Scapolite as a Vectoring Tool Towards Mineralization: A Case Study from the Mary Kathleen Domain, Mt Isa Inlier

Alexander Edgar, Ioan Sanislav

Part of GSQ funded Magma Fertility Project

Overview

- Study Aim
- Regional Geology and Field Area
- Petrography
- Geochemistry
- Explanations and Conclusions

Scapolite as a fluid tracer

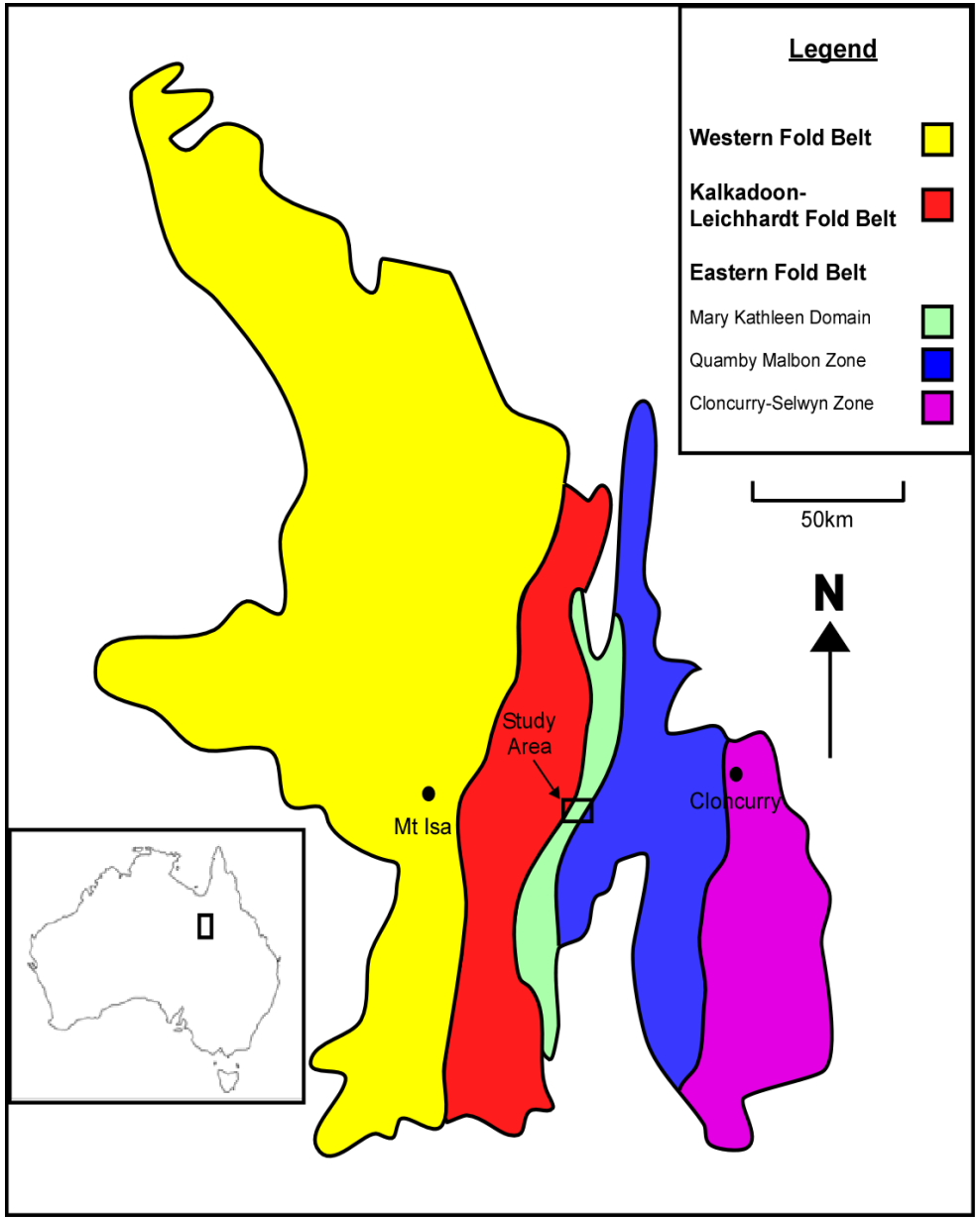
- Is stable over a wide range of metamorphic conditions
- Its widespread in the Mary Kathleen Domain
- Can incorporate a wide range of volatile components: CO_3, SO_4, Cl, H_2O, F, Br
- The partition coefficient for Cl/Br between scapolite and co-existing fluid is ~1 (Pan and Dong, 2003)
- Can incorporate trace amounts of metals (Cu, Zn, Zr, Pb, Ti, Fe, Mn) in its structure (Christy and Gatedal, 2005; Shaw, 1960)

Aims and Objectives

- Aims:
  - To test if scapolite geochemistry changes with proximity to mineralization and thus can be used as a vectoring tool in exploration.
  - To test if scapolite geochemistry can indicate the presence of fertile fluids – (i.e. increased Cu content with proximity to ore zone).
  - To test if scapolite geochemistry indicates the presence of igneous fluids
- Objectives:
  - Categorize scapolite based on geochemistry and petrography.
  - Derive a genetic model for scapolite formation.
  - Derive a paragenetic sequence of scapolite formation relative to deformation and alteration.

