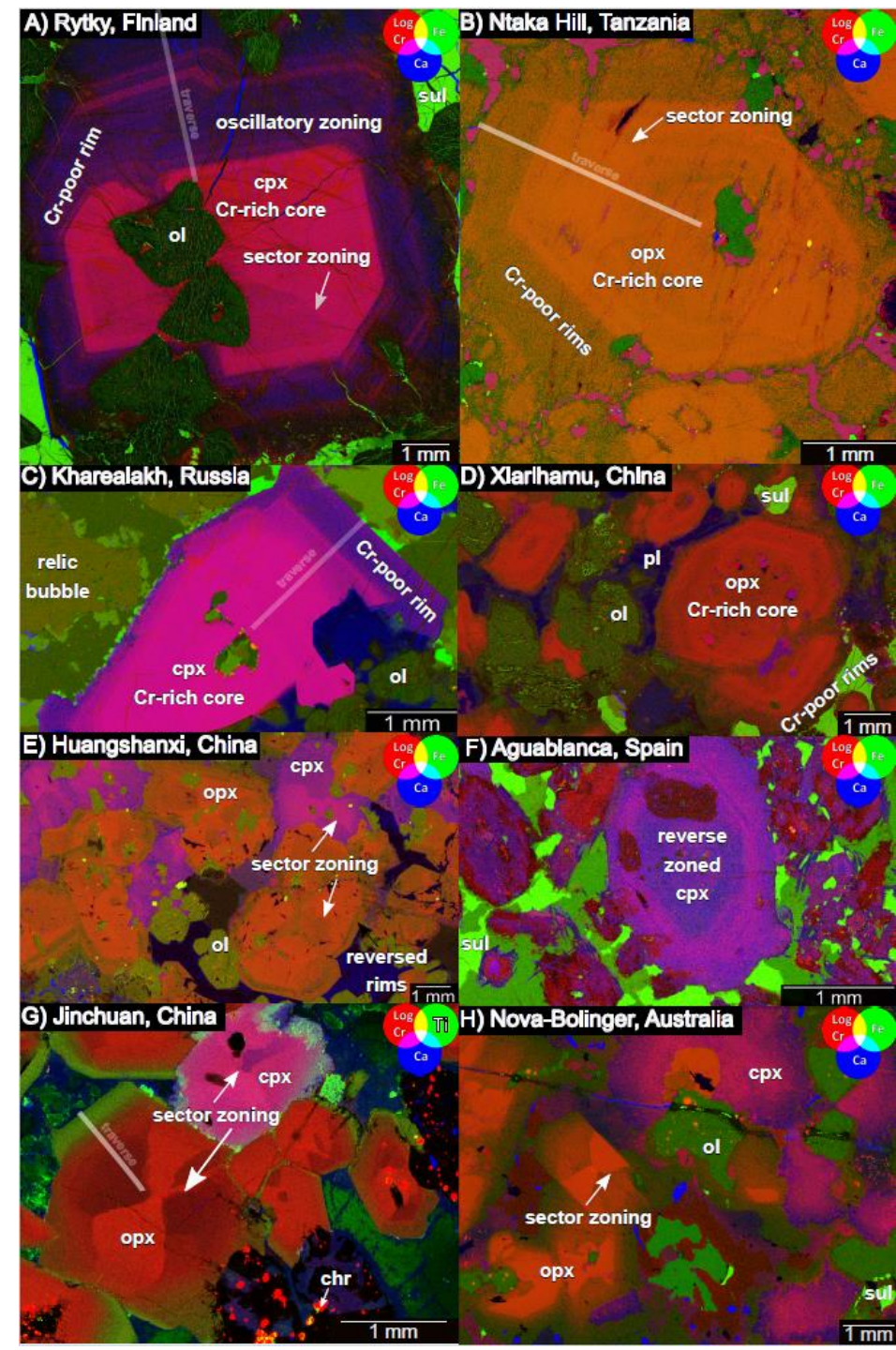
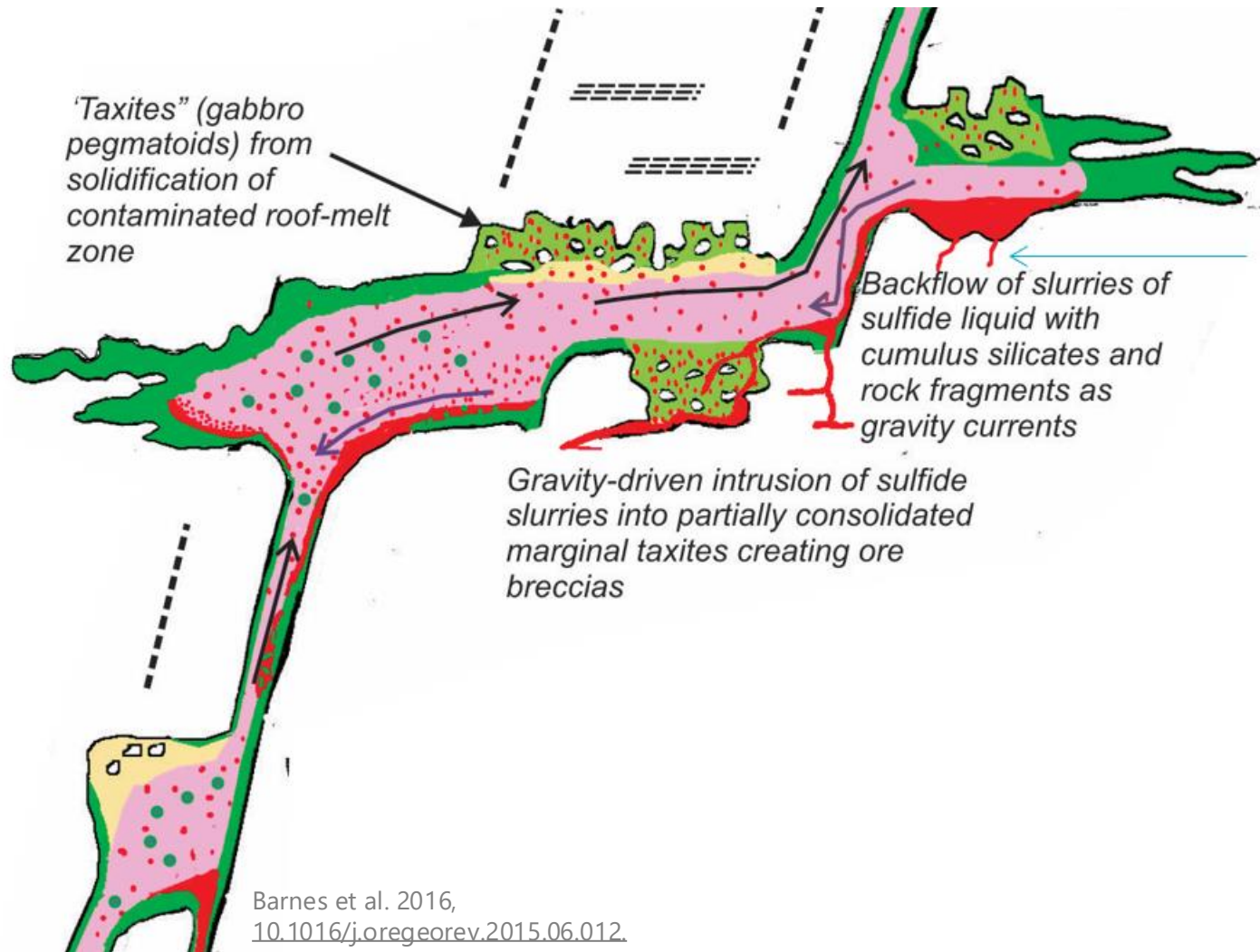
# Pyroxene – In-situ indicator mineral



