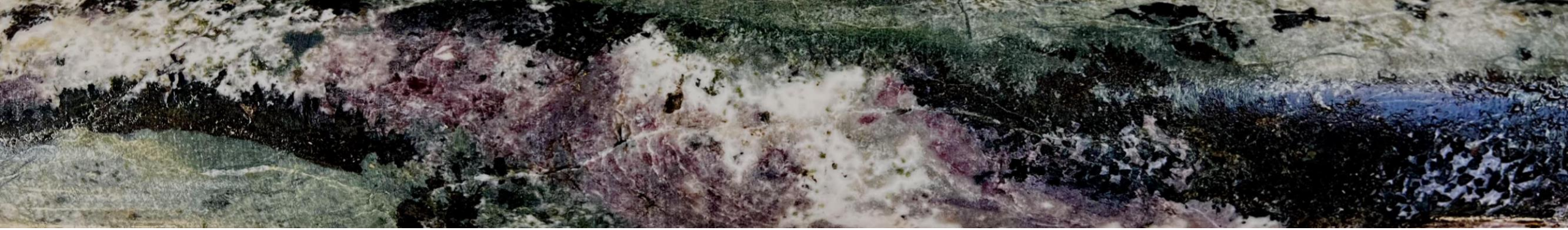

Mineral geochemistry and textural relations of Ni sulfides and Co arsenides ores from the atypical Avebury nickel deposit, western Tasmania, Australia

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6th August 2024

CODES CENTRE FOR ORE DEPOSIT AND EARTH SCIENCES | RRC REGIONAL RESEARCH COLLABORATION CRITICAL METALS

UNIVERSITY of TASMANIA

Acknowledgements

CODES

RRC

CODES Supervisory team

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Avebury Nickel Mine staff

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Mineral Resources Tasmania

Mornington Core Library

CSL

Central Science Laboratory (CSL)

Microscopy and microanalysis facilities

Mt Agnew, Zeehan mining district, western Tasmania

International Ni-Cu Symposium

Thunder Bay 2024

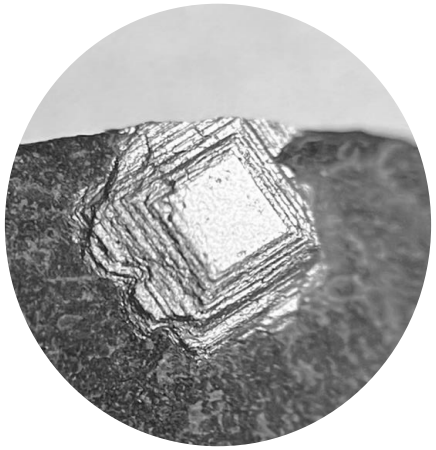
Outline

Introduction
- Background
- Nickel deposits in Australia

Geological setting
- Nickel occurrences in western Tasmania
- A nickel deposit in the world-class Zeehan tin-silver-lead-zinc district

Avebury Ni deposit
- Stratigraphy
- Mineralization
- Implications of Geochemistry
- Genetic model

Conclusions

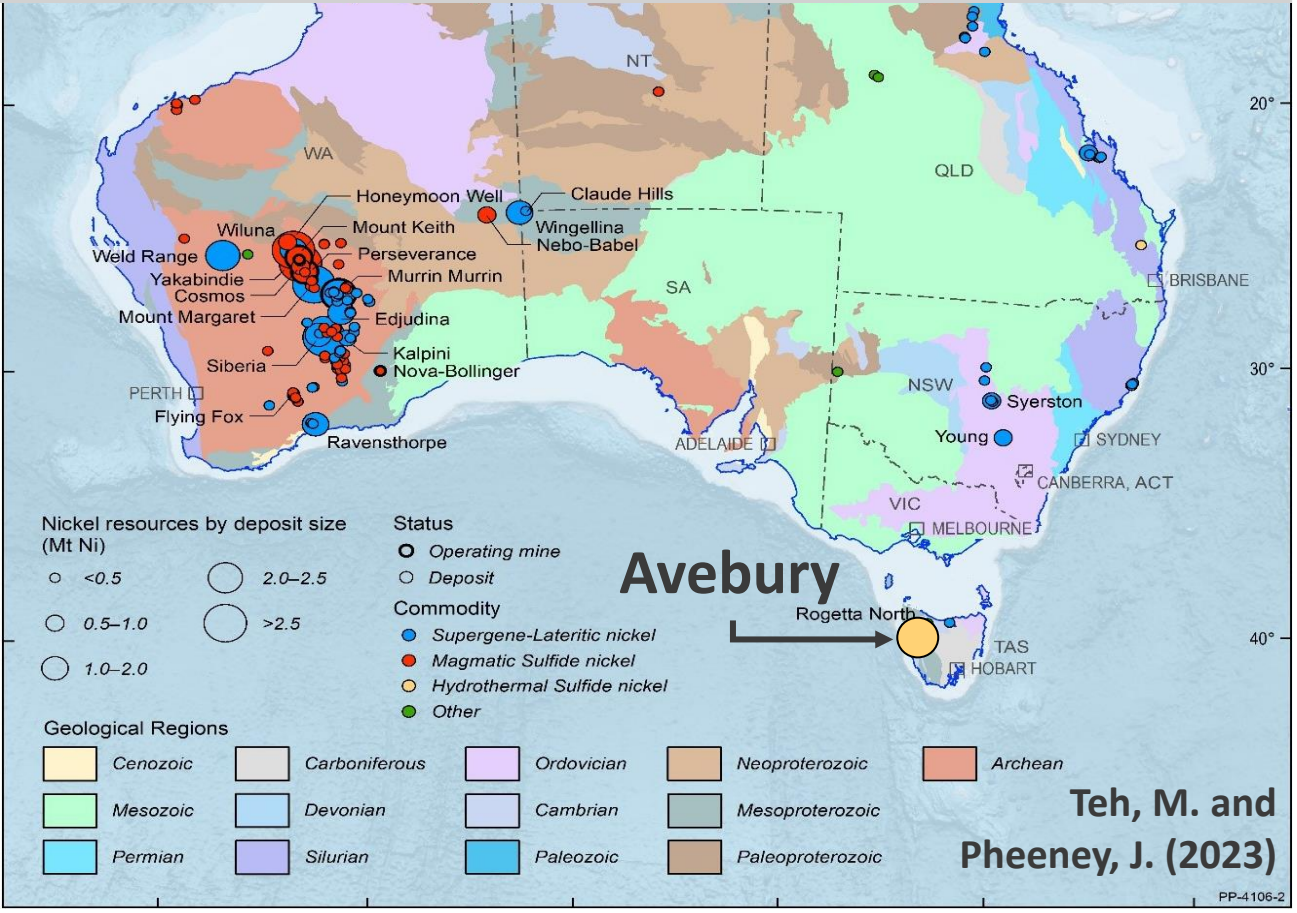


Cobaltite (CoAsS),
Avebury Ni mine, Jose Barillas (2023)
Stereo zoom microscope image

"Aurora Australis, Zeehan",
Josh Denholm

Avebury — A puzzling nickel mineral system

Is Avebury a hydrothermal magmatic Ni-S deposit?

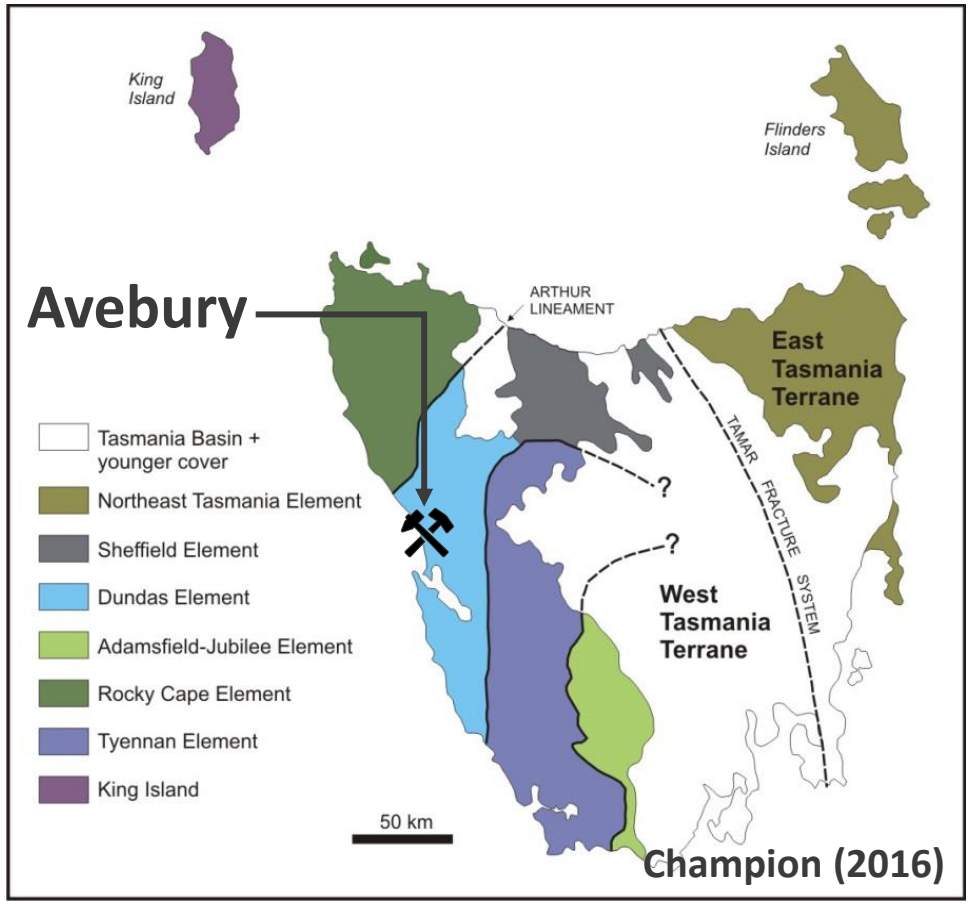


Teh, M. and Pheeney, J. (2023)

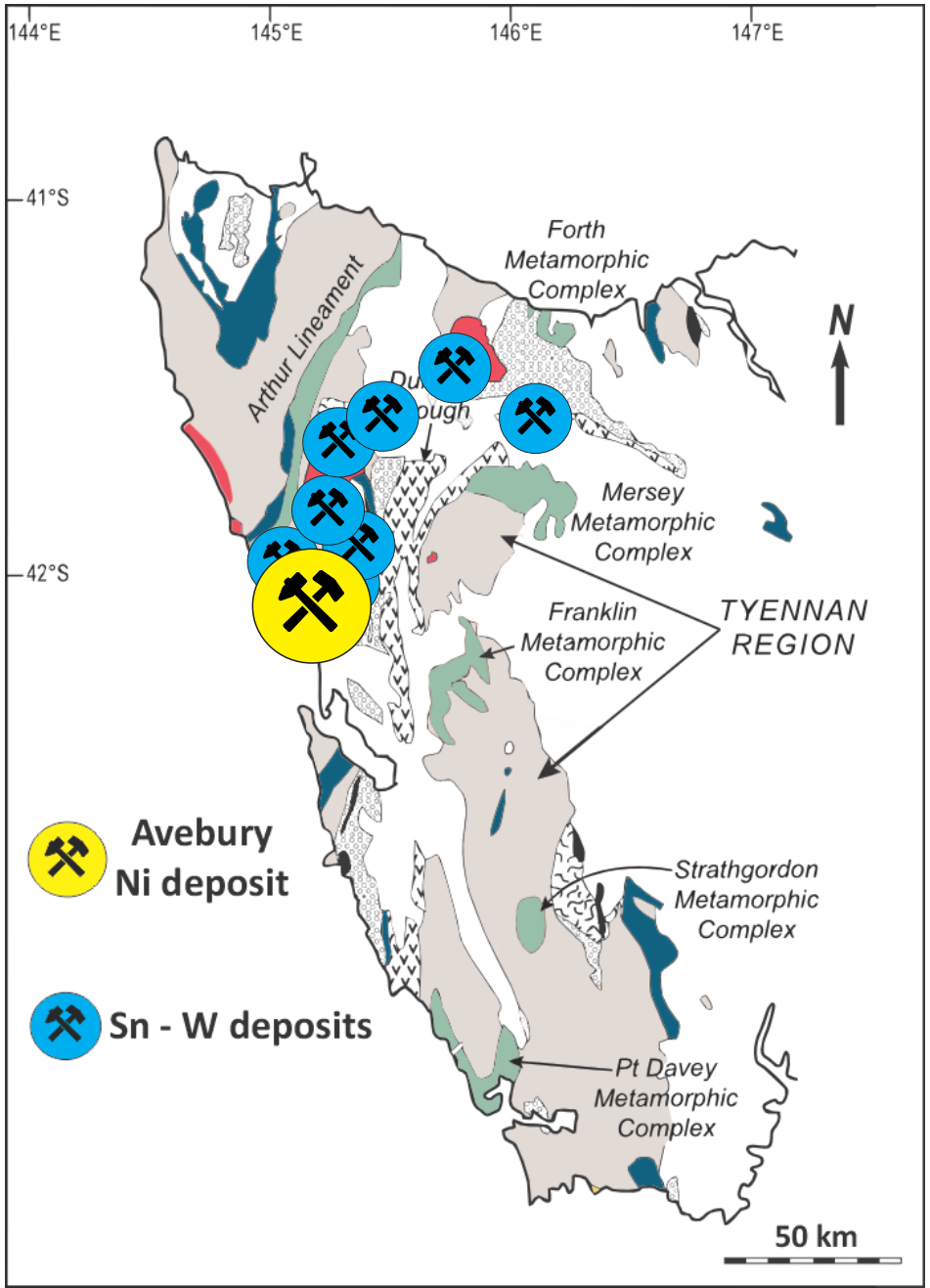
JORC Classification	Tonnage (Mt)	Ni (%)	Ni (kt)	Co (ppm)	Co (kt)
Indicated	8.7	1.0	87	244	2
Inferred	20.7	0.8	166	223	5
TOTAL	29.3	0.9	264	229	7

Avebury nickel mine (2023)

The geology of western Tasmania is unique in Australia



Avebury is located in a significant granite-related Sn-W and base metals district!



modified after Brown (2021)

Tectonic setting — A complex history

At least five major tectonic events:

1. **Early to middle Cambrian**

Tyennan Orogeny: Obduction of the western Tasmania ophiolite, Cambrian ultramafic – mafic complex

2. **Middle Cambrian**

E - W extension and eruption of the submarine Mt Read Volcanics, which are hosts of VHMS deposits

3. **Late Cambrian**

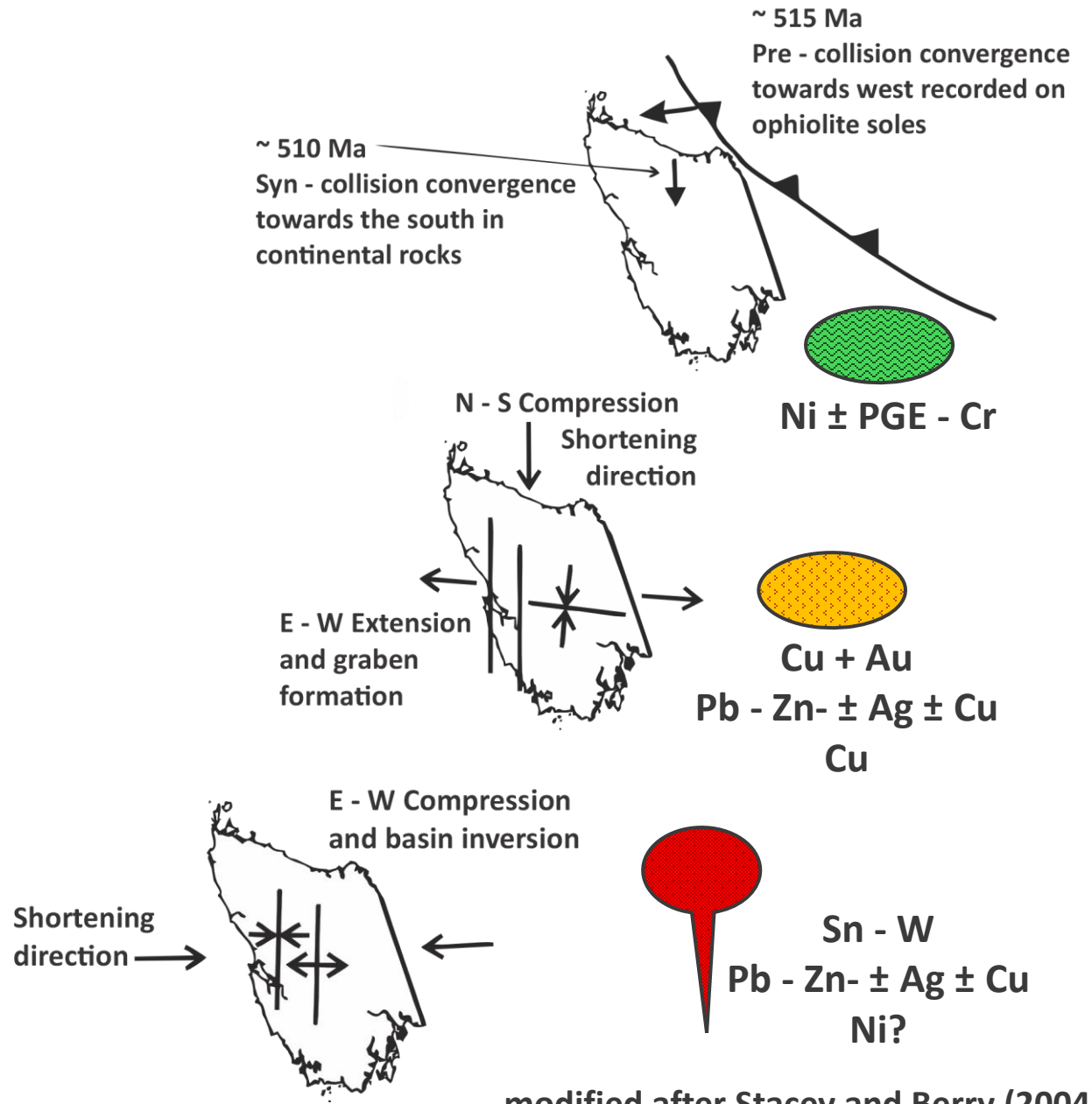
Delamerian Orogeny: E - W compression and basin inversion