Regional Geology

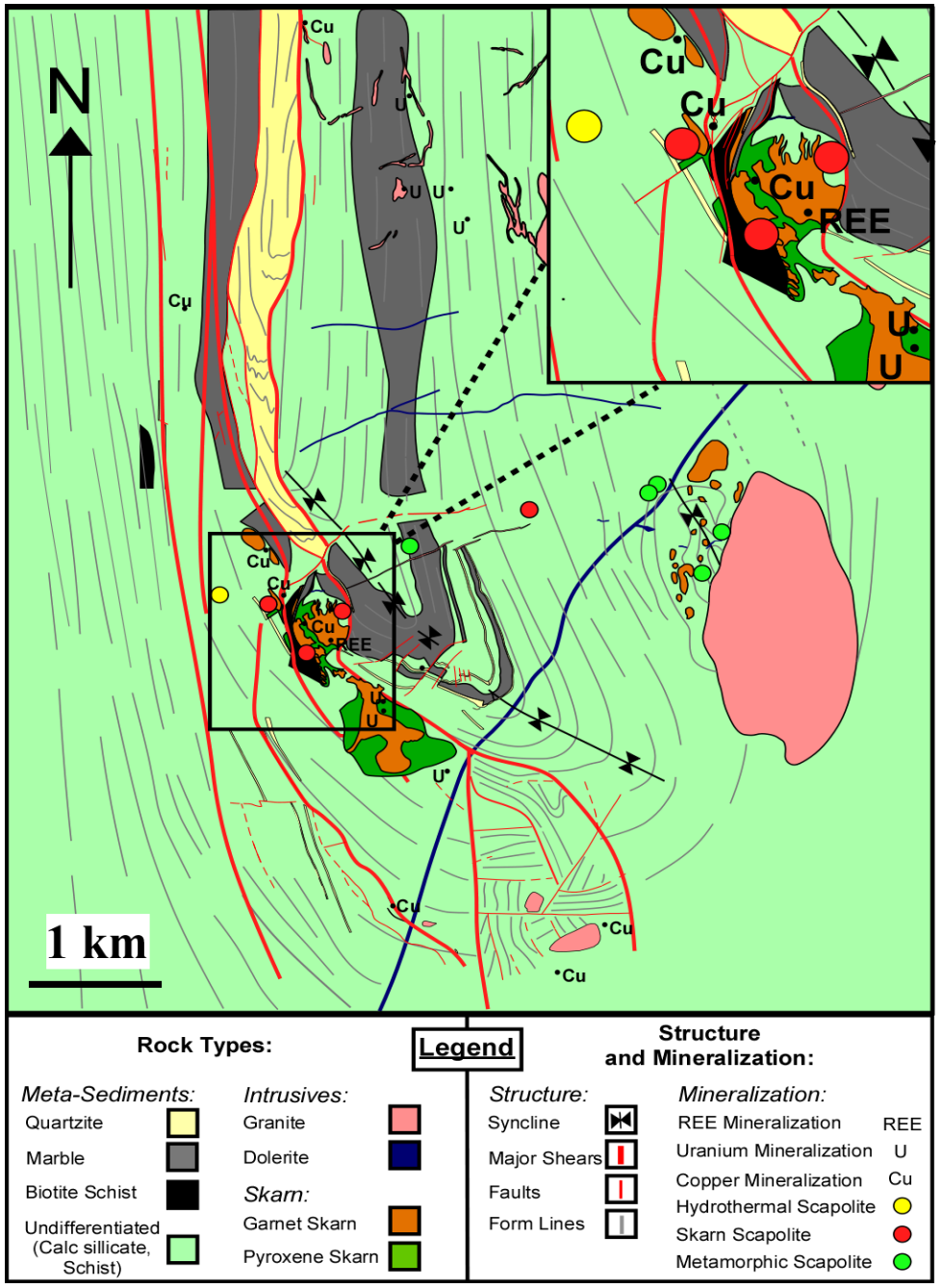
- Situated within the Mt Isa Inlier Eastern Succession
- Eastern Succession comprises Mesoproterozoic marine meta-sediments intruded by numerous igneous bodies
- Geologically active for at least 400 million years (1900-1500Ma)
- Study area located within the Mary Kathleen Domain