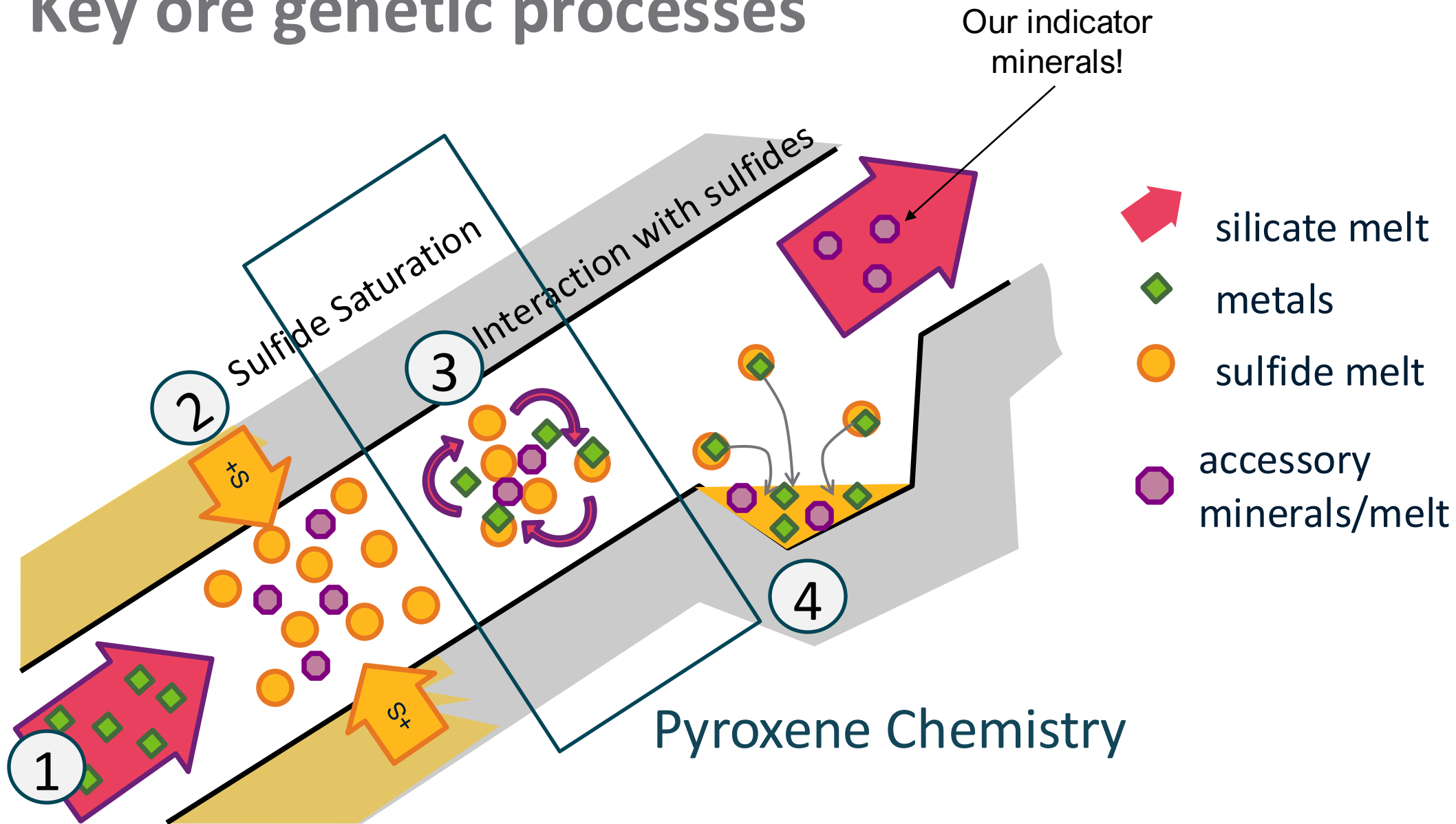
# BARREN



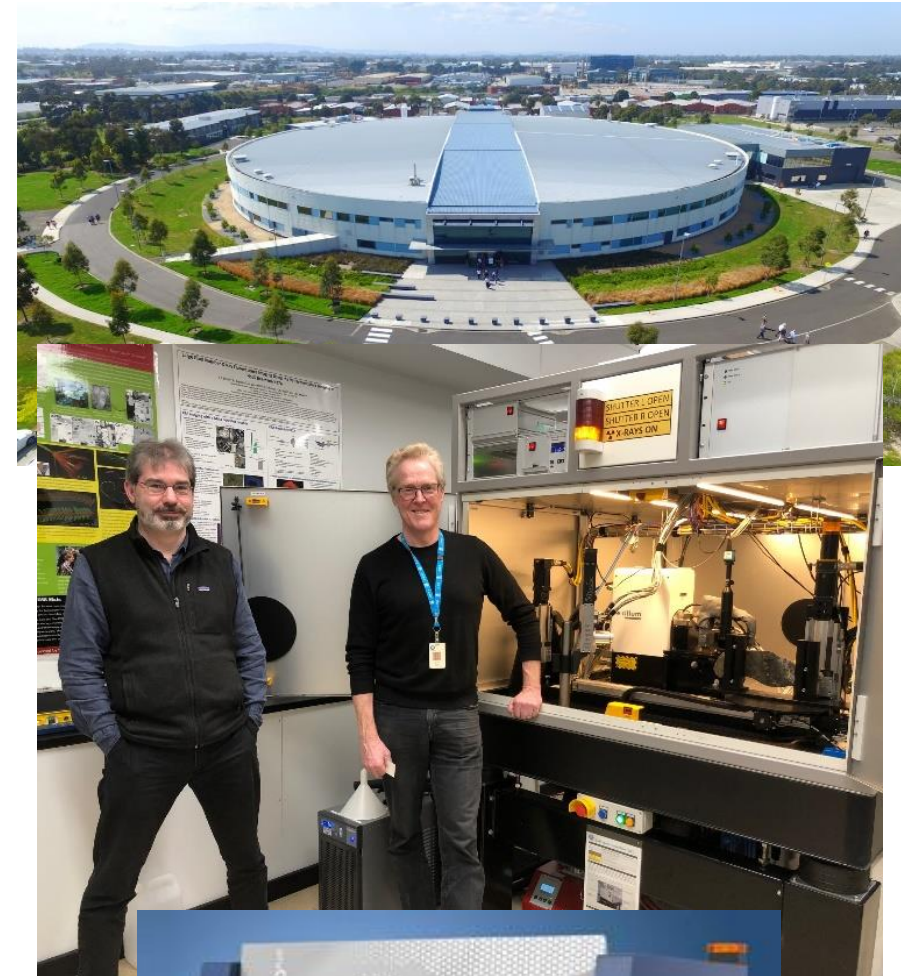