4. **Middle Devonian**

Tabberabberan Orogeny: N and W – NW folds

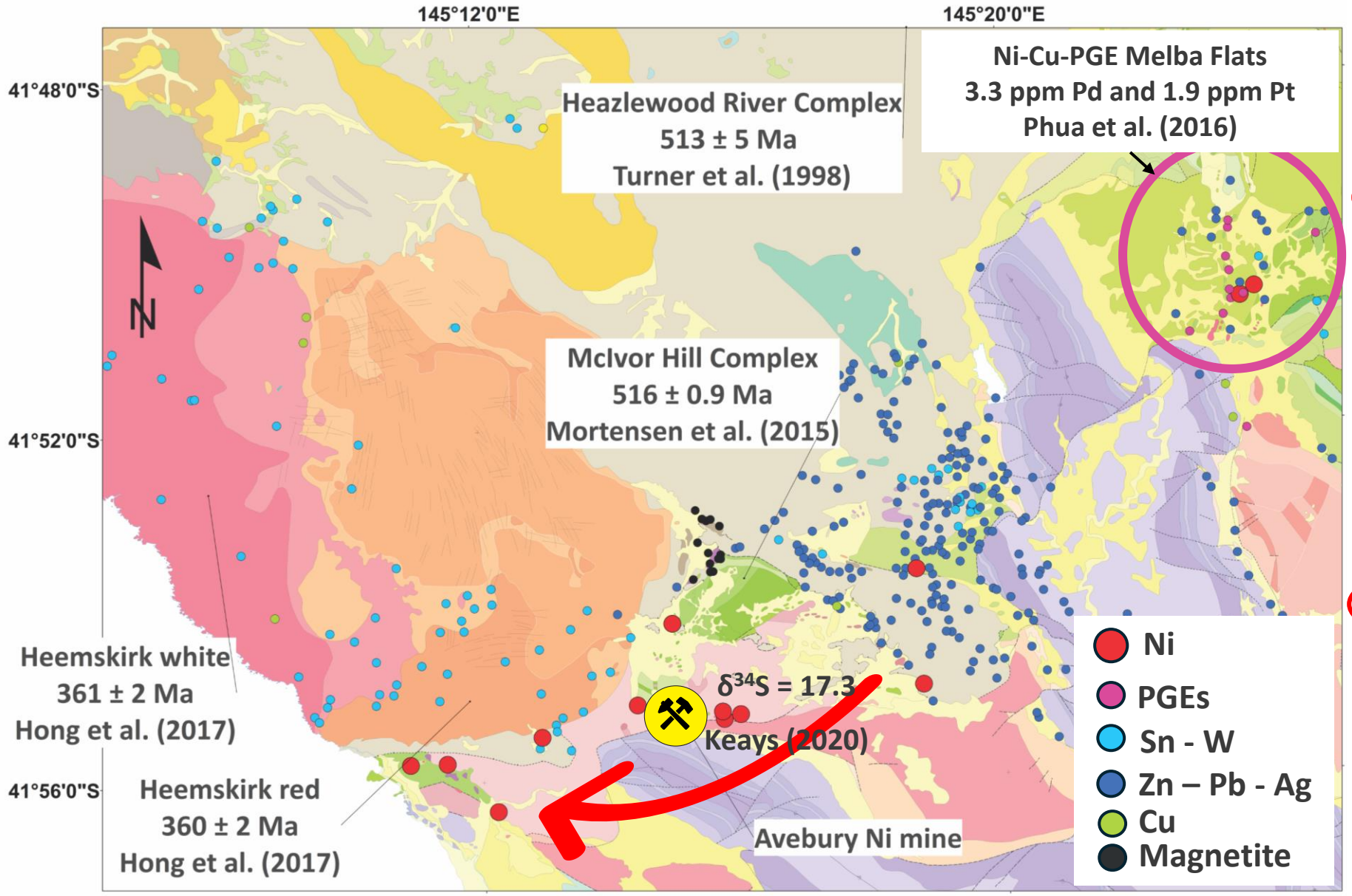
5. **Late Devonian to Carboniferous**

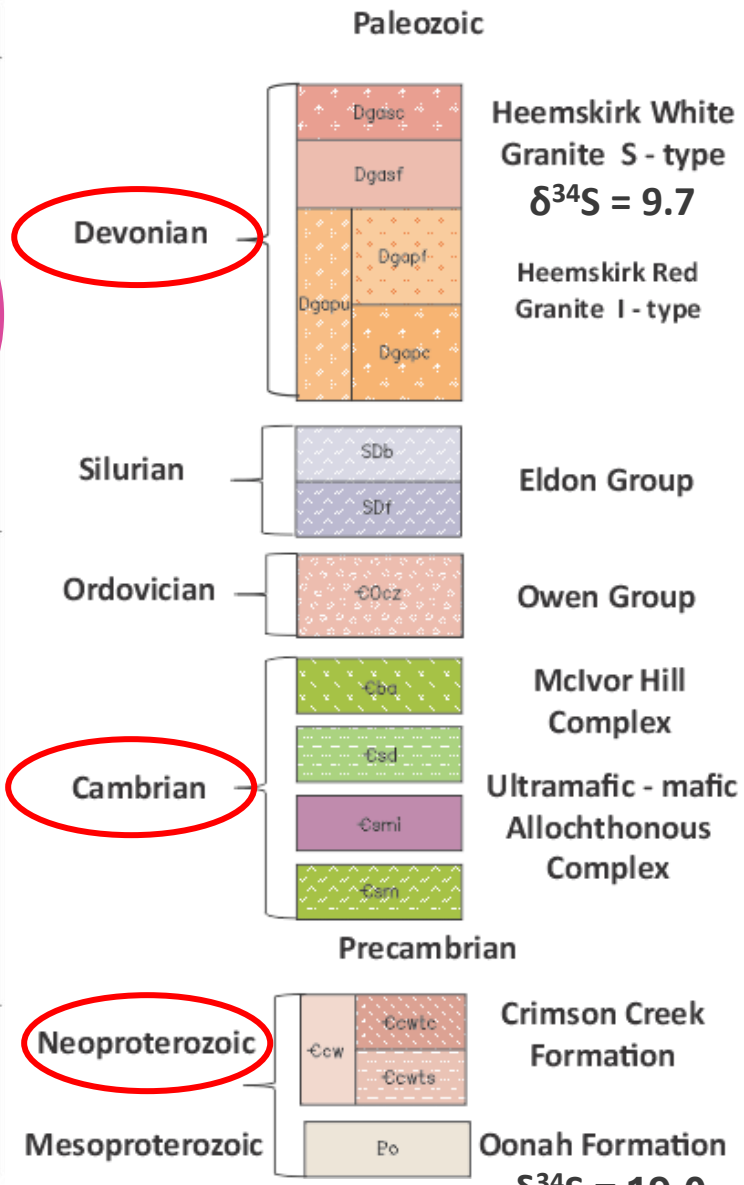
Post-collisional granite magmatism related to Sn - W - base metals deposits



modified after Stacey and Berry (2004)

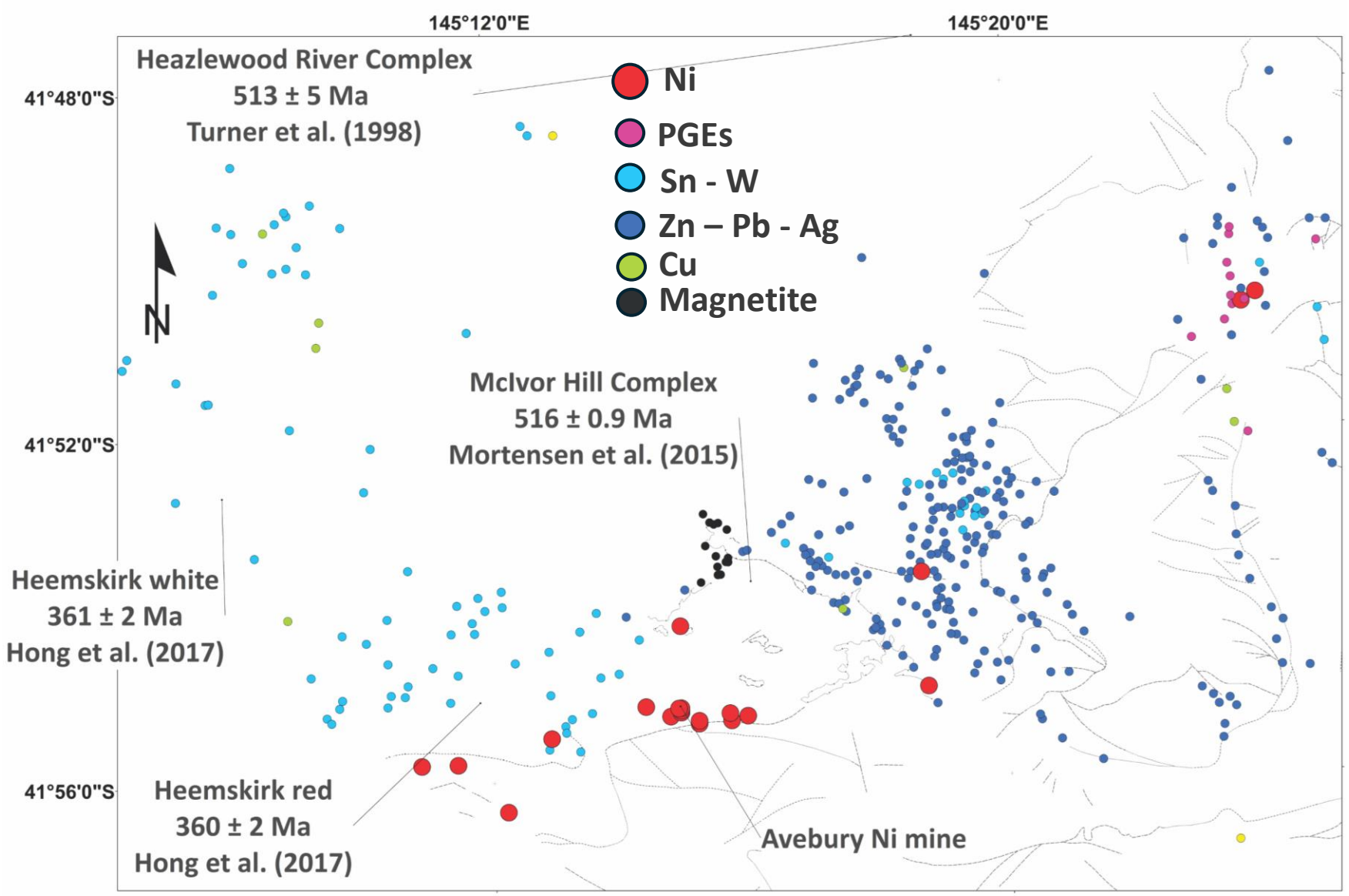
Geology and mineralization — Zeehan mineral field





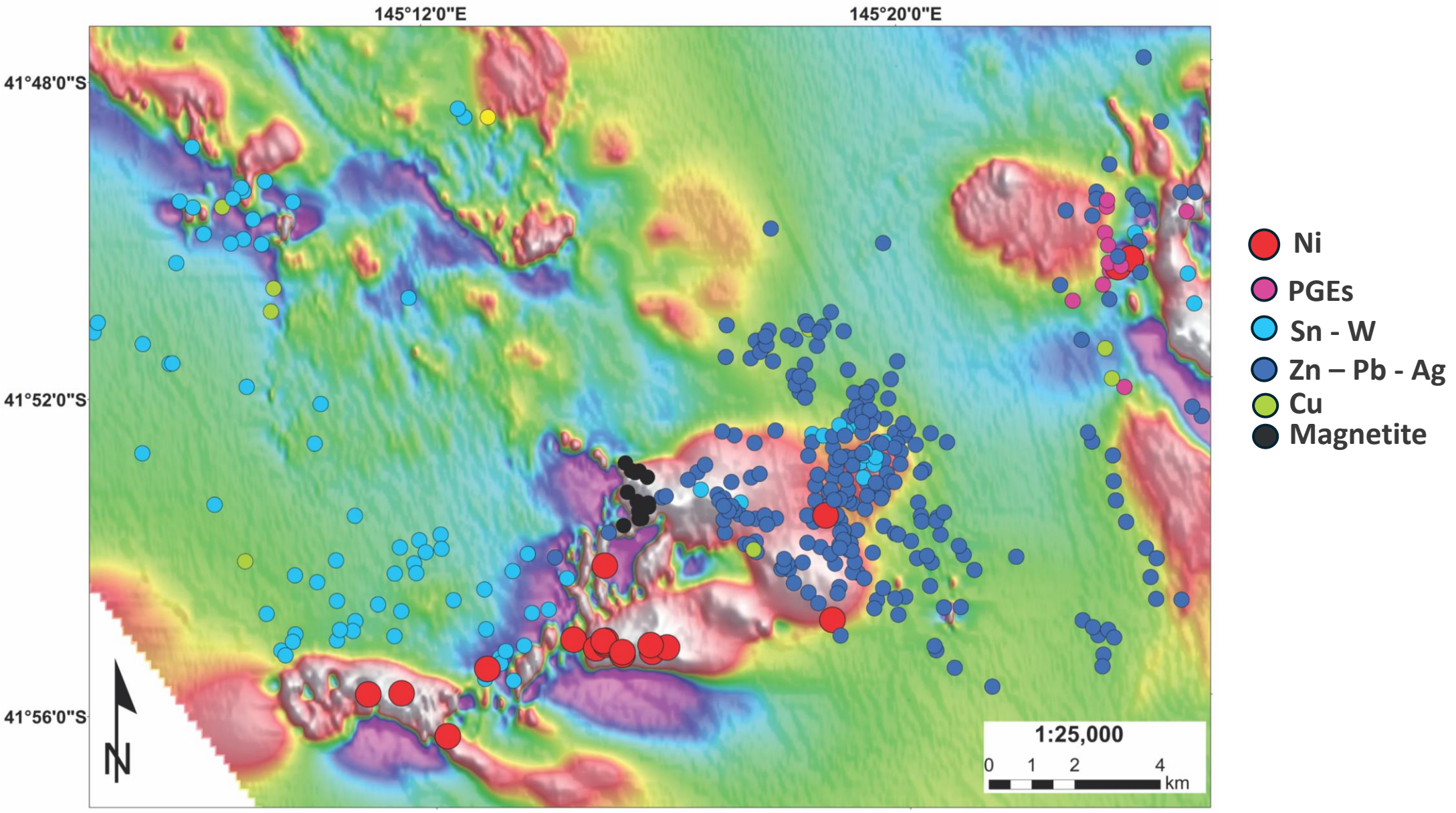
Source, age and timing of mineralization?