After Blake, 1987

Local Geology

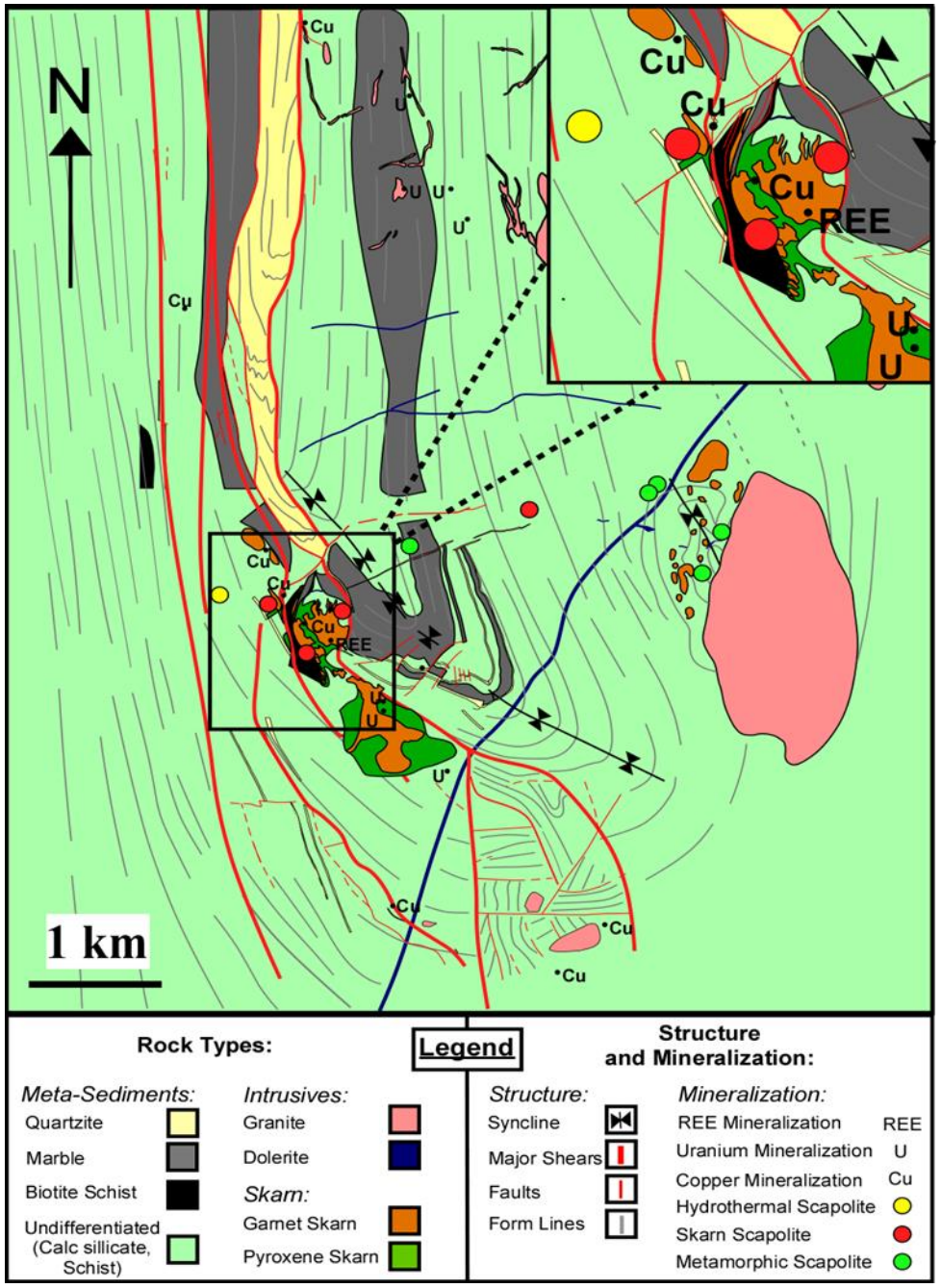
- Elaine Dorothy Deposit
- Mary Kathleen Syncline
- Burstall Granite
- Mary Kathleen Shear
- Sample Locations