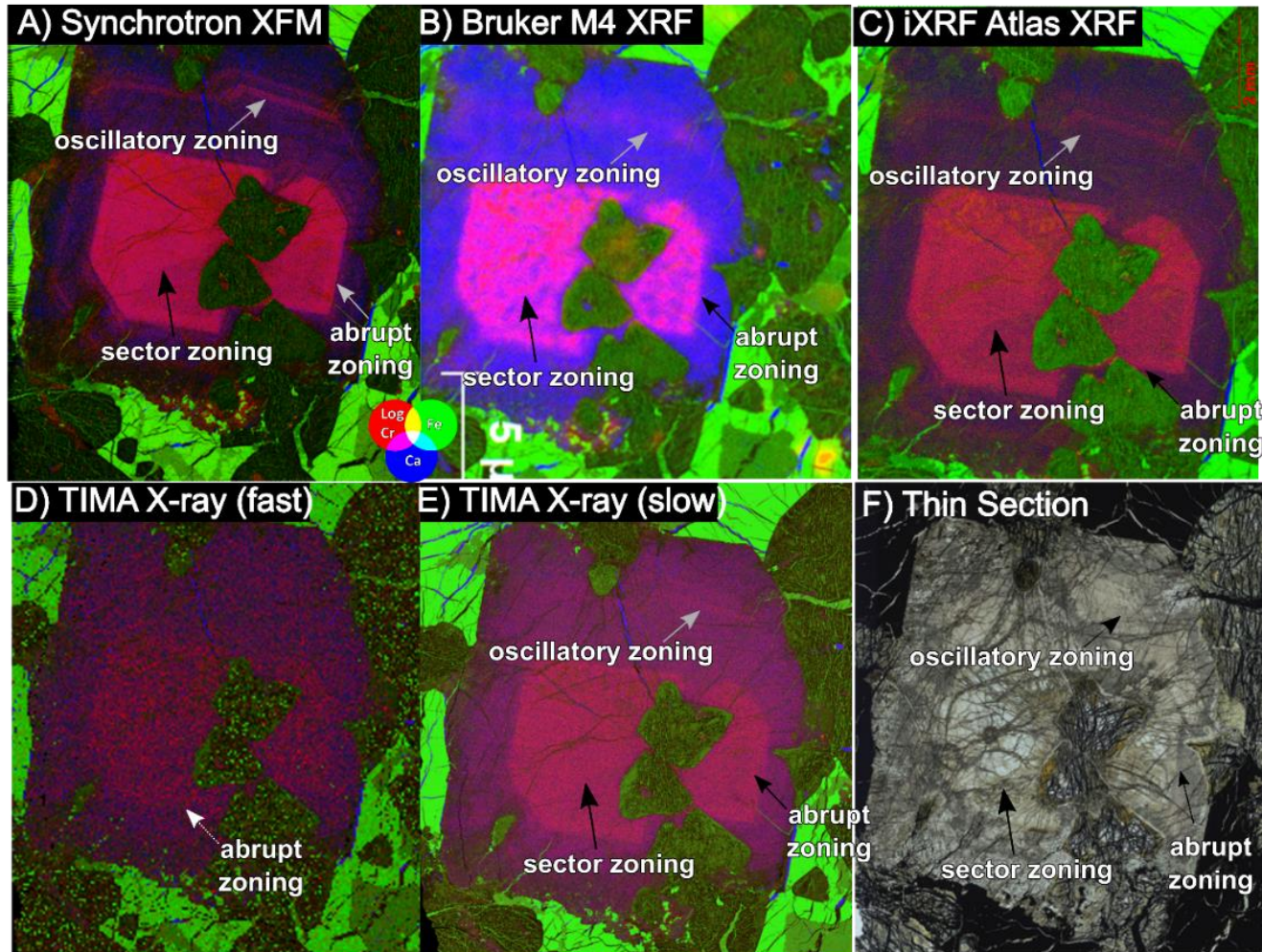
# Zoned Pyroxene in Conduits