Nickel occurrences — Zeehan mineral field

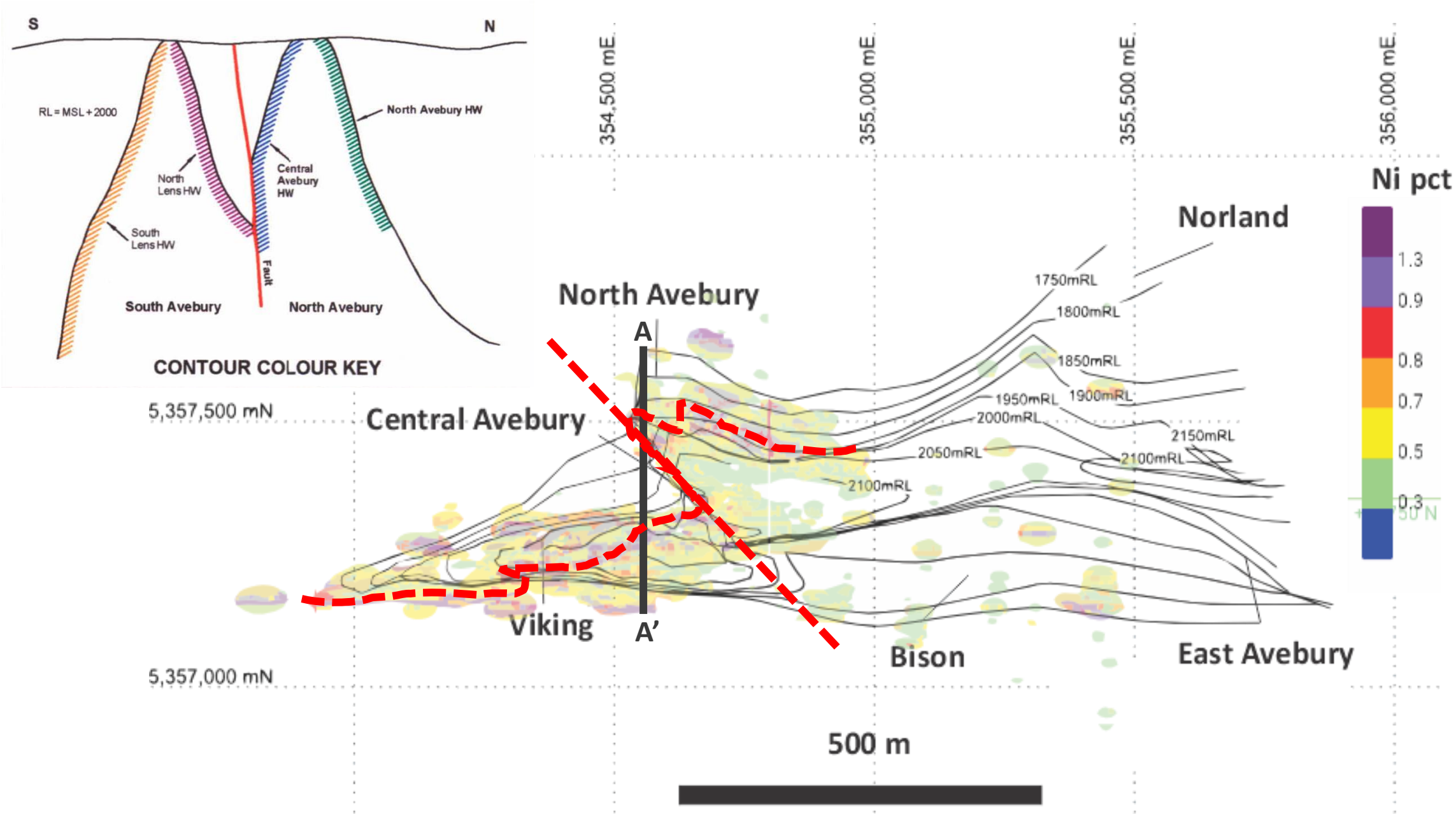


Mineral Resources Tasmania data source (2024)

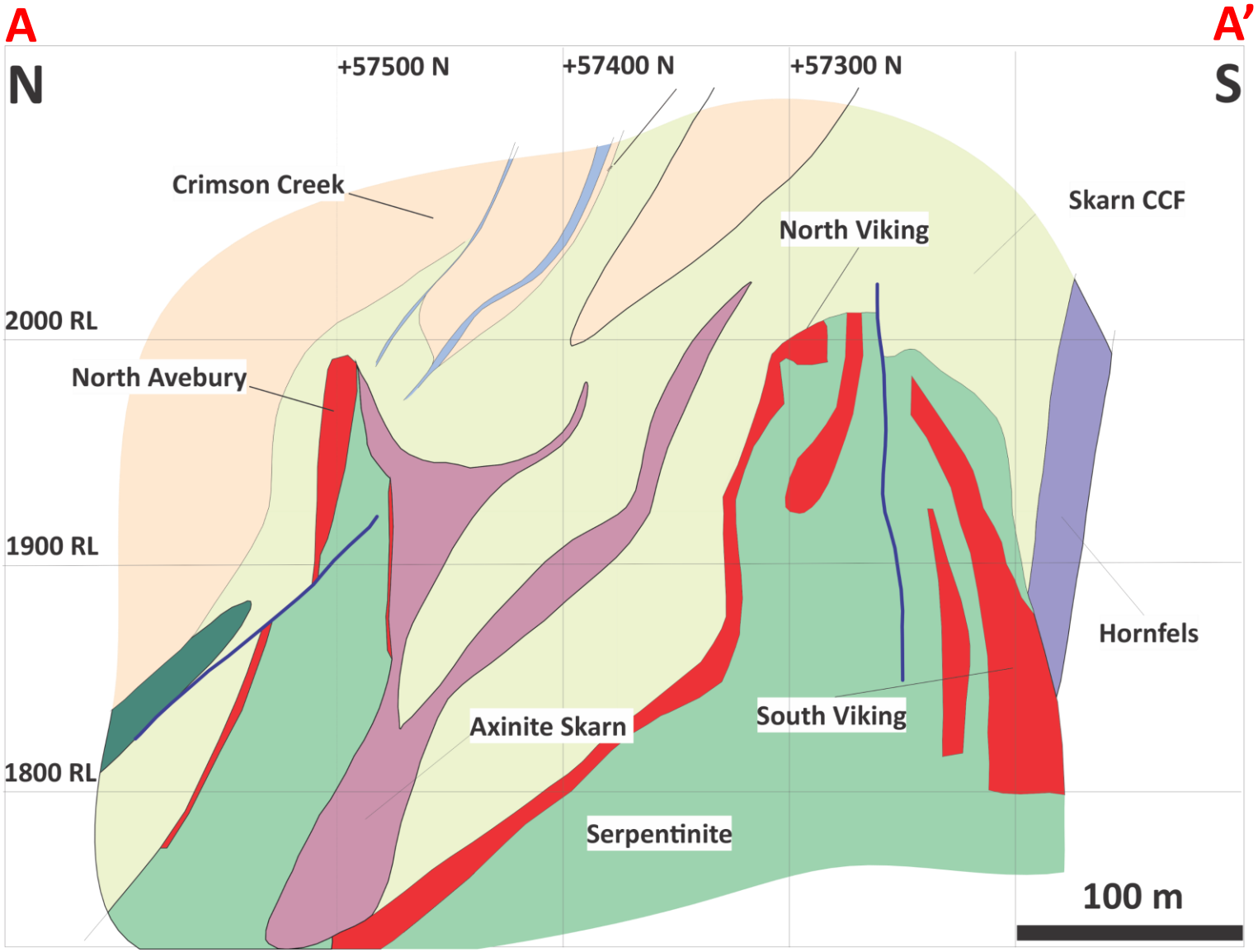
Nickel occurrences have a positive correlation with Total Magnetic Intensity (TMI) anomalies



Avebury Ni deposit geometry — Plan view



Avebury Ni deposit geometry — Cross section



Legend

Fault

Cambrian

Serpentinized ultramafic - mafic complex

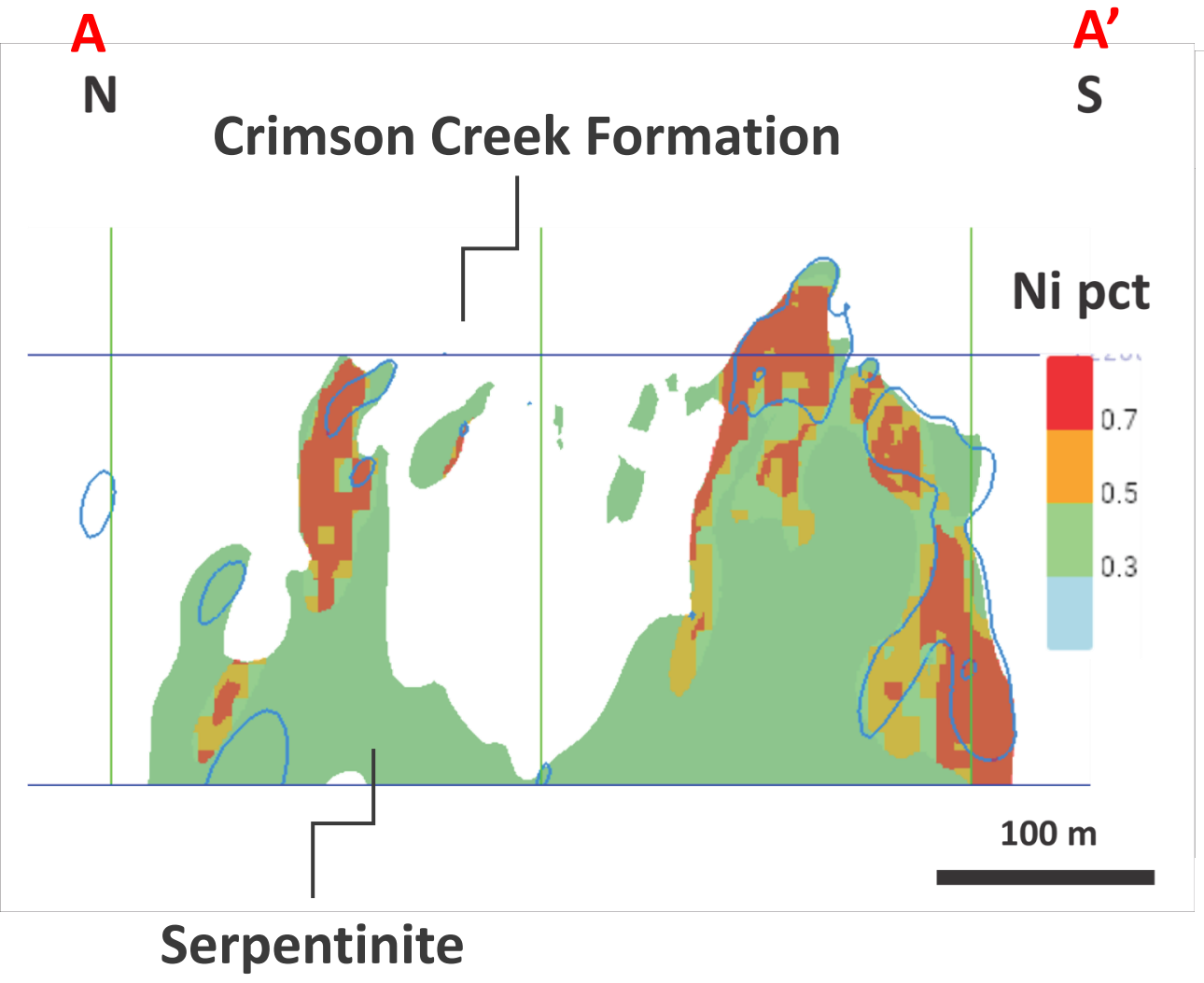
- Nickel sulfides in serpentine
- Serpentinized ultramafic

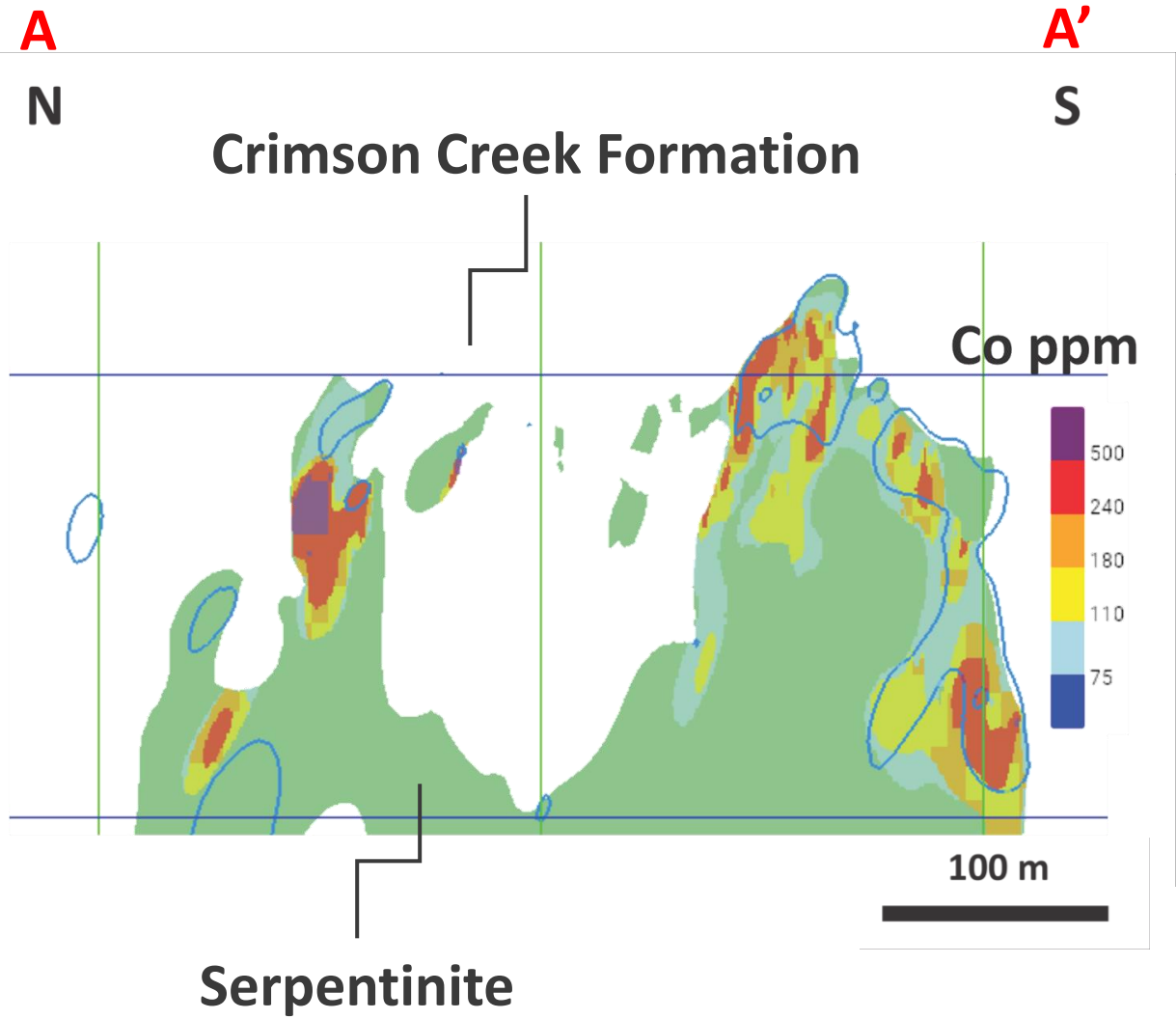
Neoproterozoic

Crimson Creek Formation

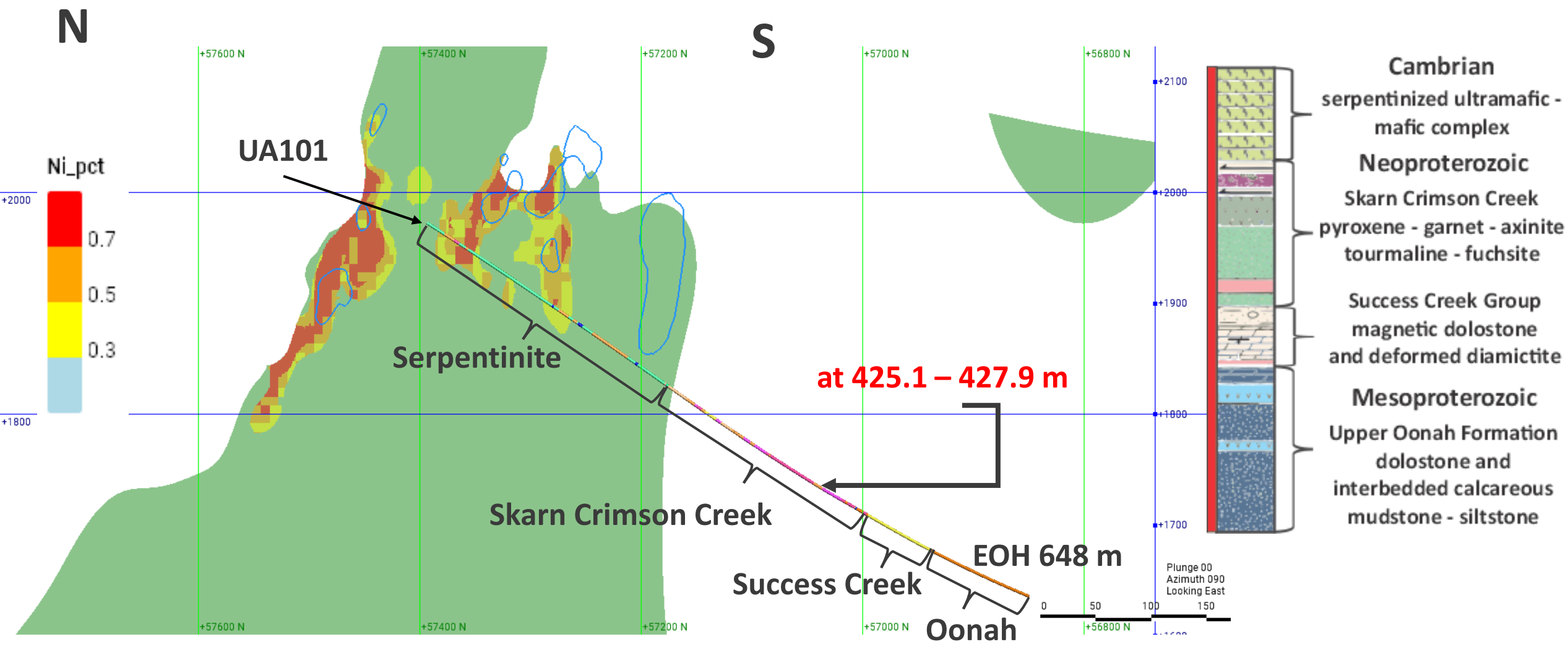
- Massive graded, lithic greywacke, phlogopite - biotite alteration
- Volcaniclastic breccia, actinolite - diopside alteration
- Laminated siltstone
- Laminated - black shale
- Axinite Skarn