Petrography

Scapolite paragenesis

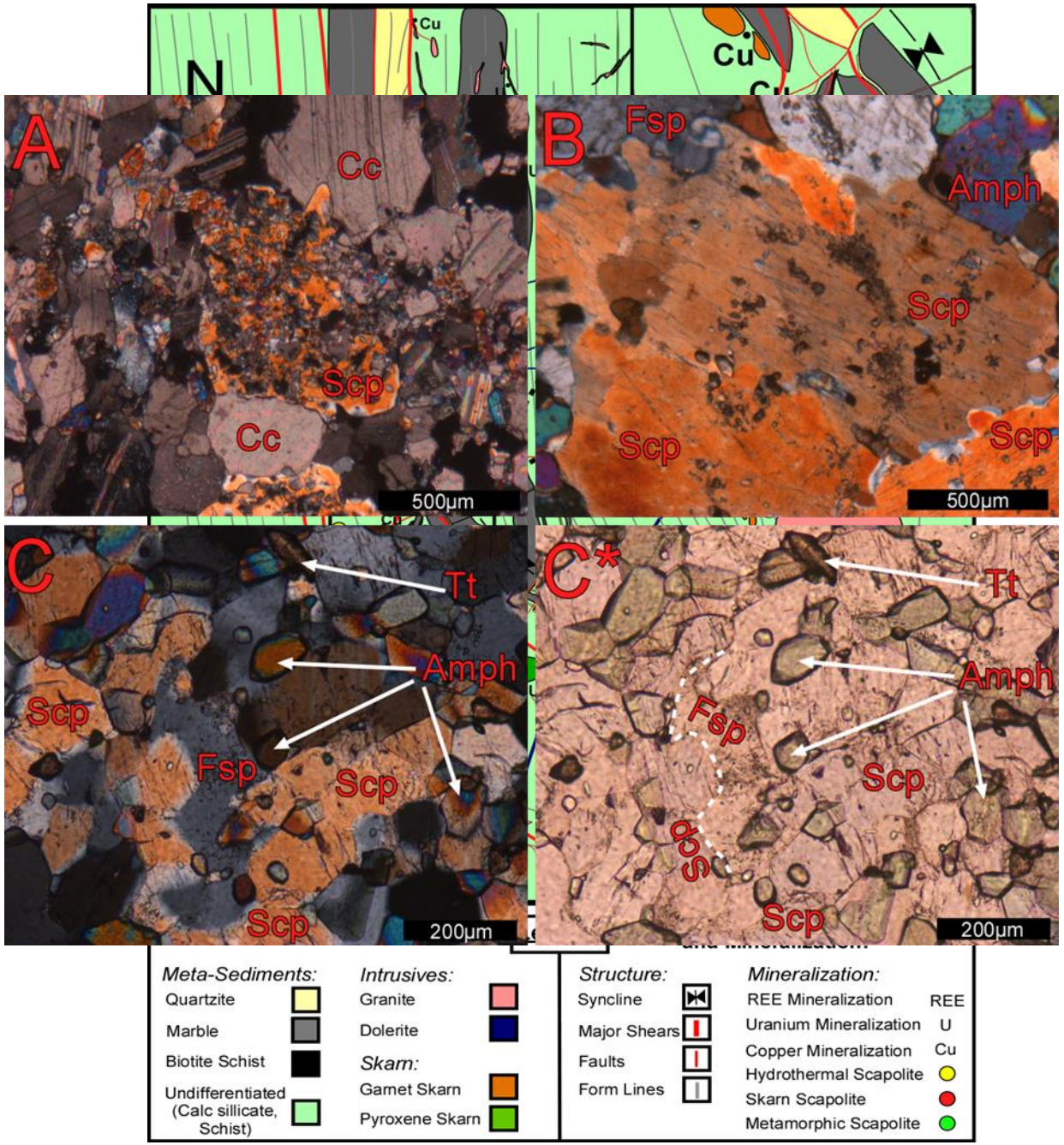
- Metamorphic scapolite – first generation
- Skarn scapolite - second generation
- Hydrothermal scapolite- third generation