# Key ore genetic processes



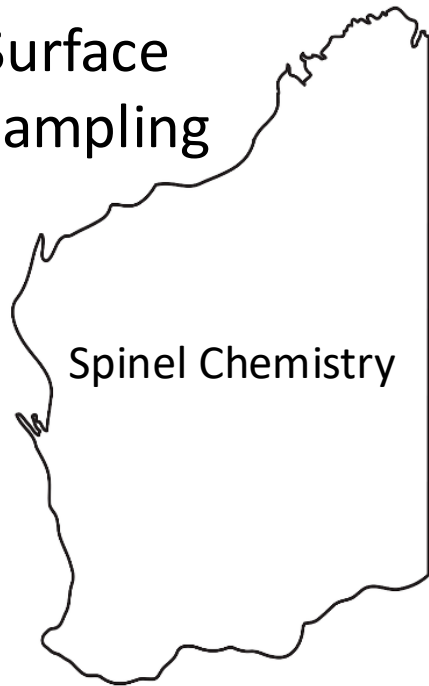
# Analytical Tools - XRF



# Indicator Minerals for Exploration at all scales

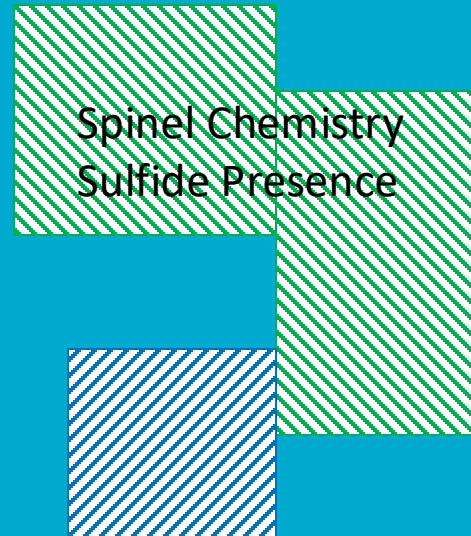
## Regional Scale Exploration

Surface sampling



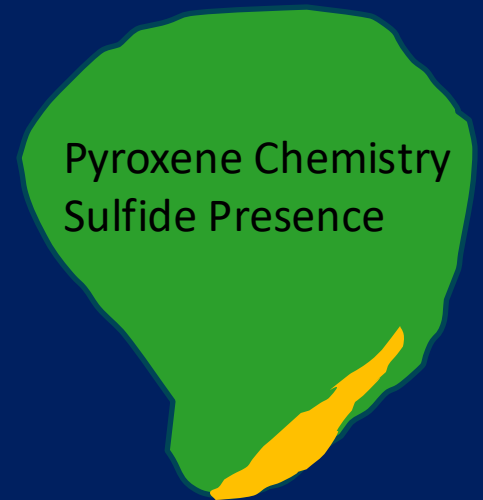
## Tenement Exploration Scale

Cover sampling

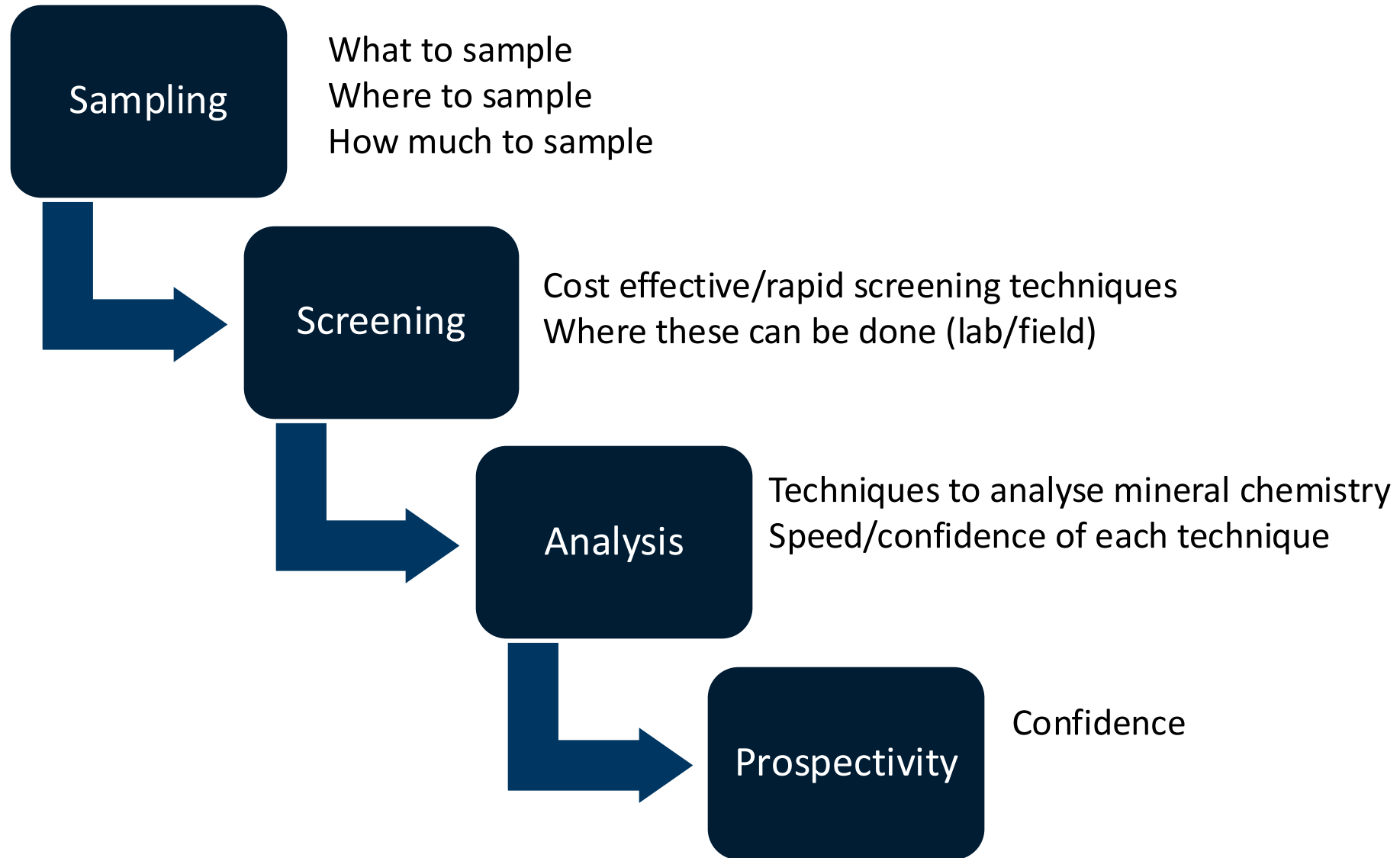


## Intrusion Scale Exploration

Basement Sampling



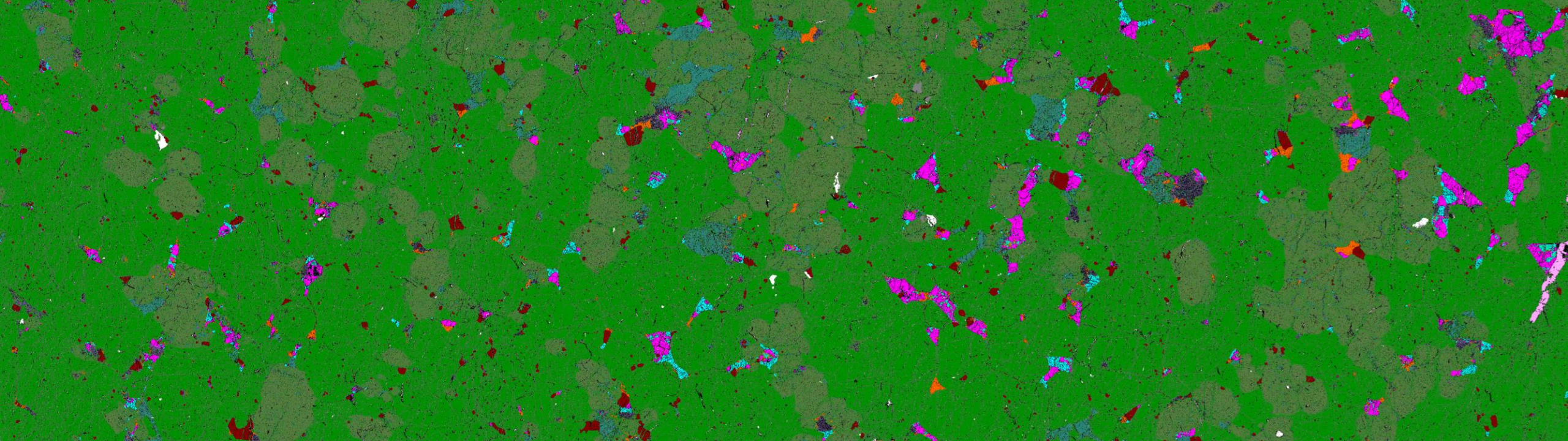
# The CSIRO Indicator Mineral Workflow – M10426 report