Avebury — Nickel and cobalt mineralization in serpentinized ultramafic



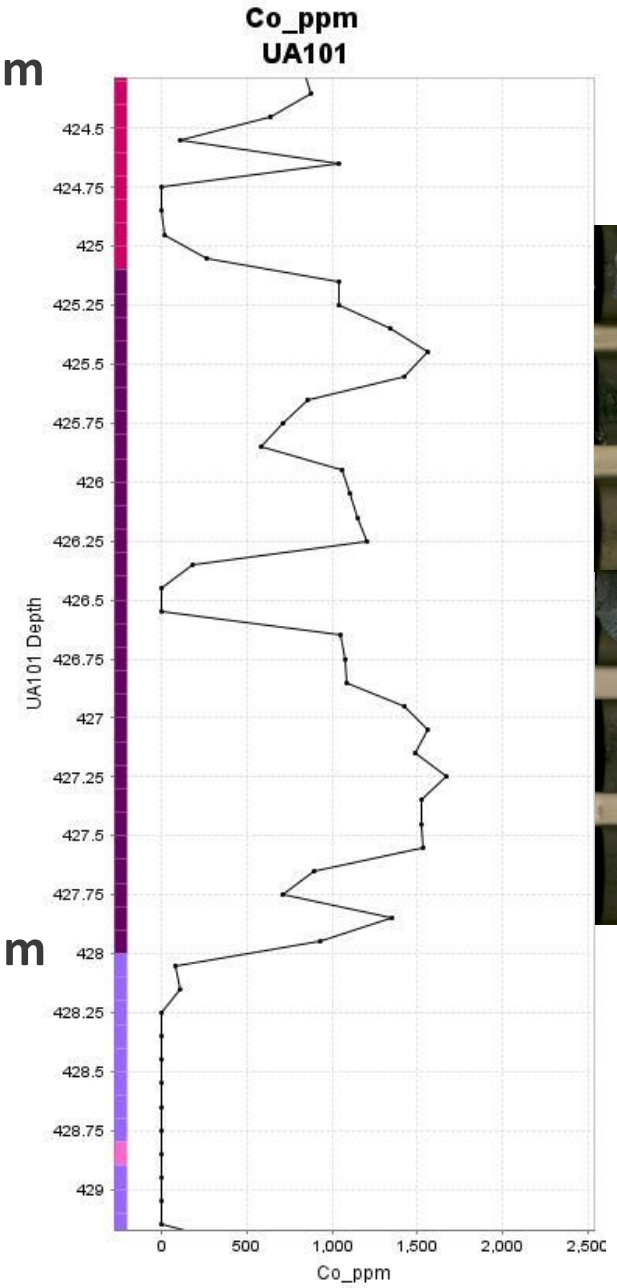


Avebury — Stratigraphy



Avebury — UA101

424.5 m



428.0 m

425.0 m

428.5 m

Low in Sr and Y

Low in Ni

High in Cr

Mineralization in Crimson Creek

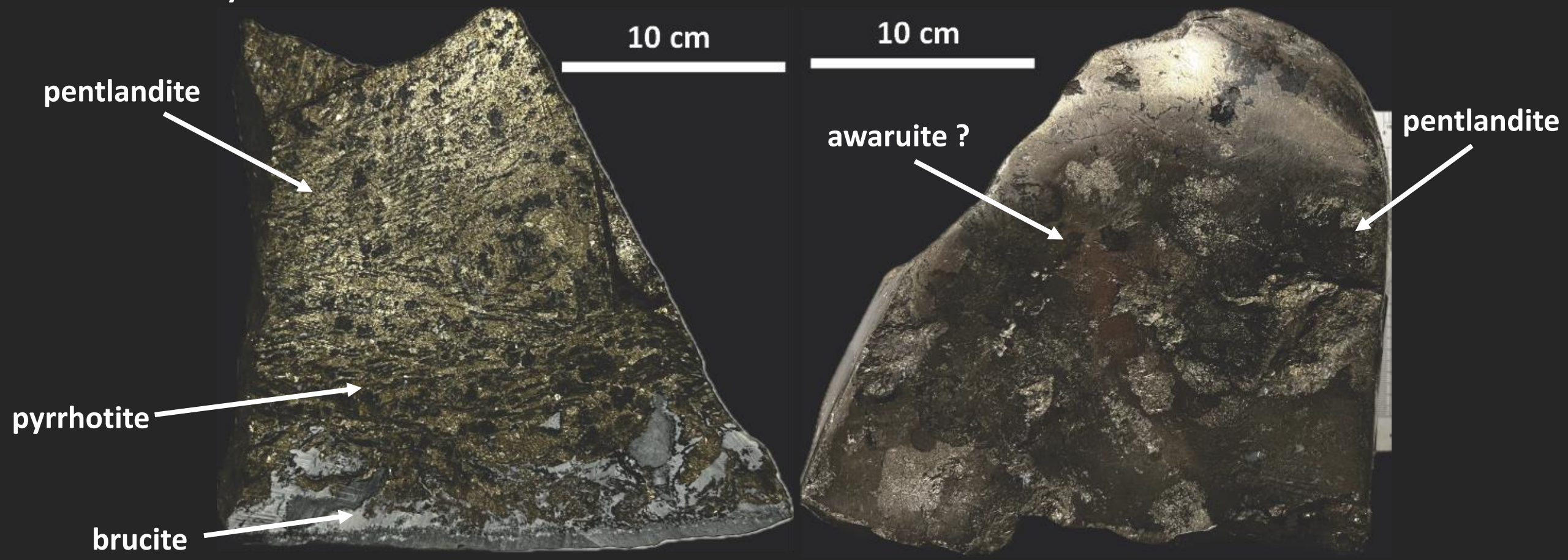
UA077: North Viking
Ni: 1068 ppm ICP @ 79.85 to 81.15

Mineralization — Sulfides and arsenides

The mineralization hosted in the Ultramafic – mafic Complex

Ore type 1: Massive nickel sulfide

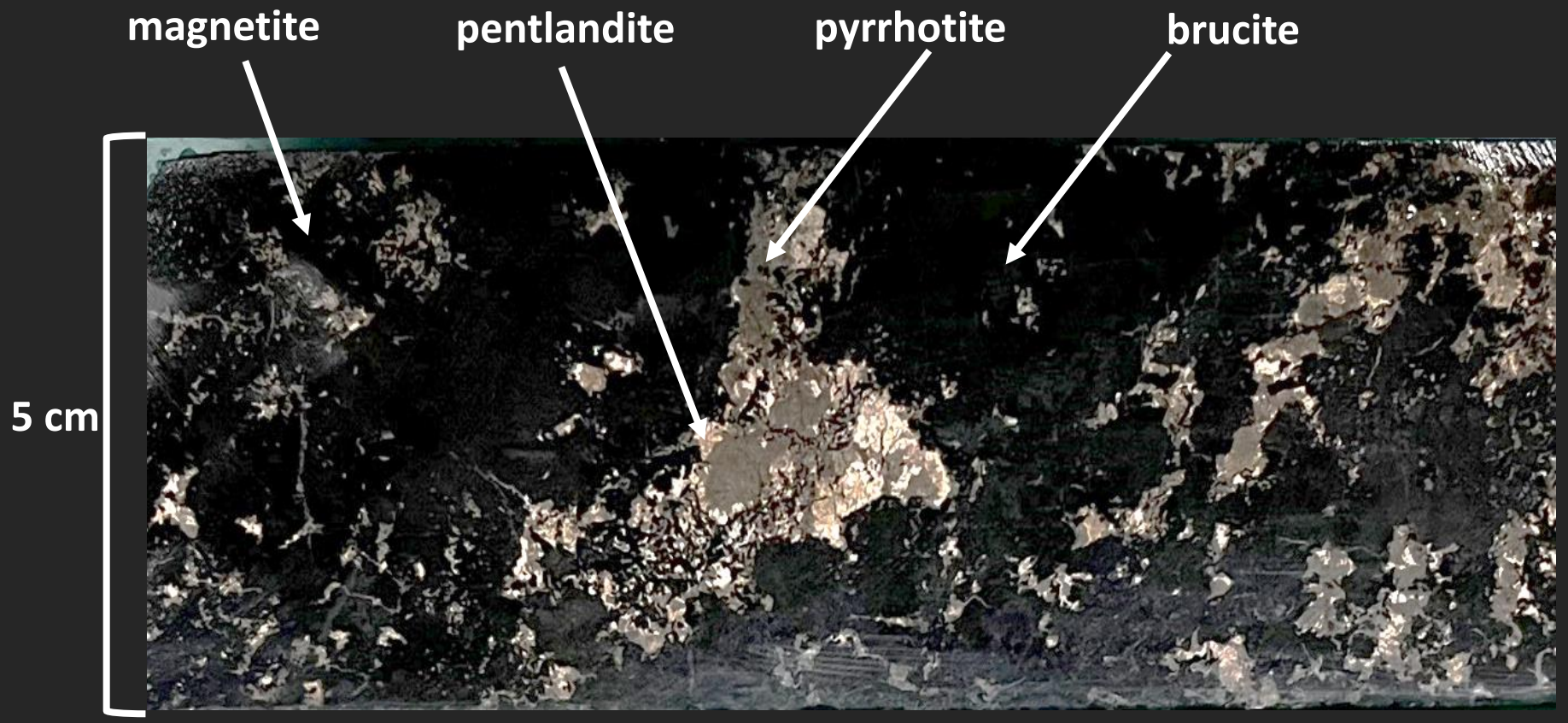
North Avebury



Mineralization — Nickel Sulfides

Ore type 2

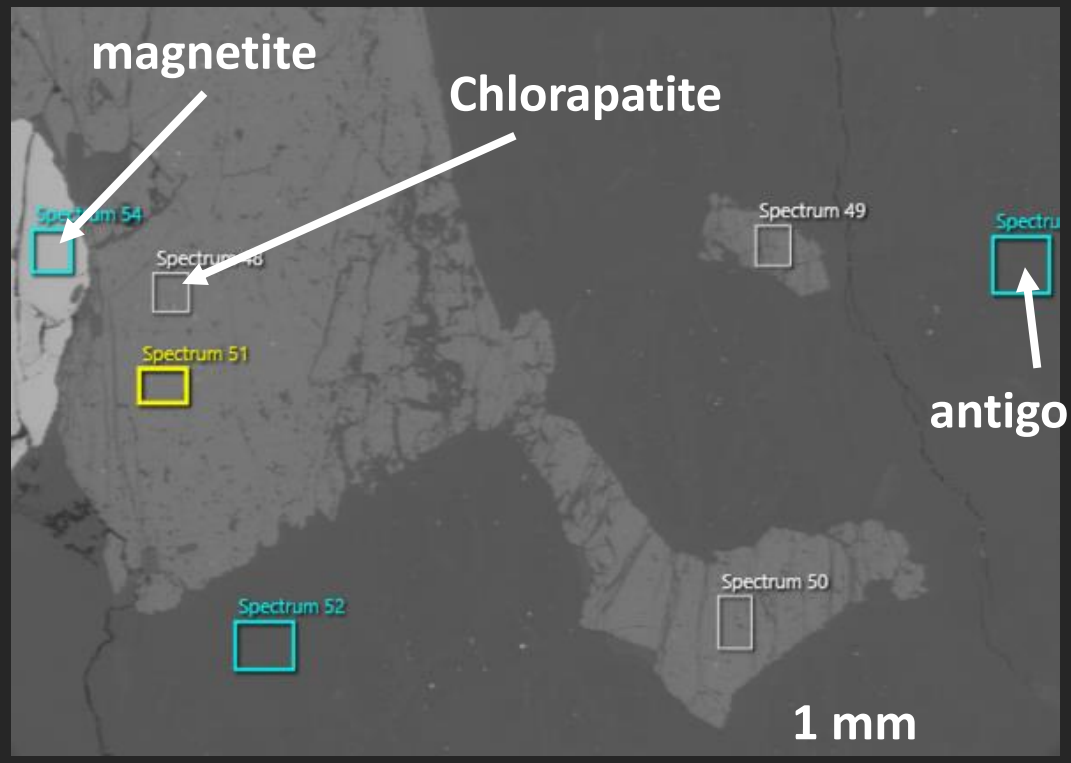
Magnetite – rich serpentinite: magnetite + antigorite + brucite



Mineralization — Nickel Sulfides

Ore type 2

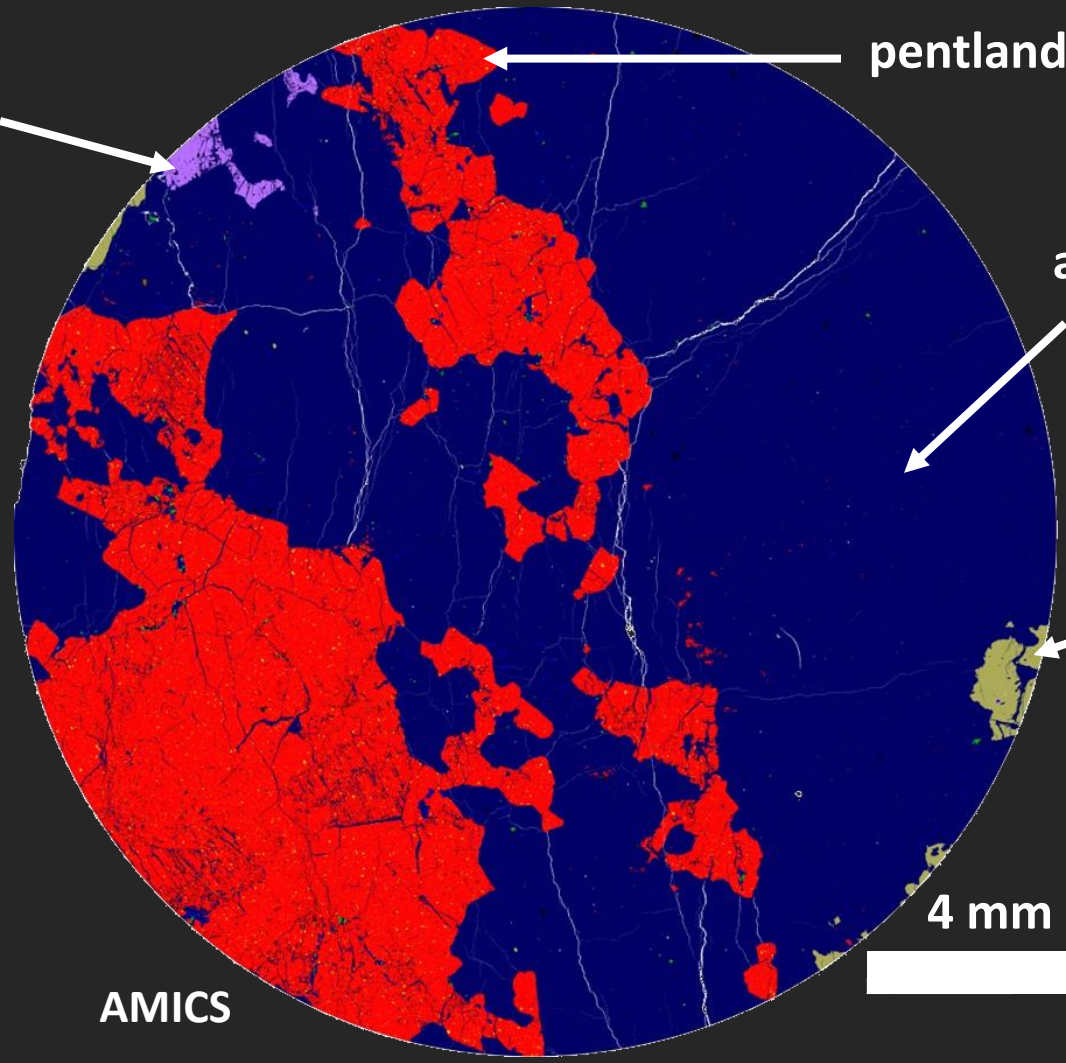
Magnetite – rich serpentinite: magnetite + antigorite + brucite