Petrography

Metamorphic Scapolite

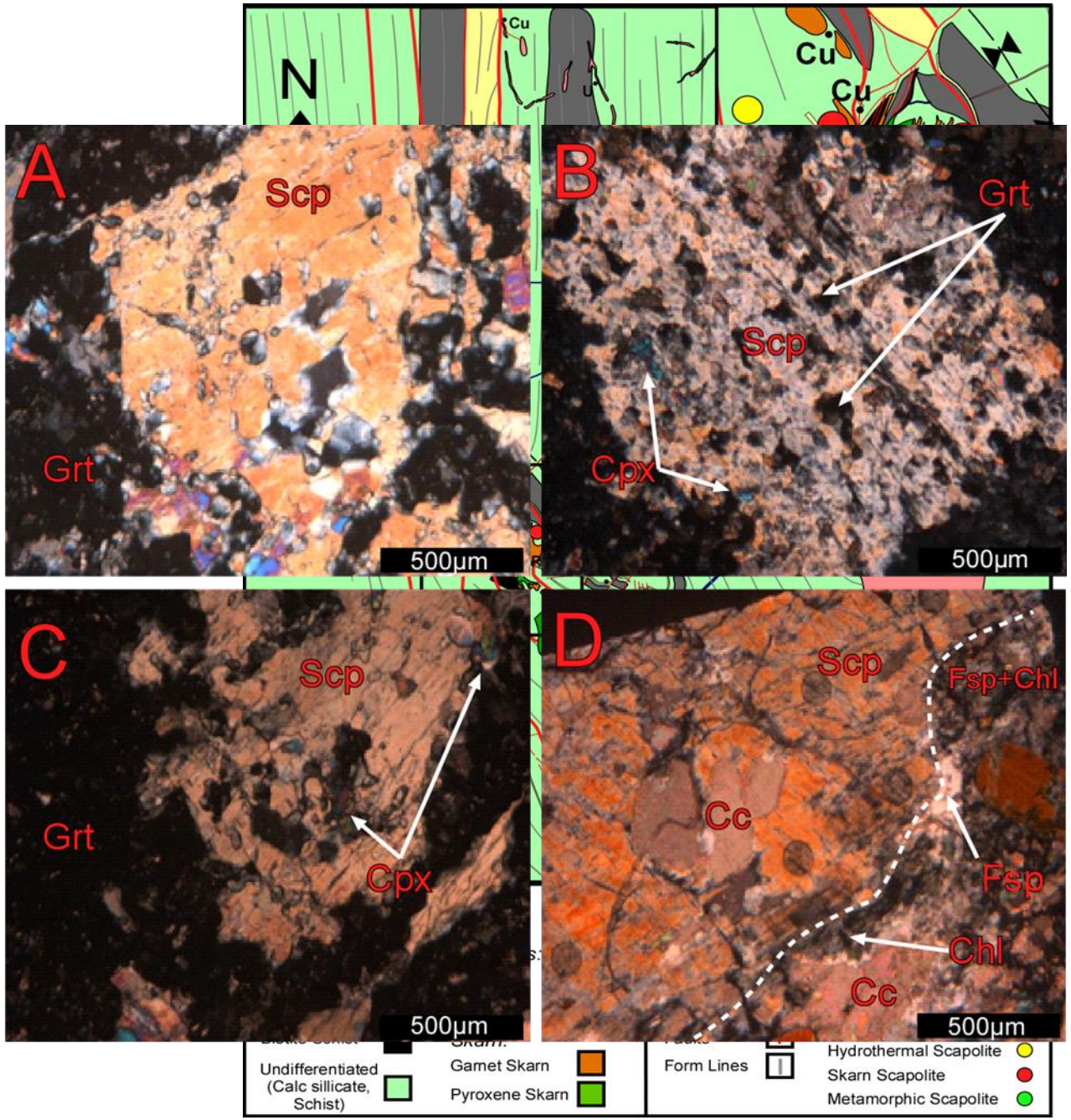
- Occurs within the calcsilicate and marble
- Assemblage - Amphibole, feldspar, calcite and clinopyroxene
- Texture – Fine-coarse grained, relatively undisturbed grain boundaries. Equigranular towards the Burstall Granite
- Colour – first-second order interference colours (greys, oranges, some bluish/purple)