# Summary

- Spinel major element chemistry (Fe, Al, Cr) is a good indicator of host rock type
- Spinel trace element chemistry (Ti, V, Ni, Co, Ga) can indicate sulfide presence and potentially sulfide volume
- Pyroxene zoning (Cr, Ti) can signify conduit style systems and may indicate high metal enrichment
- Watch our website:  
<https://research.csiro.au/magnico>





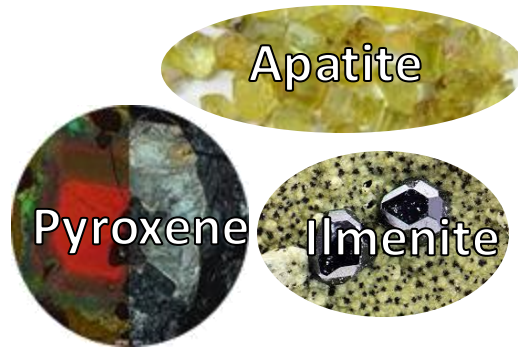
# Advancement of Indicator Minerals for Polymetallic Mafic-Ultramafic Magmatic Ore Systems

**Margaux Le Vaillant**

& William Smith, Stefano Caruso, Morgan Williams, Louise Schoneveld, Walid Salama

# Next Phase of Research

## IM4NiS#2



### Key Objectives:

- 1) Improve ML models and add **more phases**
- 2) Develop proximity indicators at deposit scale
- 3) Build an **online application**

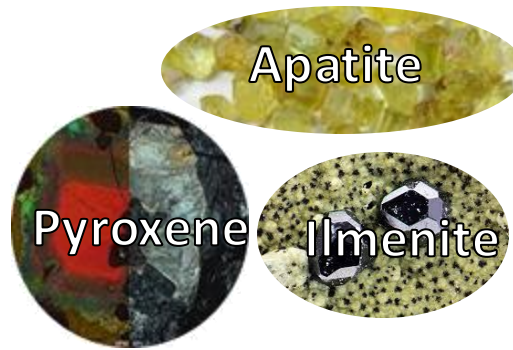


*Still open to additional sponsors*



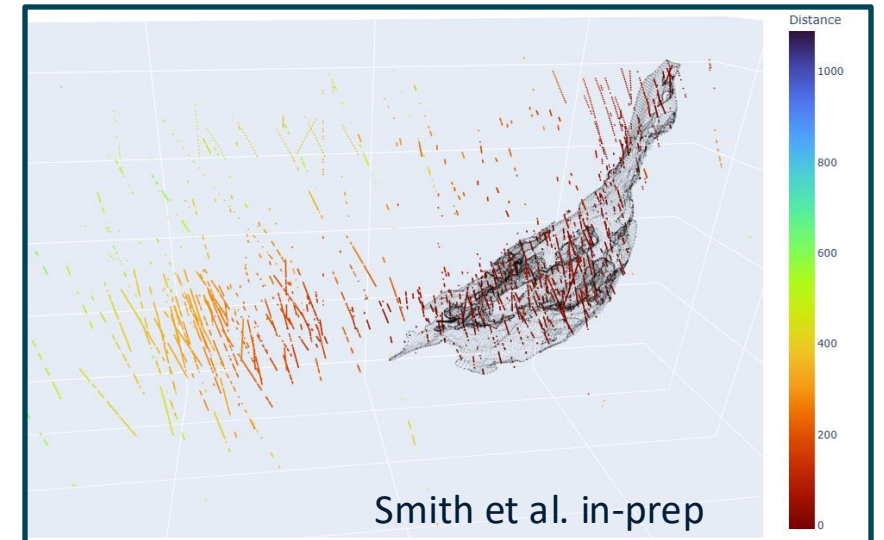
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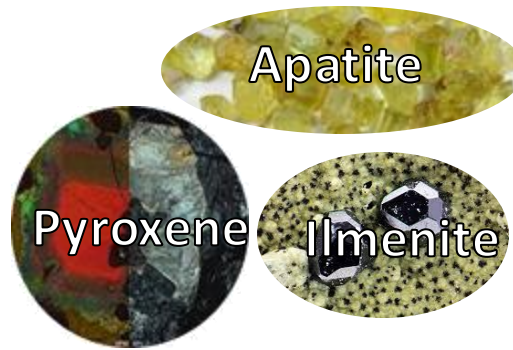


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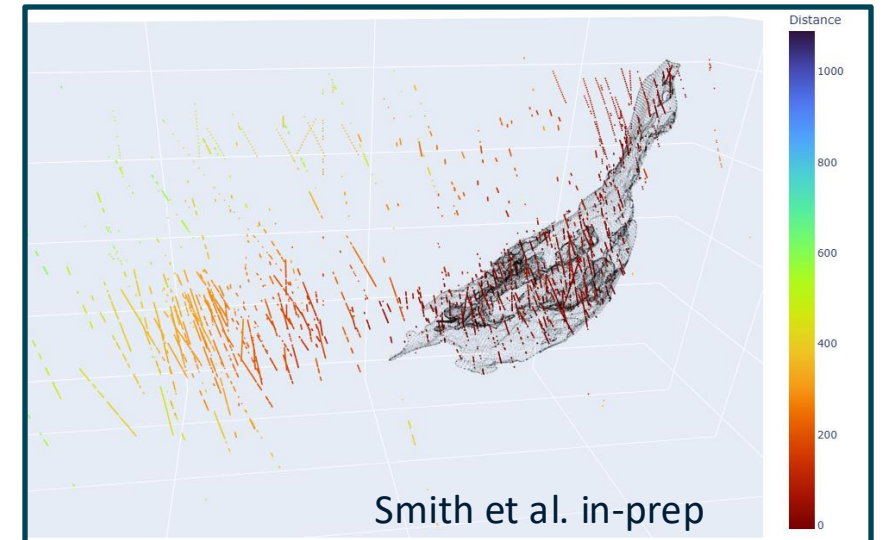
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*Still open to additional sponsors*