BSE

Apatite
374 ± 14 Ma
U-Pb

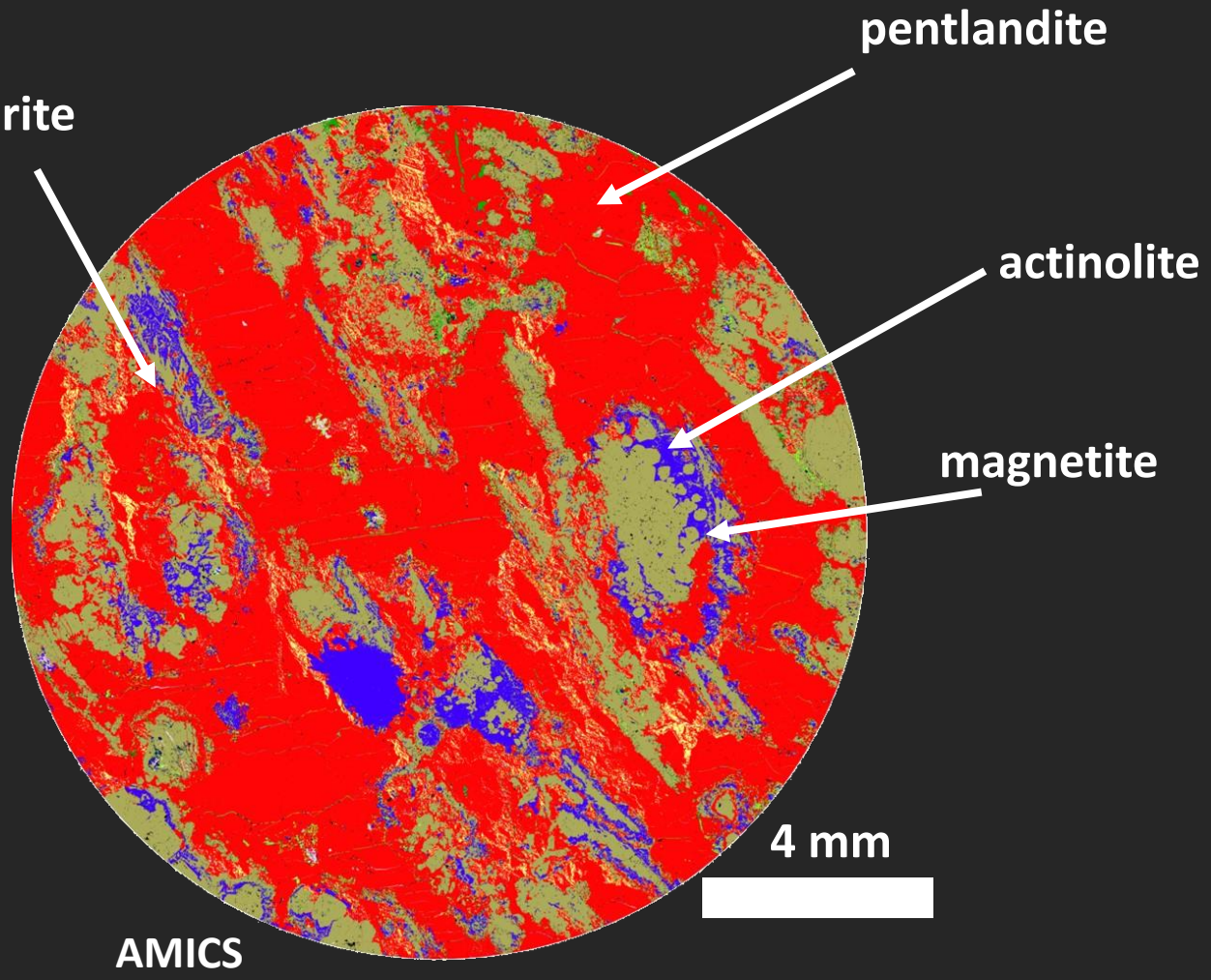
antigorite



AMICS

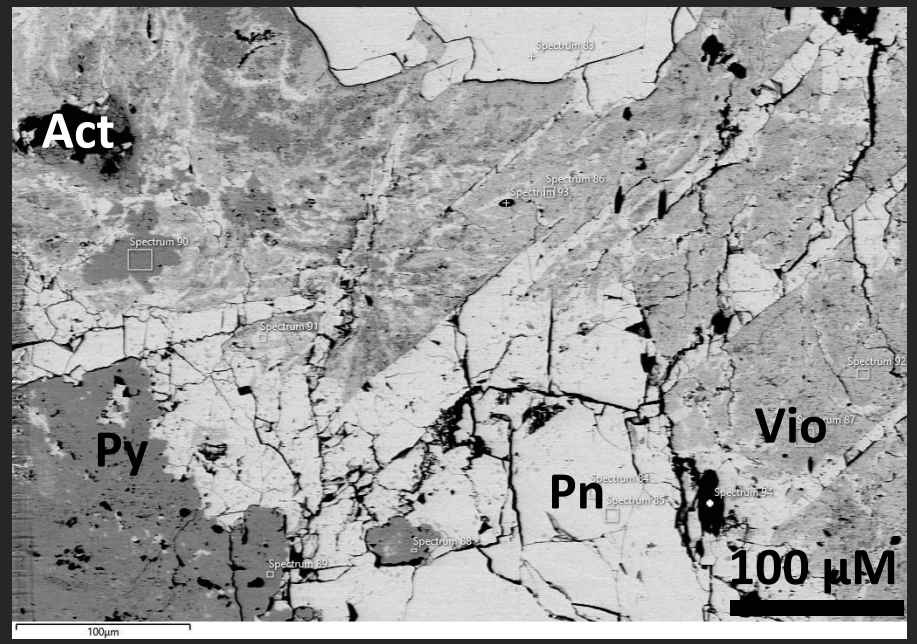
Mineralization — Nickel Sulfides

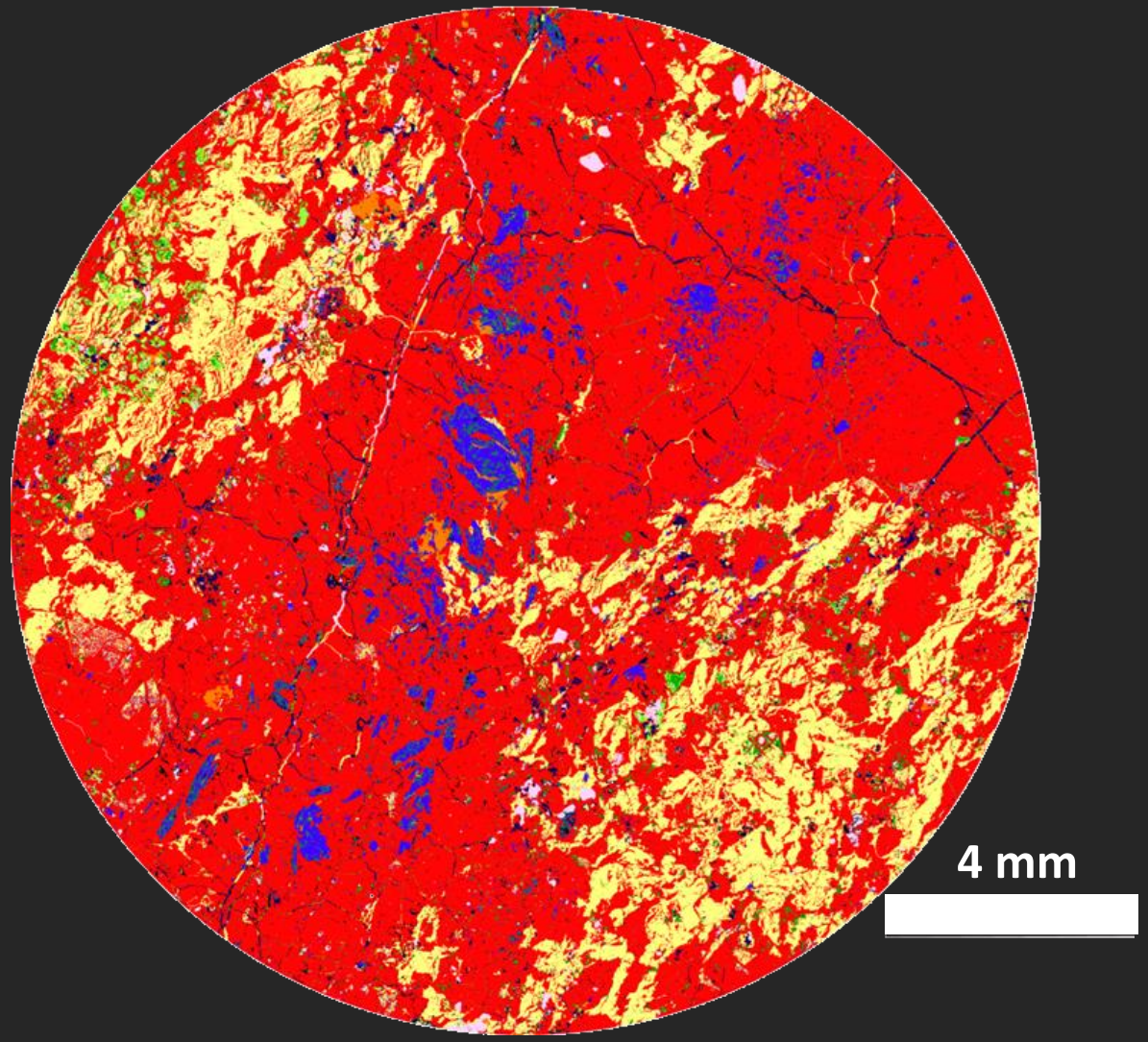
Ore type 1
Deformed massive nickel sulfide



Mineralization — Nickel Sulfides

Ore type 3: massive nickel sulfide in Crimson Creek
UA092 @ 32.10- 32.50

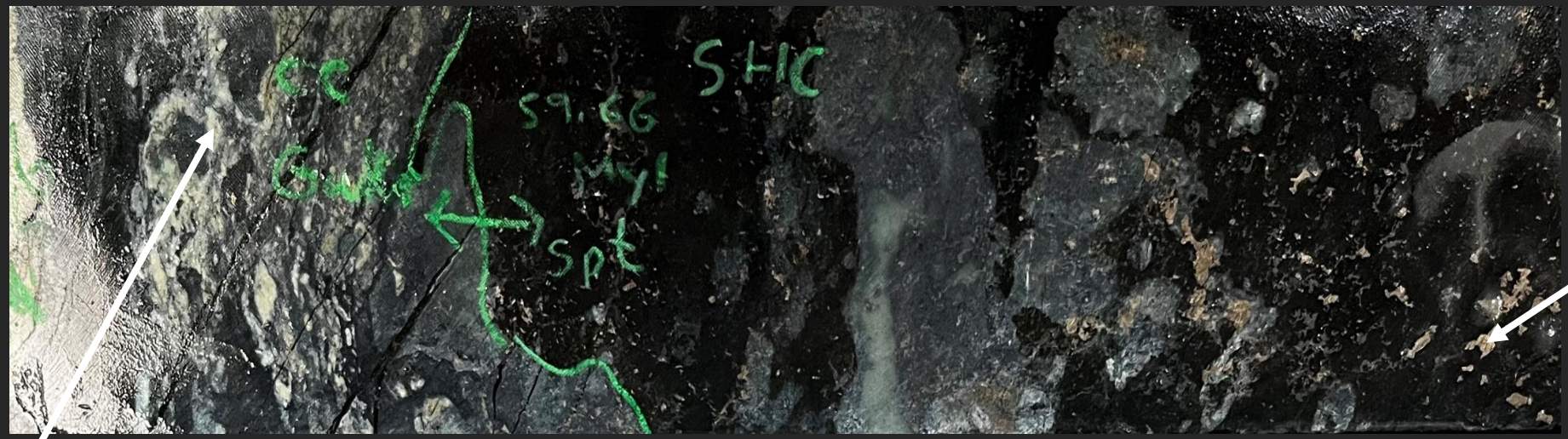




Skarn — serpentinite mineralization

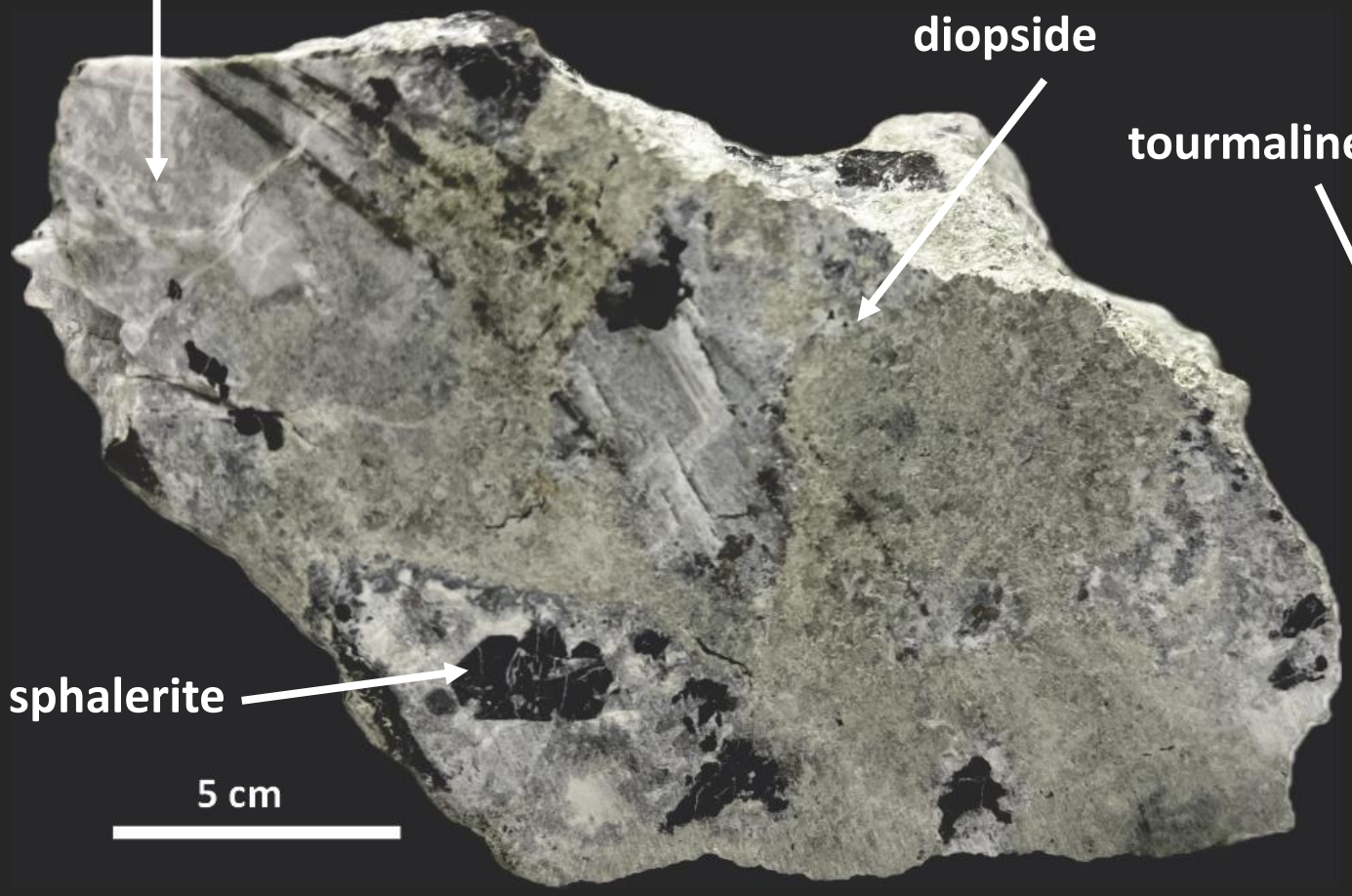
Ore type 4

Skarn serpentinite: Metasomatized serpentinite (hydrous retrograde skarn phase): lizardite -tremolite + diopside + albite + magnetite - wollastonite