Petrography

Skarn Scapolite

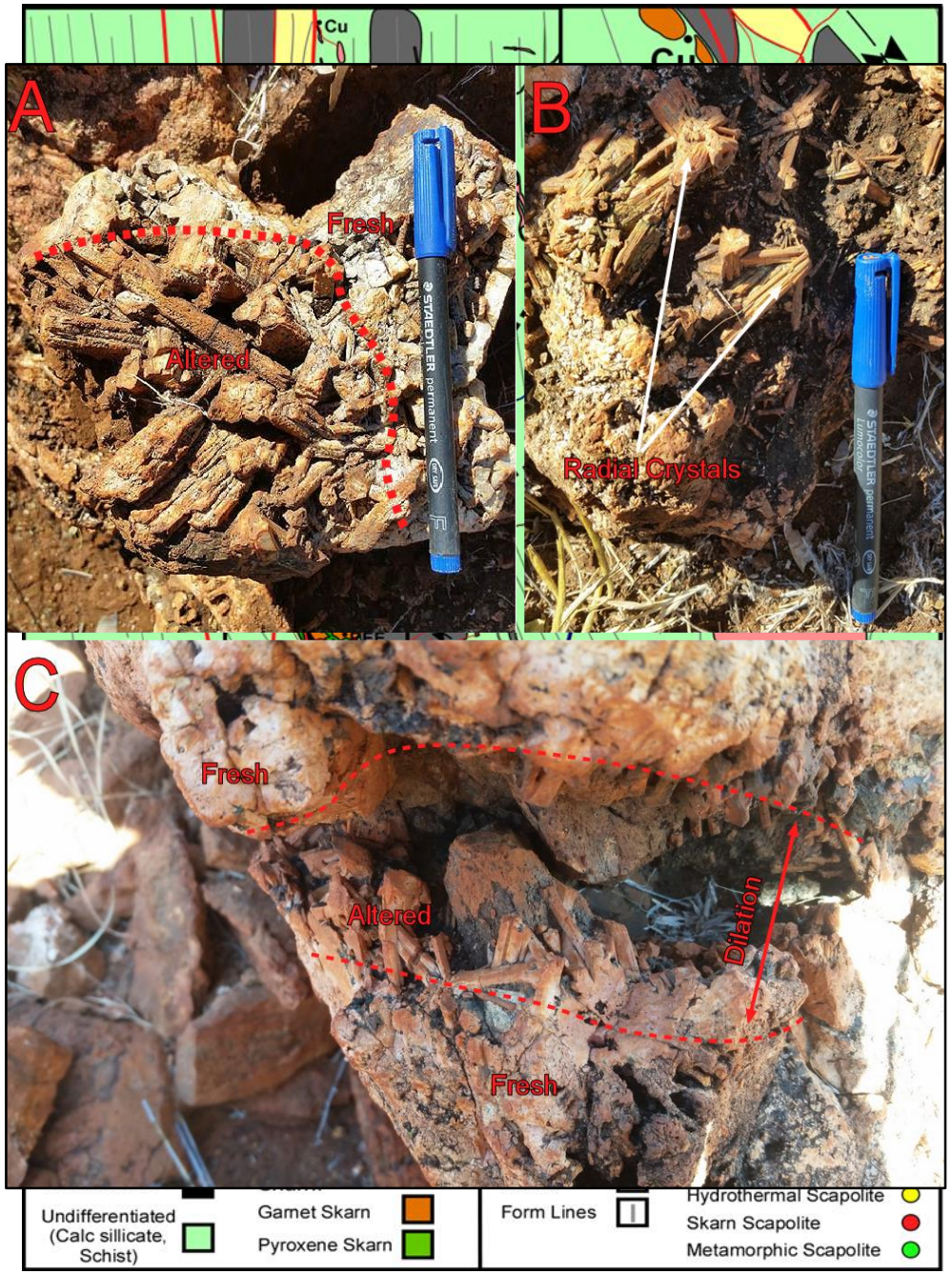
- Occurs within the garnet-cpx skarn
- Assemblage – Garnet, cpx, amph, fsp, cc, chl
- Texture – Clear reaction rim between garnet and scapolite. Skarn assemblage also occurs as inclusions suggesting syn crystallization
- Colour – Often second order interference (orange/cream)



Petrography

Hydrothermal Scapolite

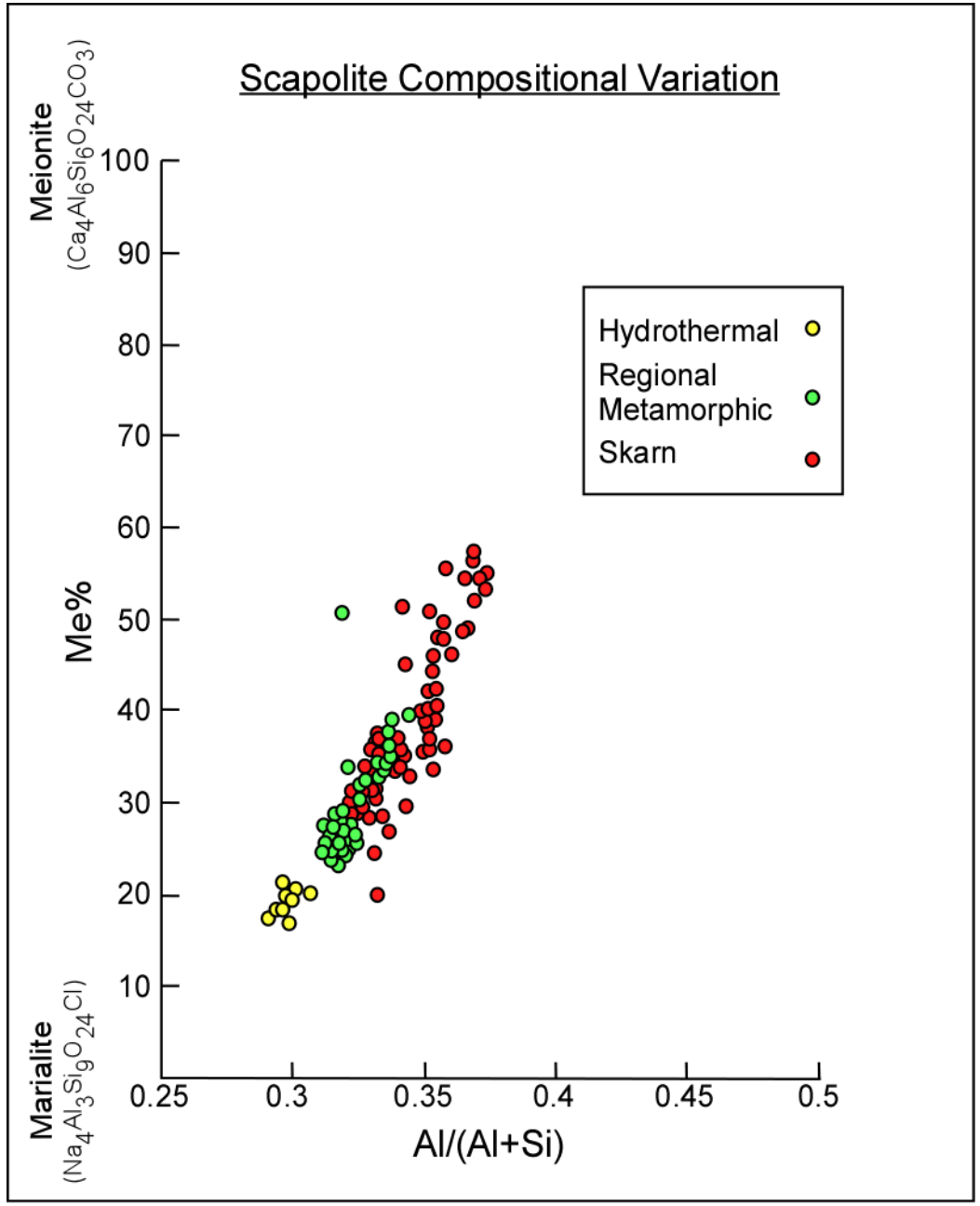
- Rare crosscutting veins of coarse grained scapolite
- Undeformed (late)
- Well defined crystals altered to albite, k-feldspar and epidote
- Fresh scapolite towards the massive vein walls
- Occurs with calcite and copper oxides