## Module 1 Prospectivity Indicators

New case studies and re-analysis of IM4NiS – M10426 project samples

- **Improve robustness** of current ML models
- **Add more phases** to the toolkit (apatite, ilmenite, pyroxenes)
- Test wider range of **cover environments (esp. Tills)**

## Module 2 Proximity Indicators (vectoring)

New case studies to evaluate the use of indicator minerals as **proximity indicators** and develop of **vectoring models**

## Module 3 Front-end Online Application

Translation of ML models onto **online App** for ease of use by exploration companies

- Work in collaboration with CSIRO's **eXploration Toolkit (XT) Team**

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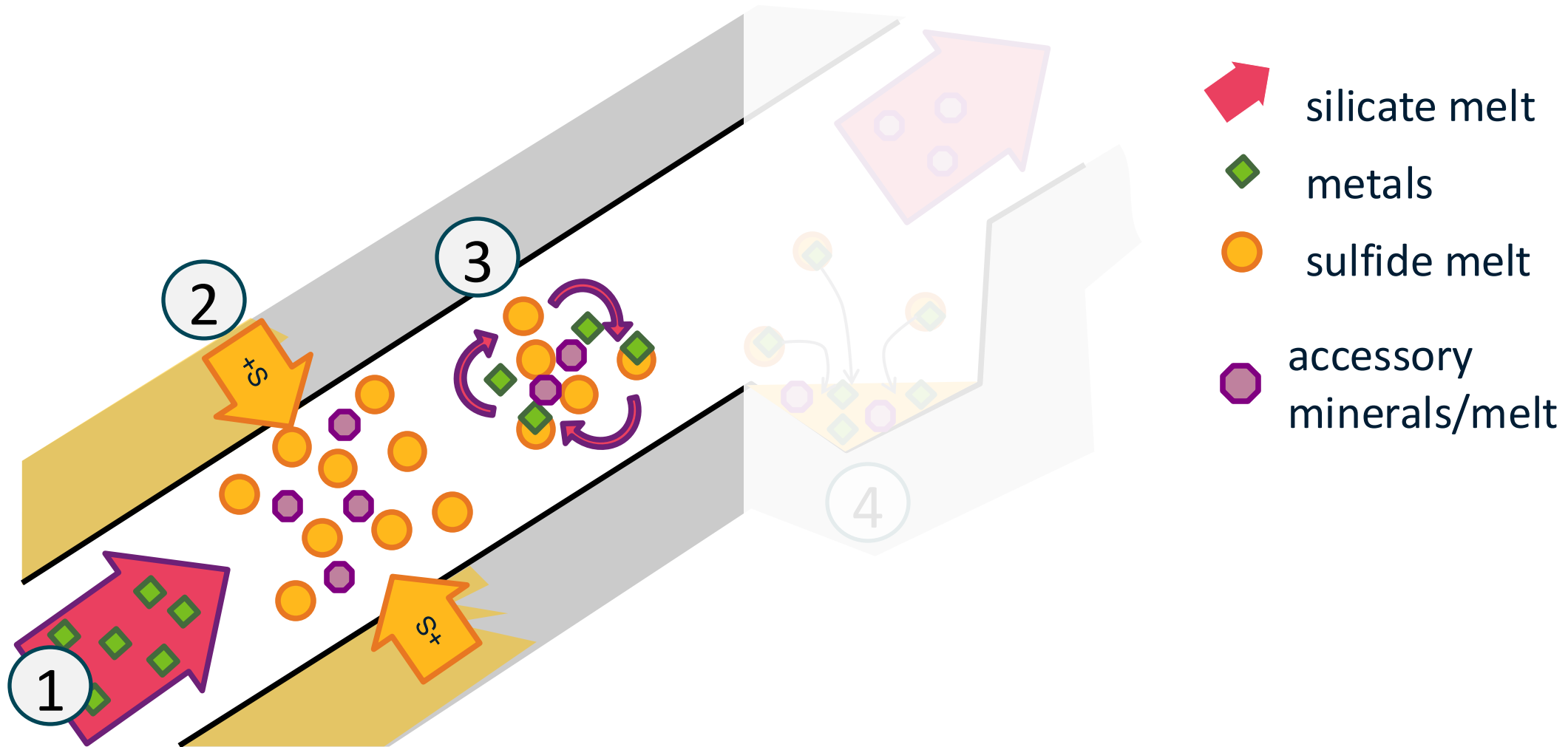
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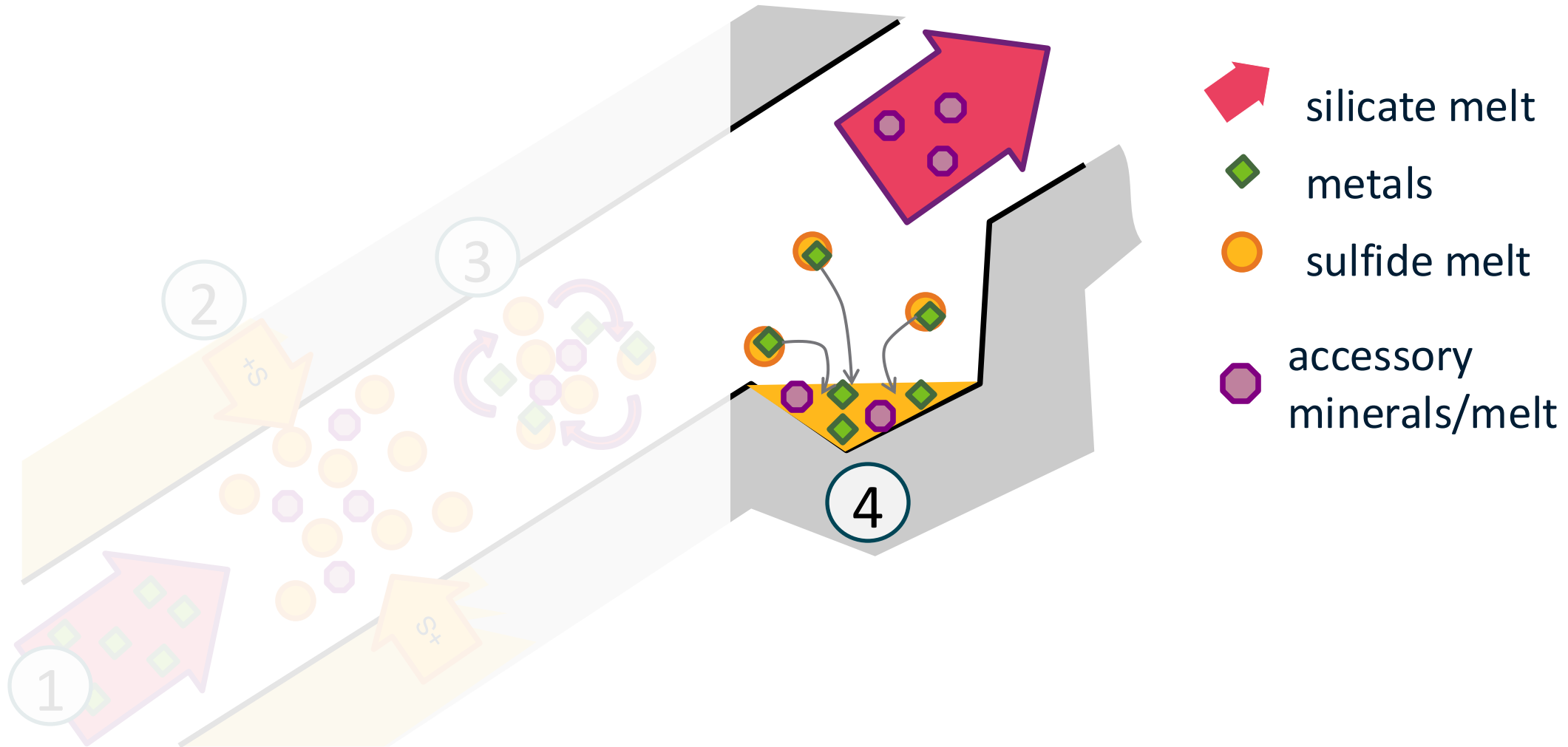
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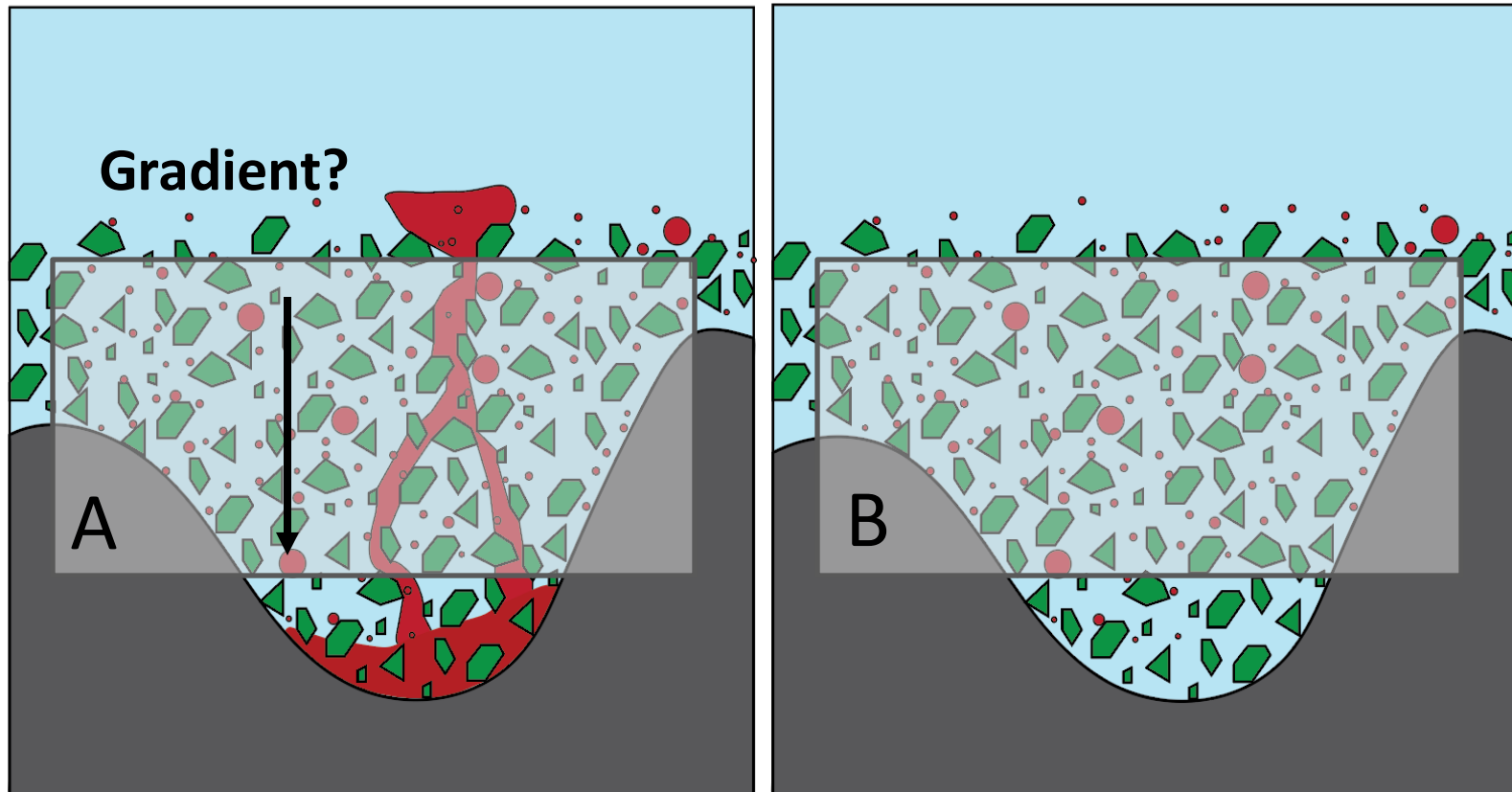