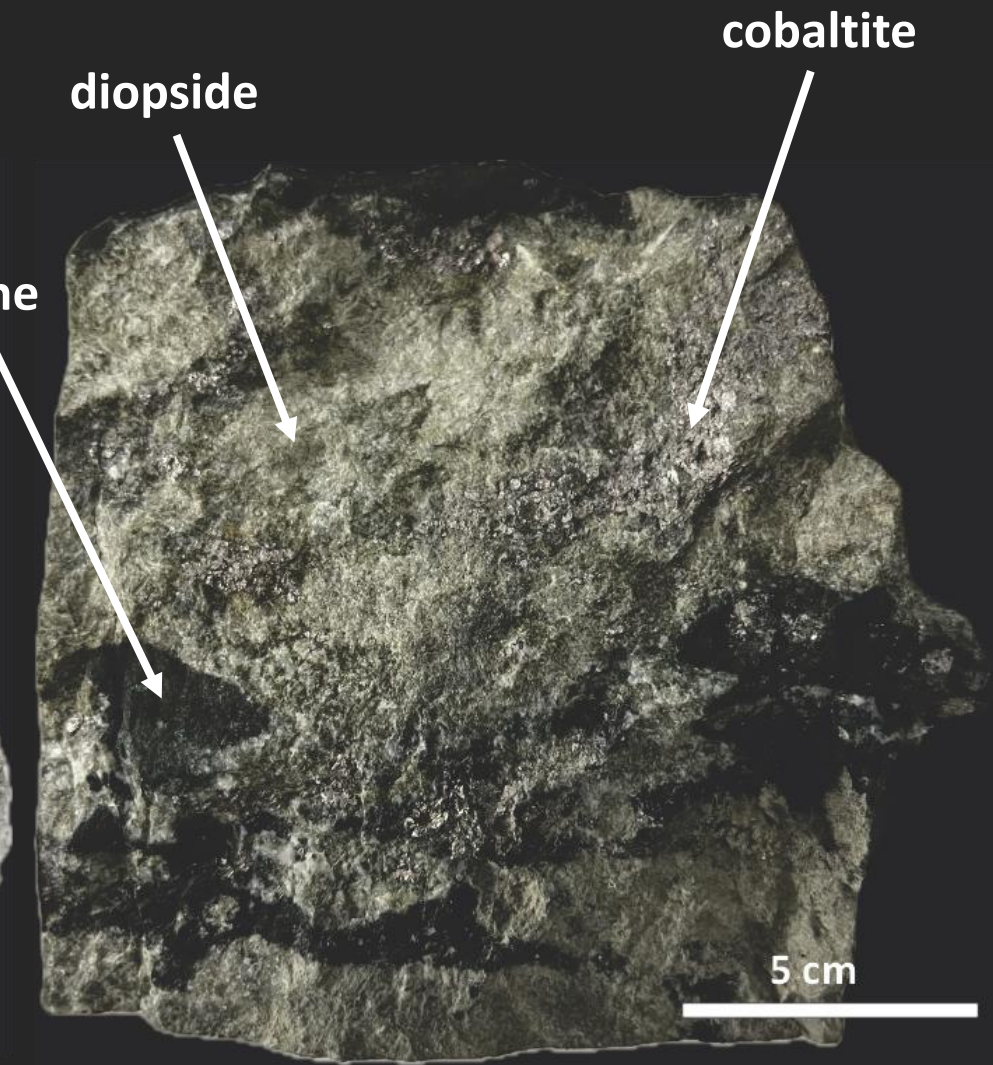


Skarn mineralization

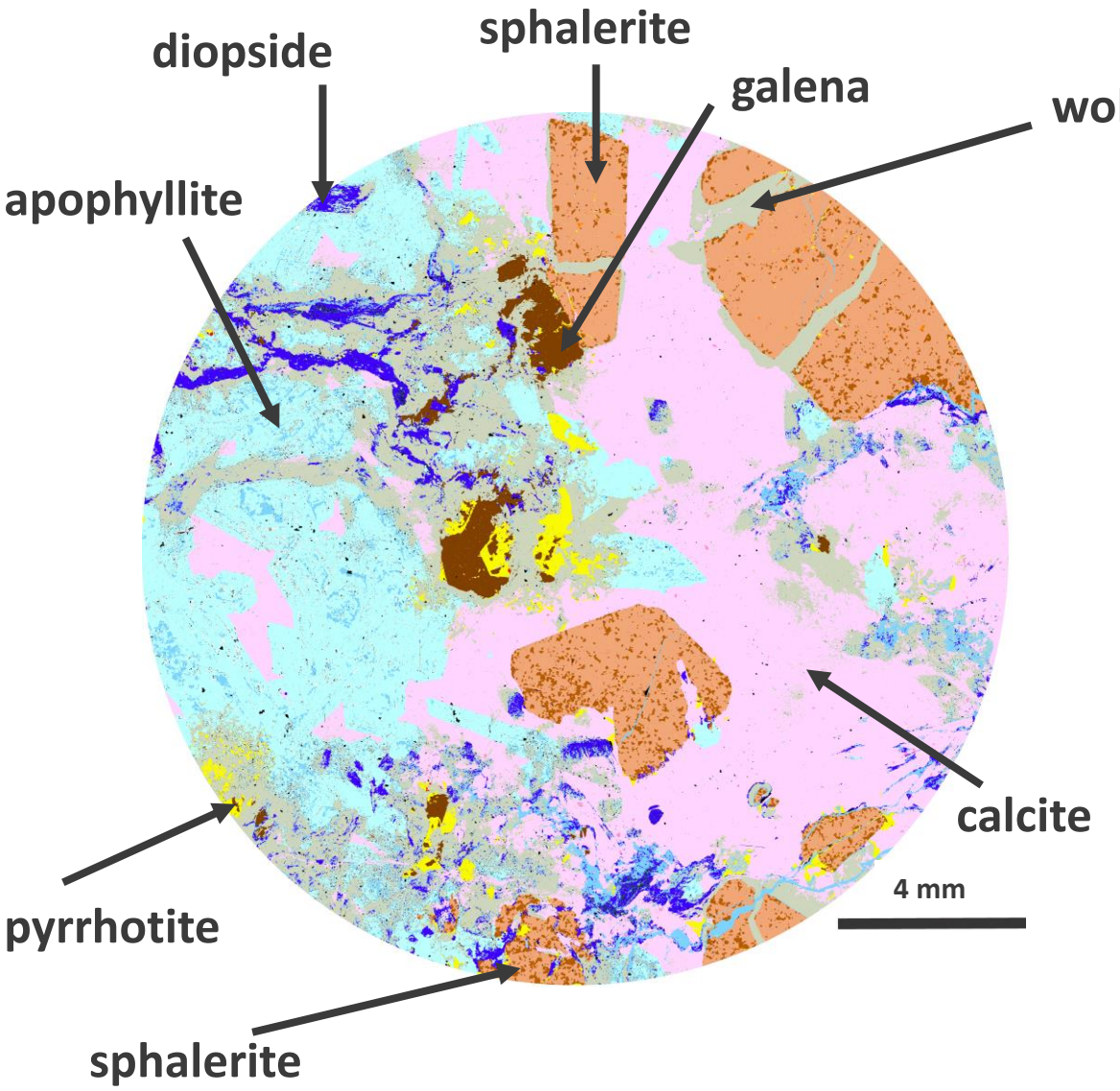
Calcslicate Skarn: Diopside, wollastonite, rich iron sphalerite, calcite

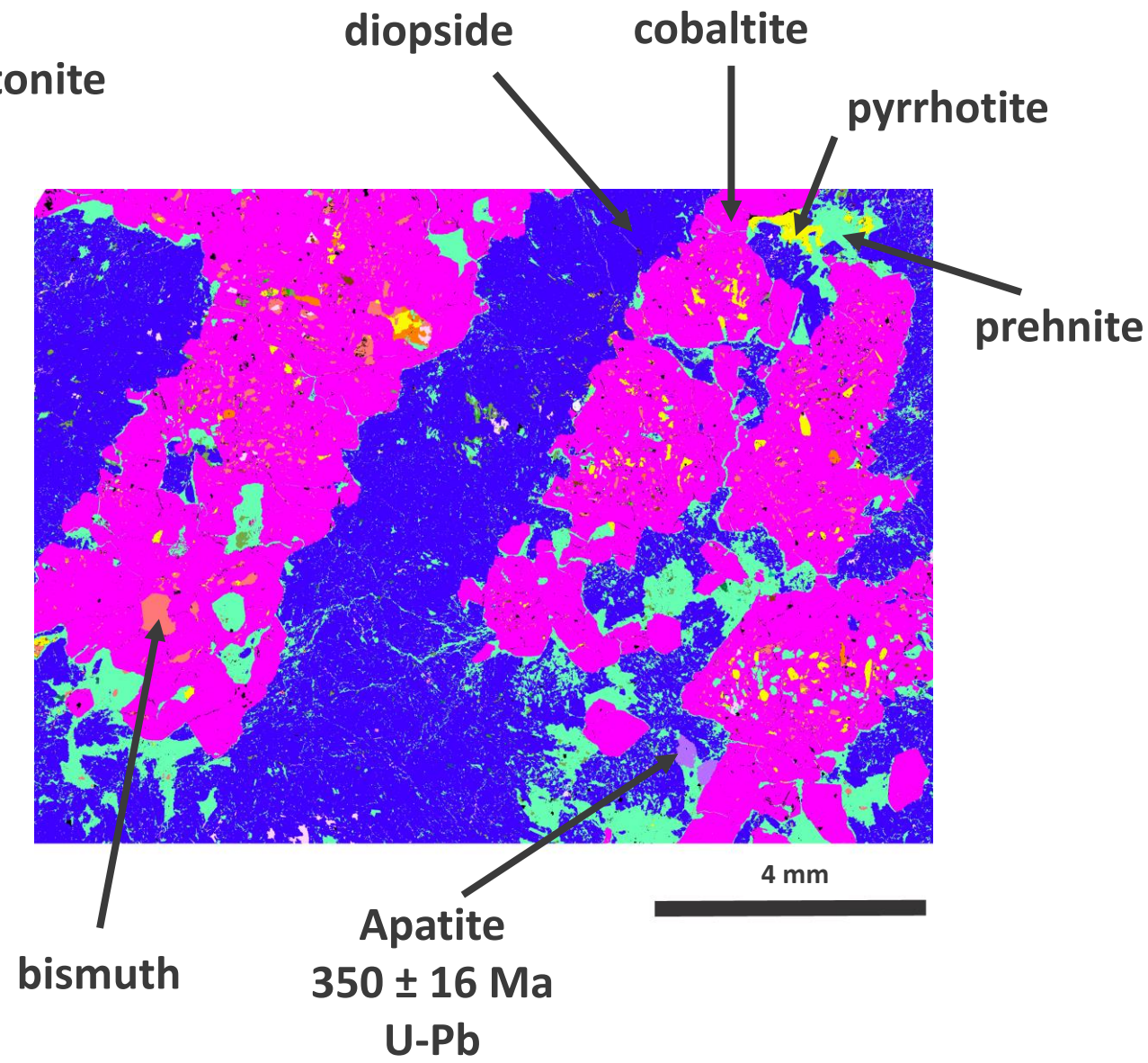


Skarn in Crimson Creek volcaniclastic sequence: Axinite Skarn: Axinite (Mg) + tourmaline - pyroxene - ludwigite



Mineralization — Skarn

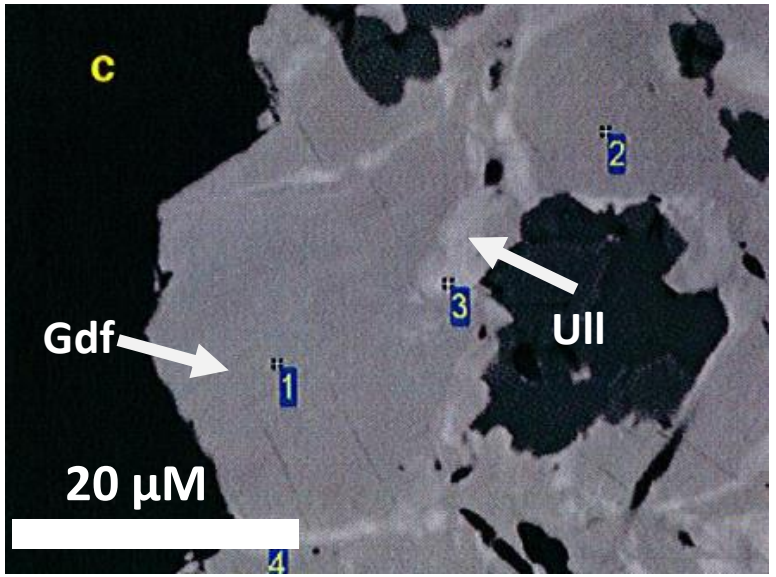


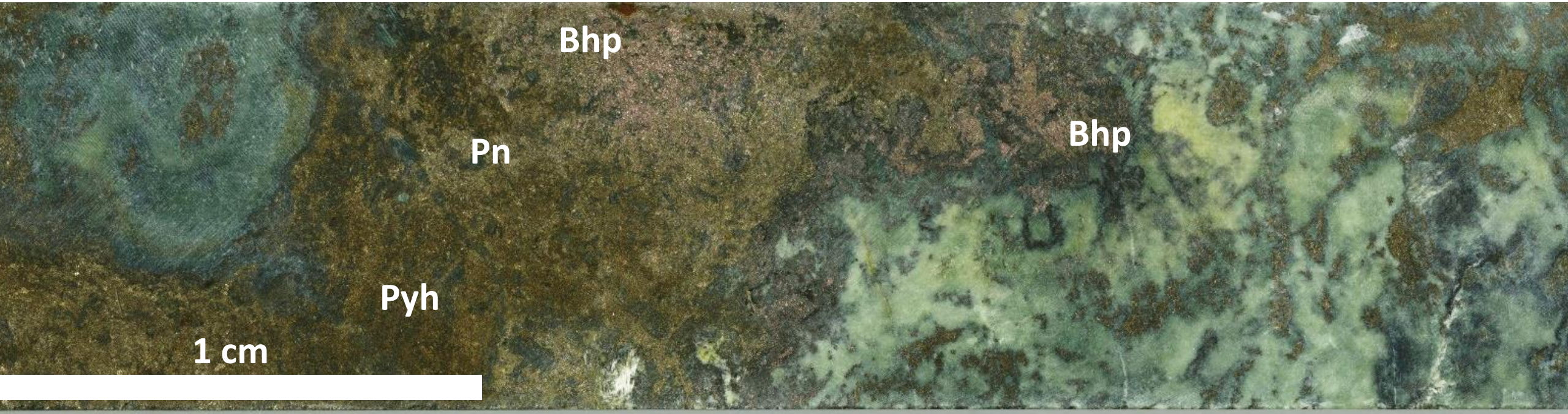


Metasomatism in Avebury

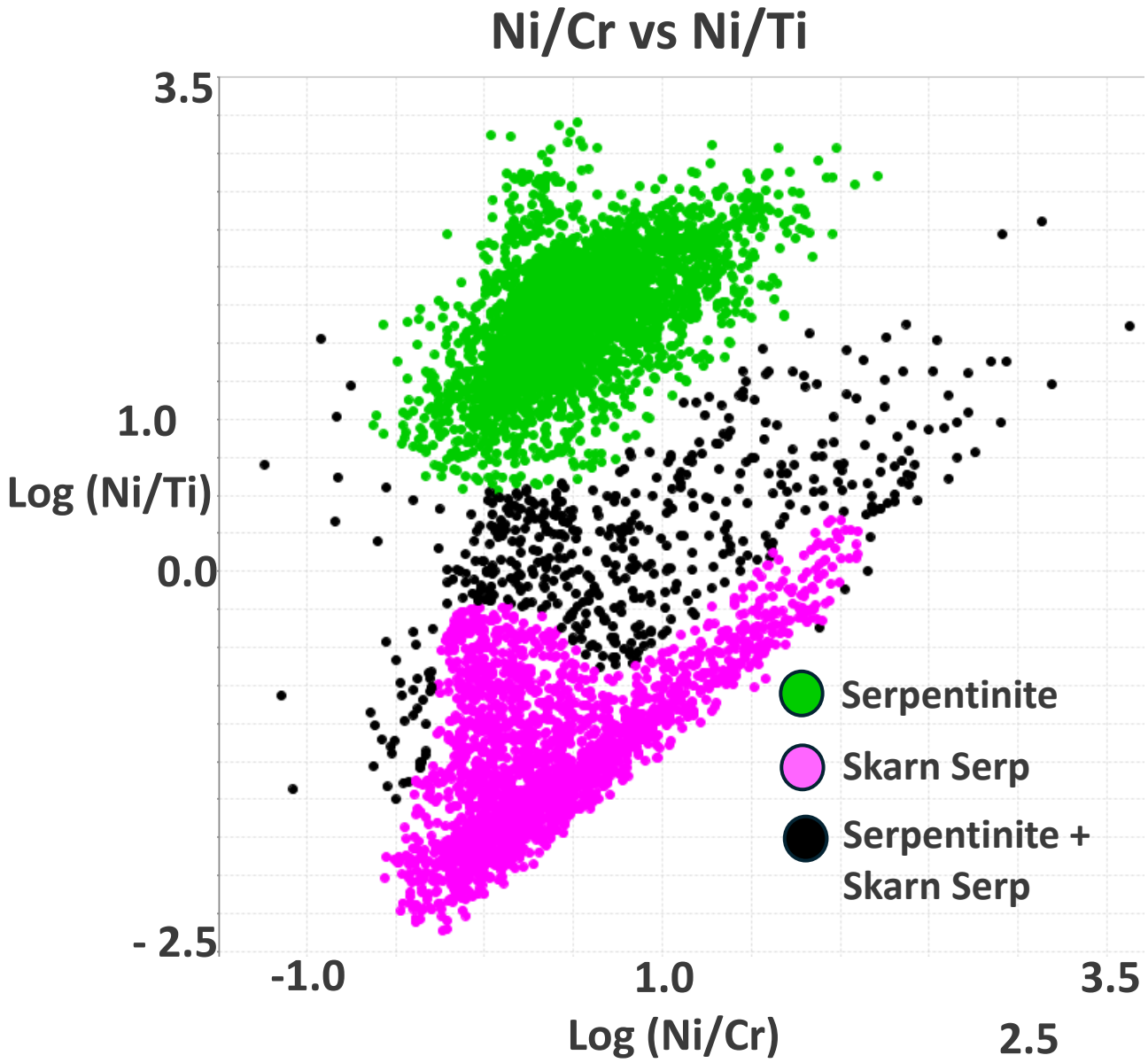
Gersdorffite (NiAsS)
Ulmannite (NiSbS)