Geochemistry

Major element composition

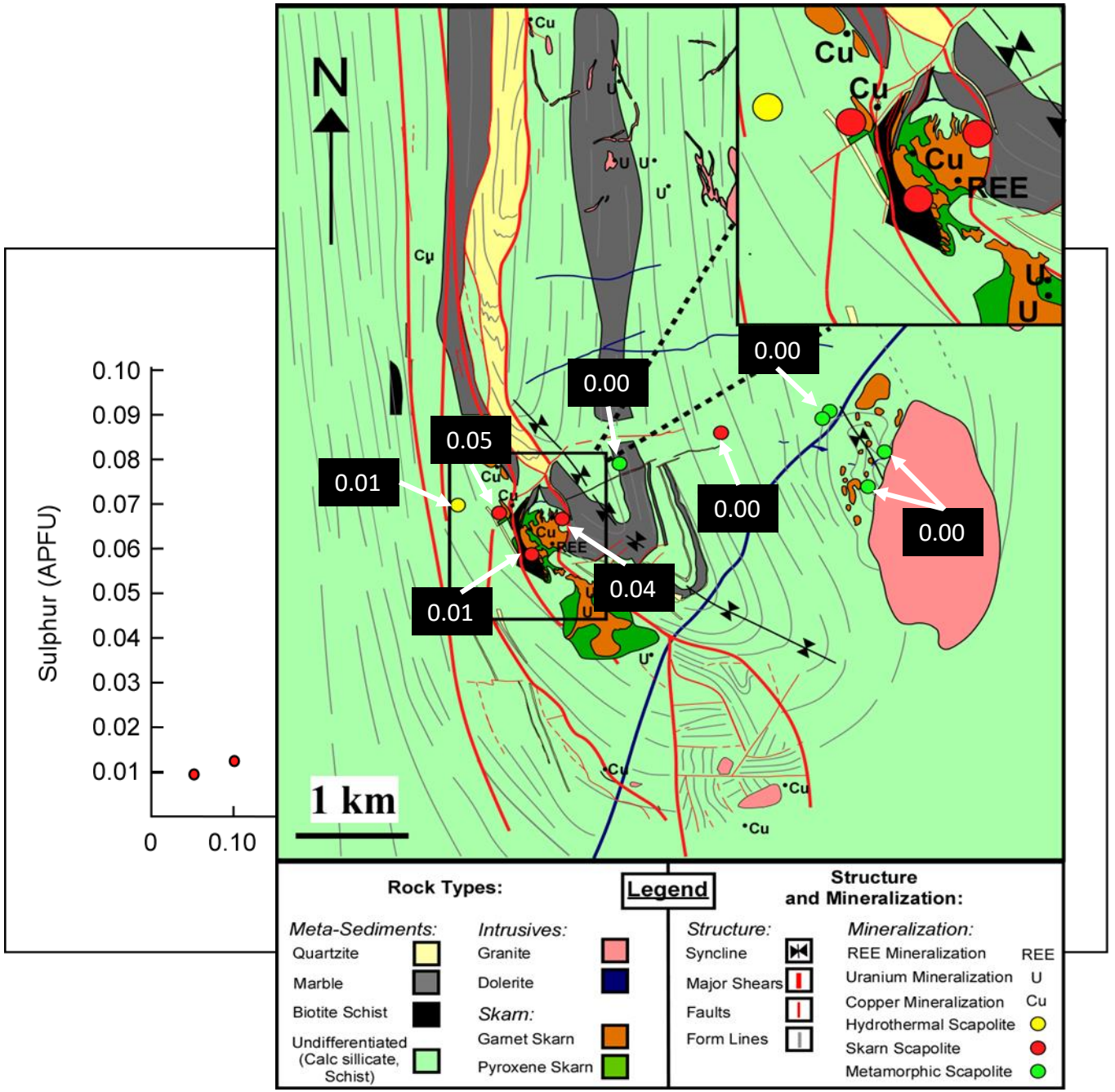
- Clear grouping in meionite content
- Hydrothermal scapolite has low meionite content
- Metamorphic scapolite has intermediate meionite content
- Skarn scapolite has a wide spread from intermediate to high meionite content