# Proximity Indicators



# Proximity Indicators

Identification of **characteristic trends and signatures** of sulfide **percolation and accumulation**



## Differences between A and B?

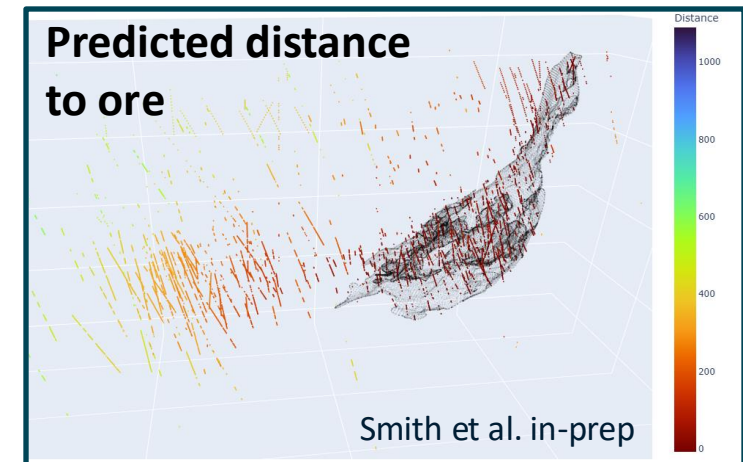
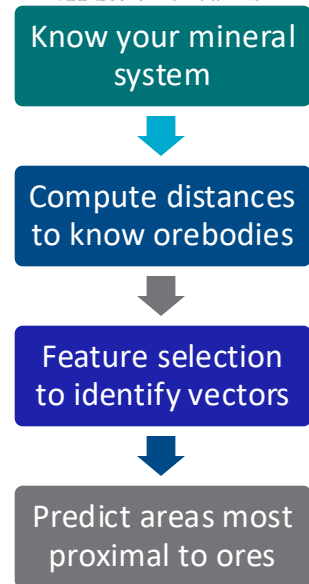
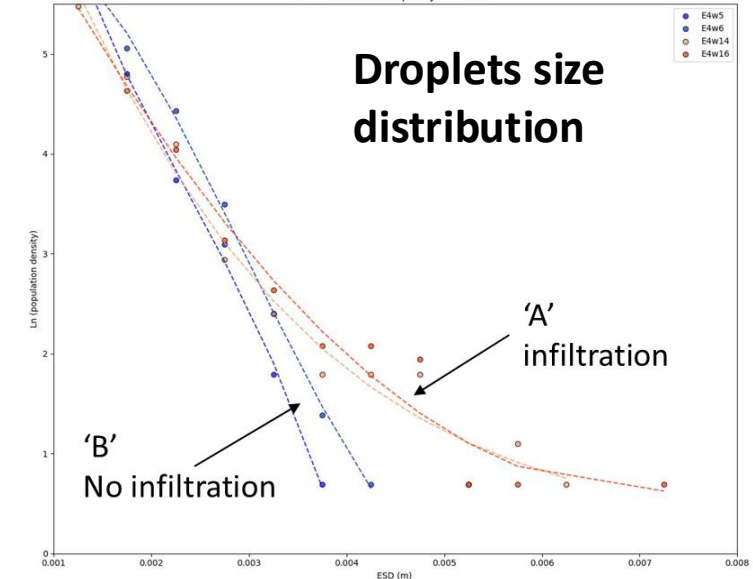
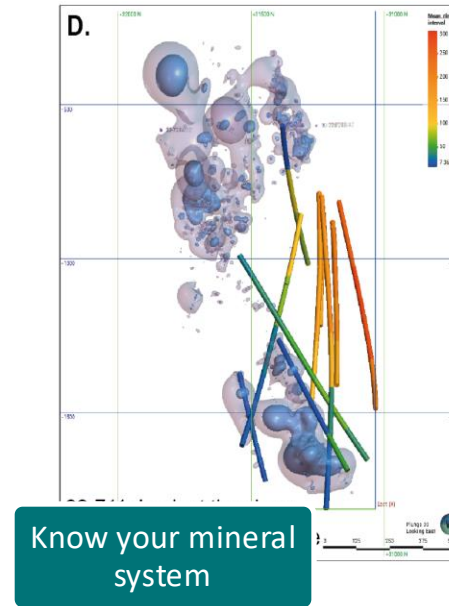
- Mineral chemistries (cumulate phases and interstitial late silicates)
- Sulfide droplets size distribution
- Whole rock geochemistry

# Proximity Indicators

Identification of **characteristic trends and signatures** of sulfide **percolation and accumulation**

**Data driven** testing and development of vectoring models

Use of **large assay datasets**, combined with collected **mineral chemistries** and detailed information on 3D geometry of known ore bodies to create **bespoke camp-scale distance to ore machine learning models**



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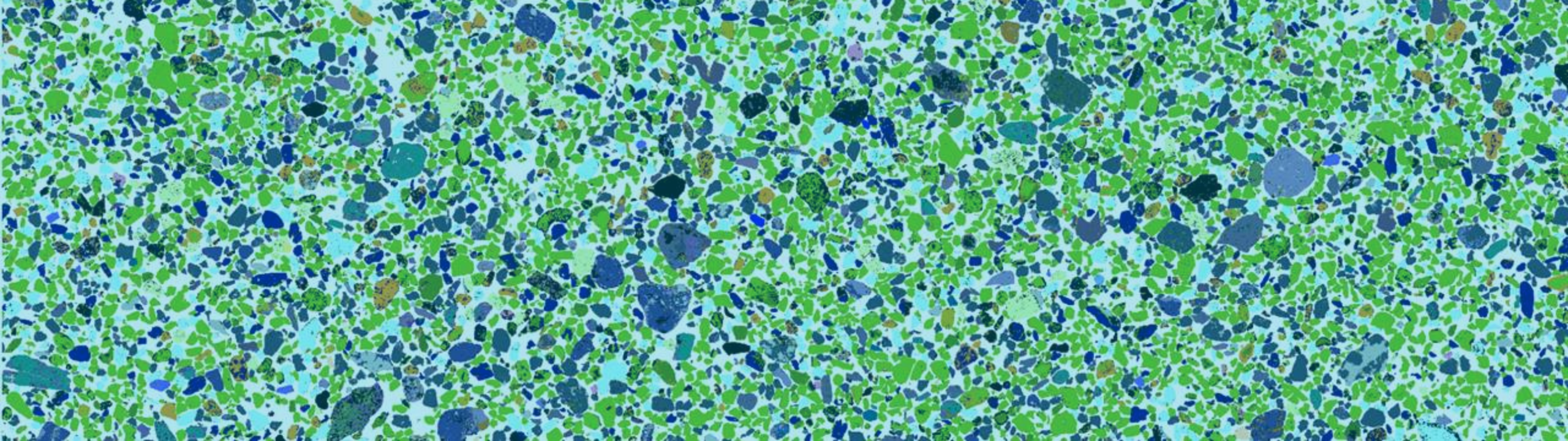
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Online  
APP



## IM4NiS – P10426 - Full report released today

### **Mineral Resources – Discovery**

Dr. Louise Schoneveld

Senior Research Scientist

[louise.schoneveld@csiro.au](mailto:louise.schoneveld@csiro.au)

<https://research.csiro.au/magnico/>

### **Mineral Resources - Discovery**

Dr. Margaux Le Vaillant

Senior Research Scientist

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<https://research.csiro.au/magnico/>

Thank you for coming! Our next  
Tech Talk on 3 July is:

## Petrophysics for Mineral Discovery during Drilling



**Prof Brett Harris**

School of Earth and Planetary Sciences (EPS)  
Faculty of Science and Engineering  
Curtin University



TECH TALK SERIES



# Spare slides

# Machine Learning

- A large, robust and consistent data set – perfect for ML
- Data broken into Training and Testing sets
- Random Forest Models
- How well do the models predict mineralisation?
- What elements are being used to make these predictions?
- Do they make geologic sense?

## Confusion Matrix