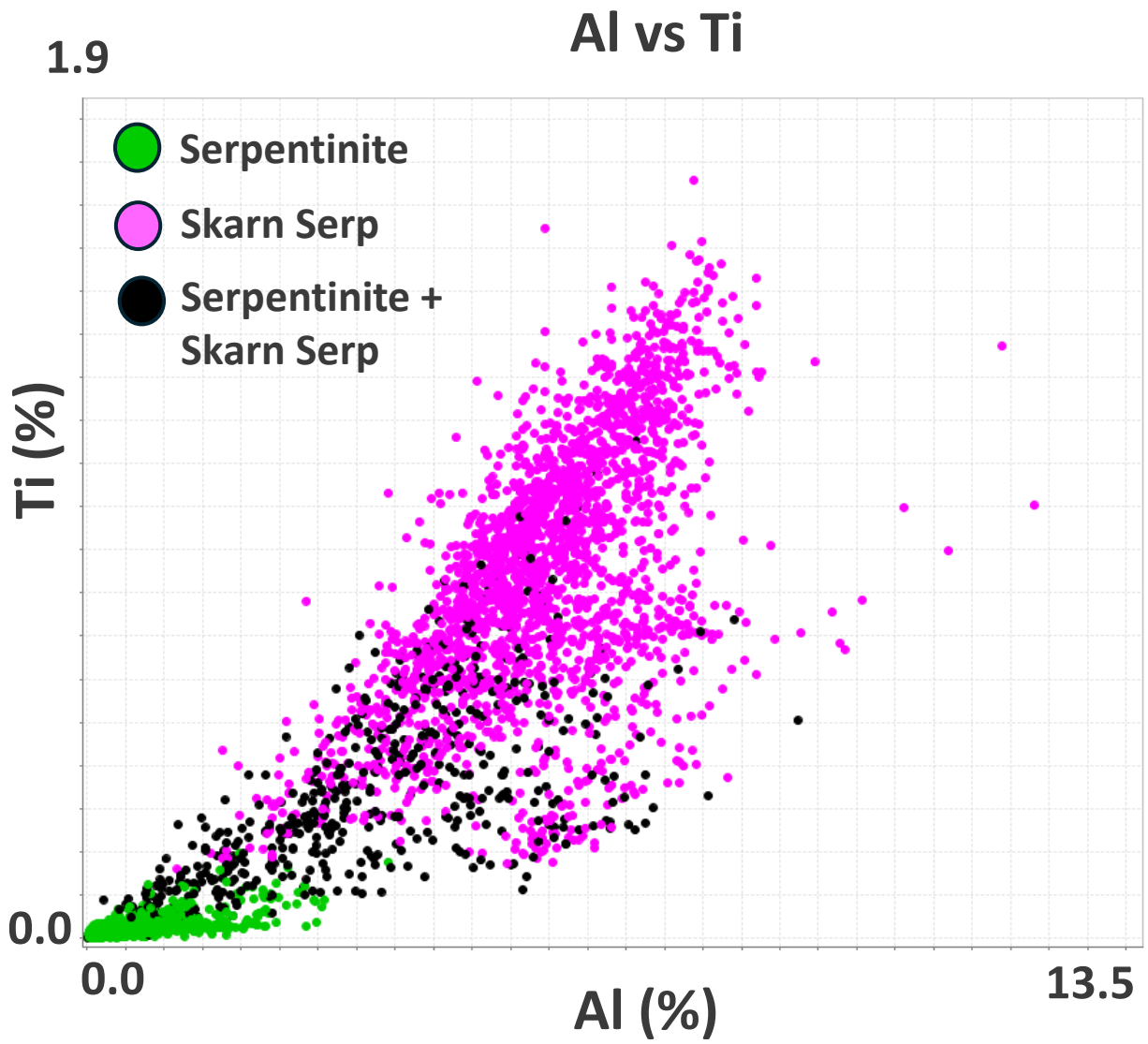
Breithauptite (NiSb) in hydrothermal veins associated with other nickel sulfides and nickel - cobalt arsenides



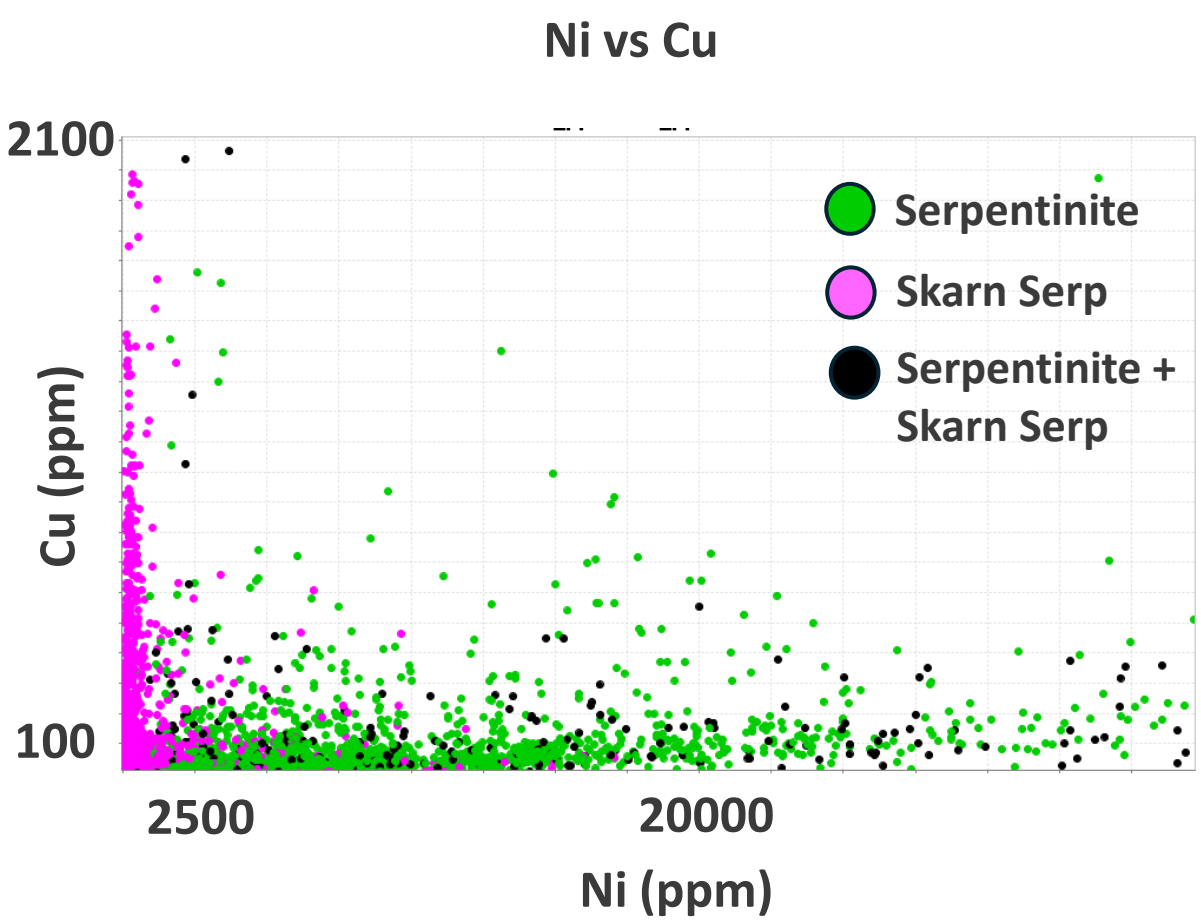


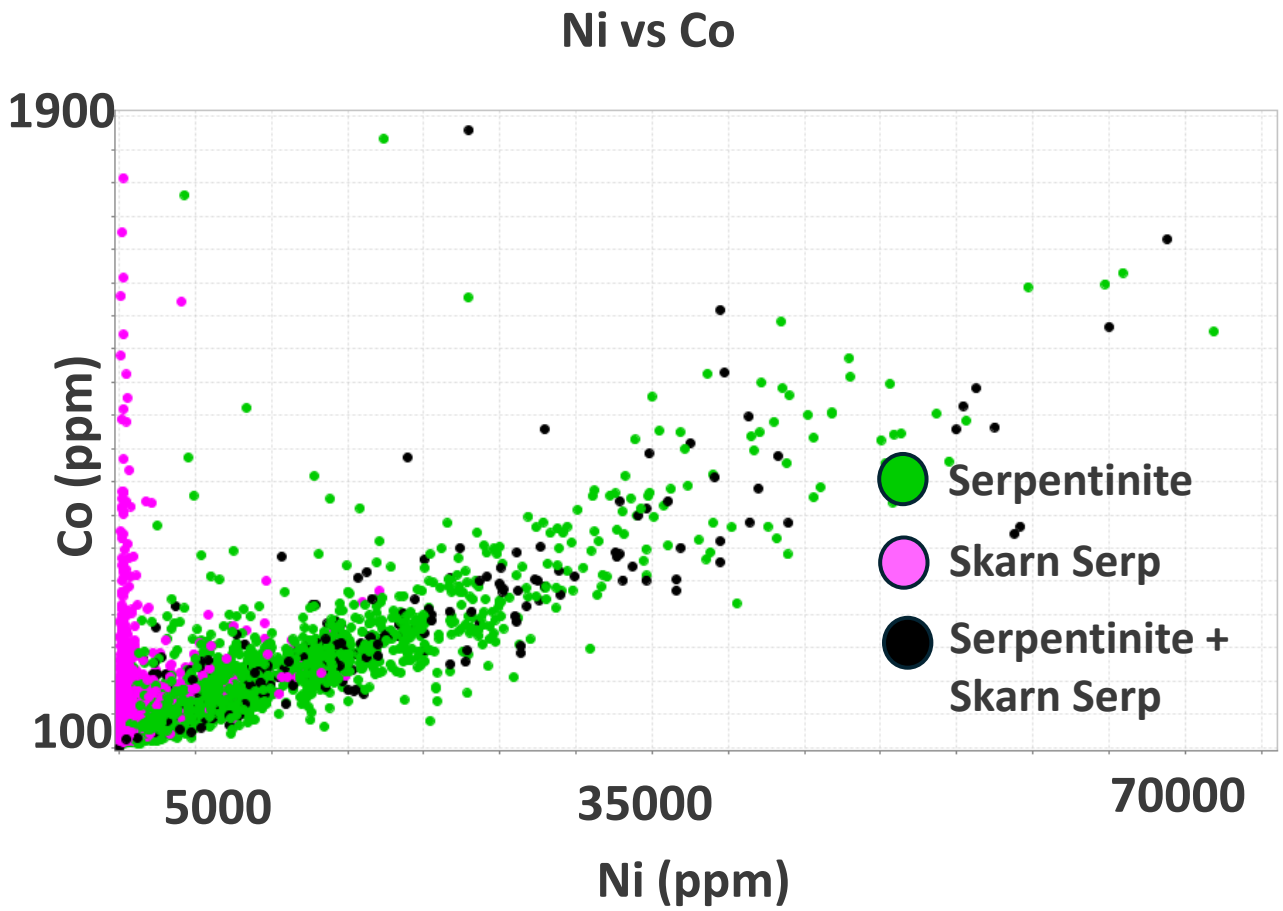
Whole rock assay geochemistry



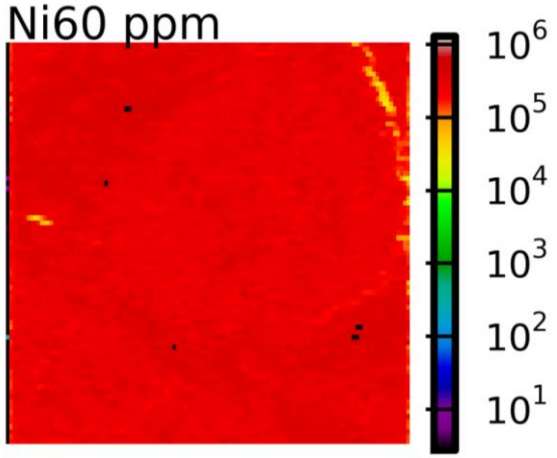


Whole rock assay: Ni vs Cu and Co

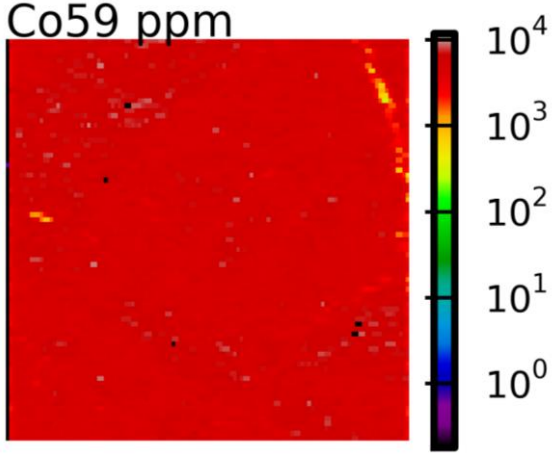




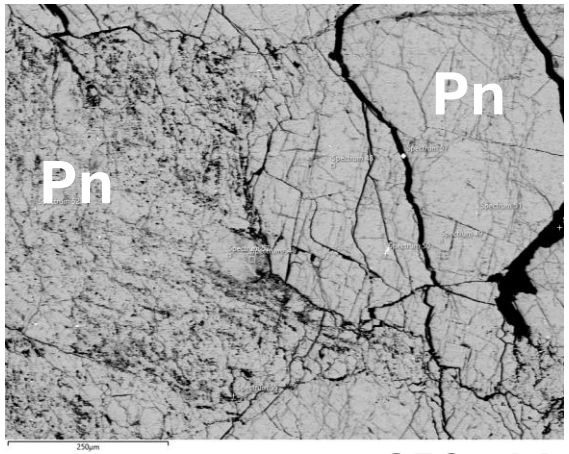
LA-ICP-MS trace-element mapping in NiS



704855 ppm, max Ni

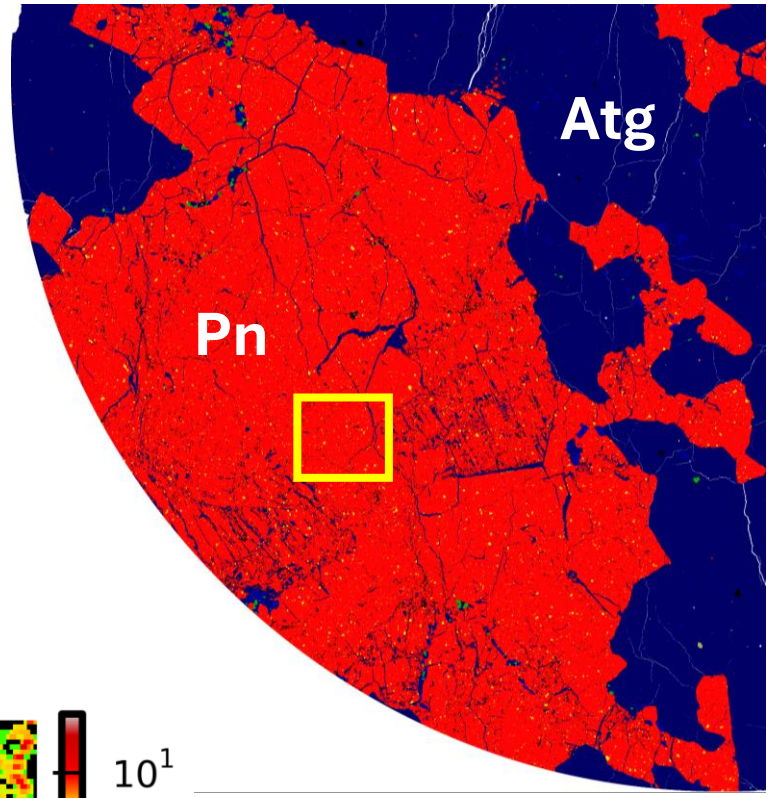


9695 ppm, max Co



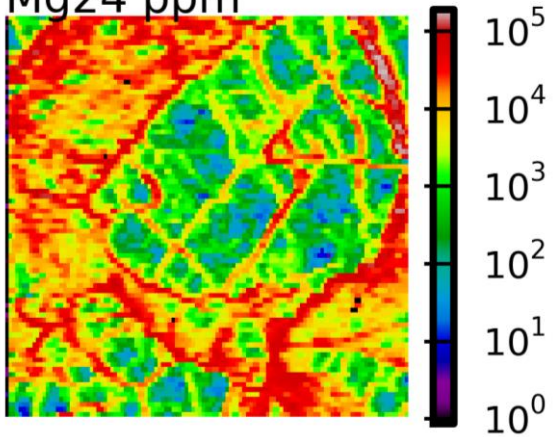
BSE

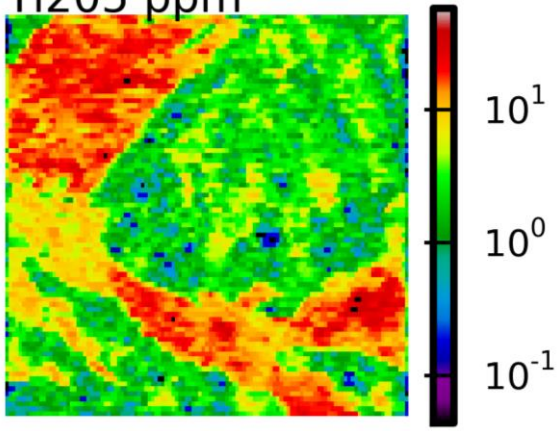
250 µM

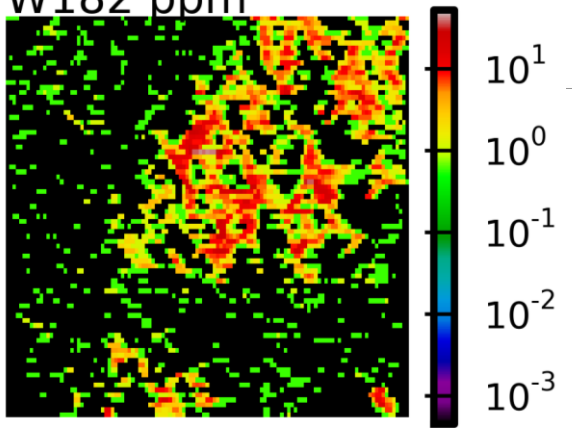


4mm

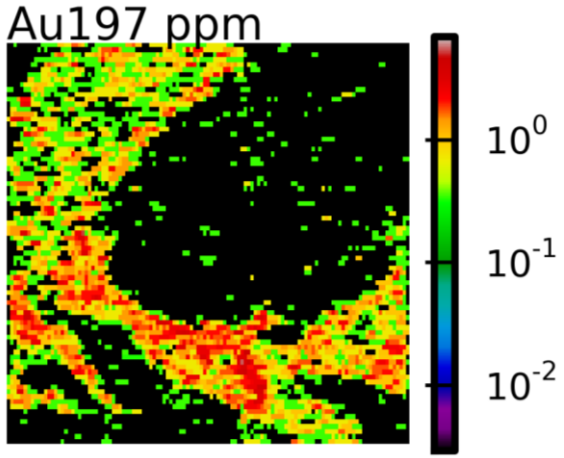
AMICS



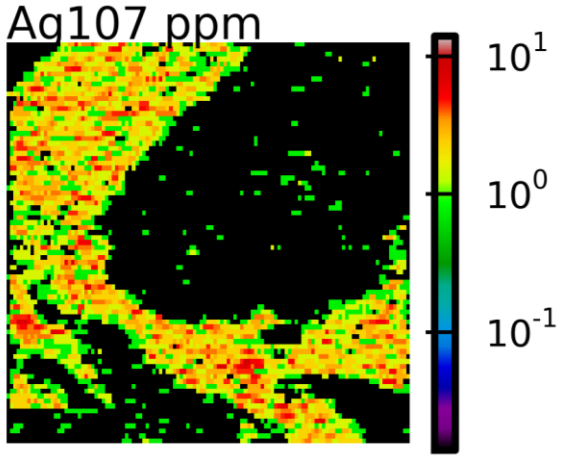




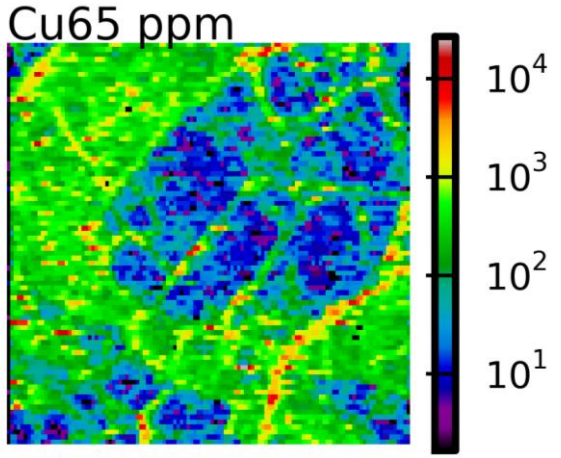
LA-ICP-MS trace-element mapping



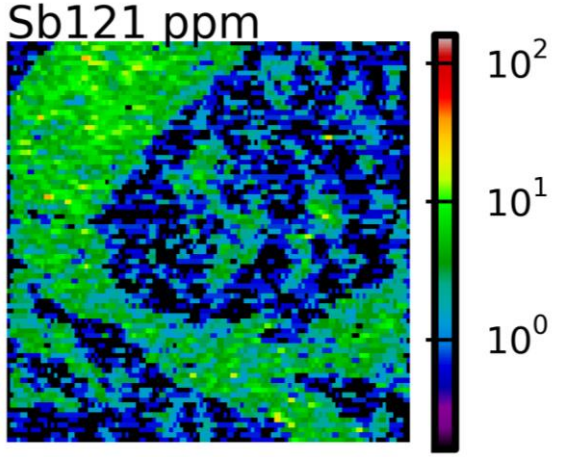
5.6 ppm, max Au

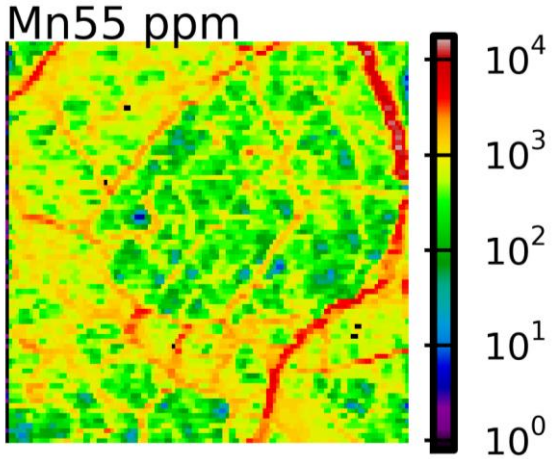


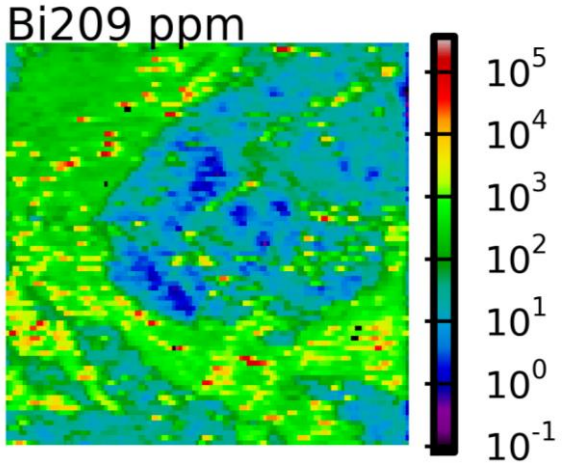
8.4 ppm, max Ag

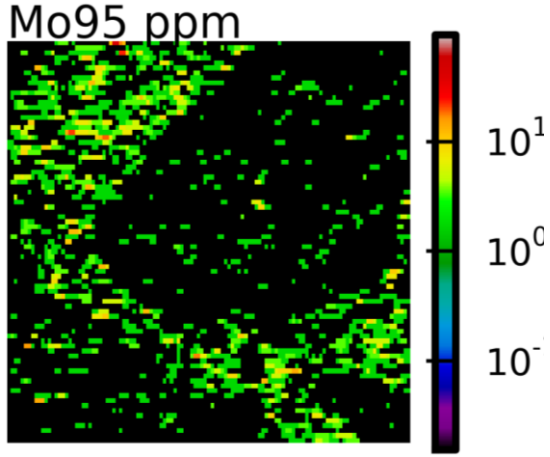


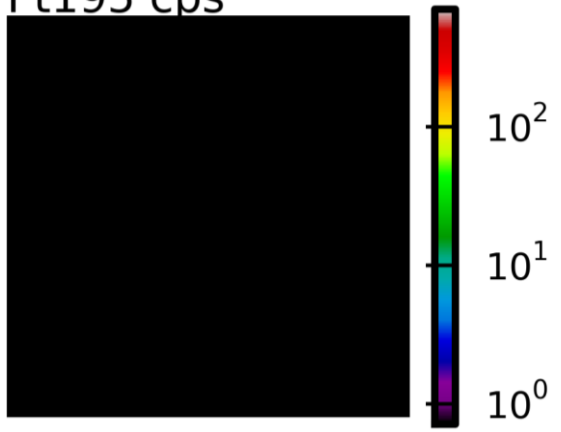
24220 ppm, max Cu



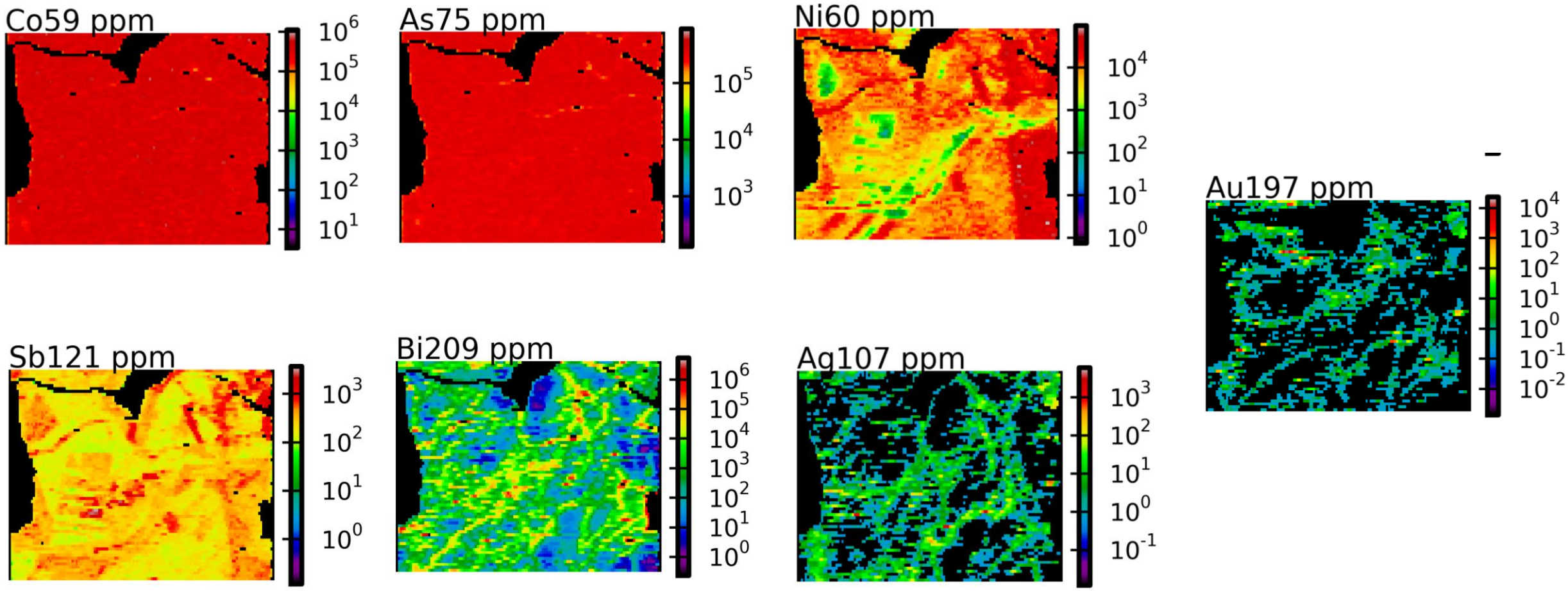




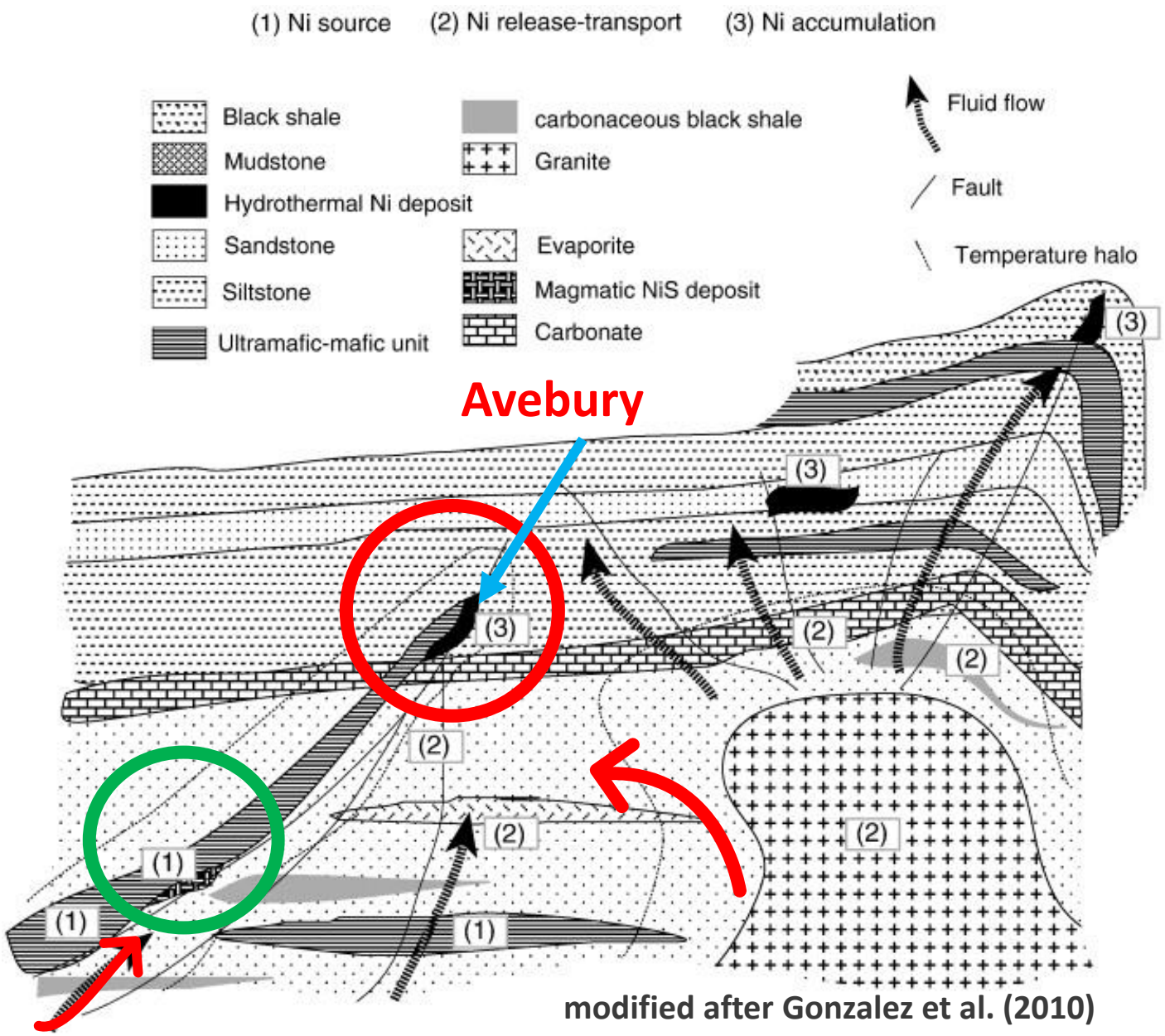




LA-ICP-MS trace-element mapping in CoAs



Possible genetic model for Avebury

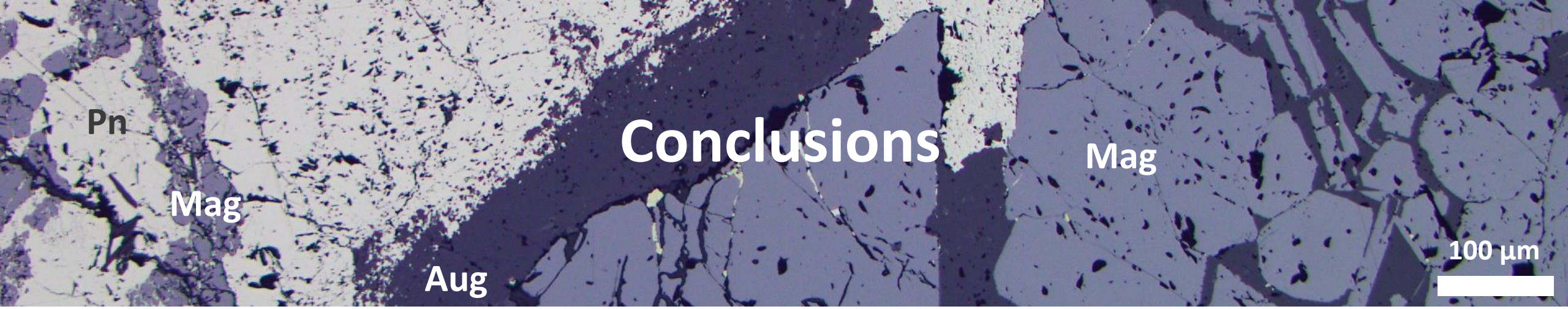


modified after Gonzalez et al. (2010)

NiS is the result of metasomatism of mafic-ultramafic rocks

NiS mineralization is a product of low-temperature alteration of magmatic Ni-Cu-PGE sulfides

NiS mineralization produced by remobilization from magmatic dikes and sills from Crimson Creek



Conclusions

Whole rock geochemistry, trace elements and ICP-MS mineral maps suggest that Avebury is a hydrothermal remobilized from a magmatic source

Avebury rocks and mineralization display strong metasomatism generated from the Heemskirk granite fluids

Co-Ni arsenides have formed where the retrograde granite-derived fluids have penetrated existing nickel and cobalt sulphides

Ultramafic sills and dikes from Crimson Creek show anomalous values of Ni-Co

Questions?

Mt Agnew,
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