Geochemistry

Major element composition

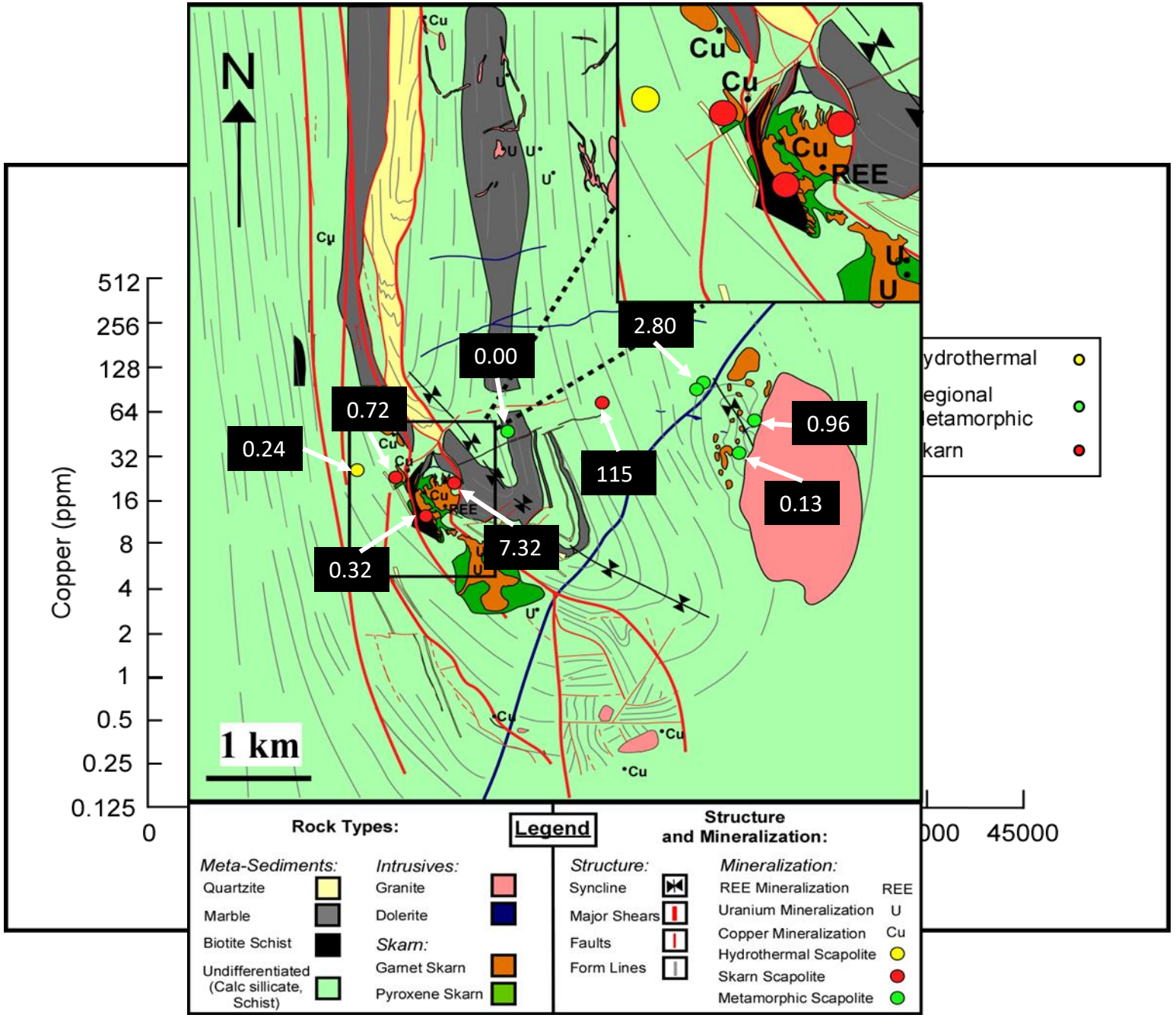
- Sulphur vs Chlorine content
- Scapolite surrounding the deposit are closely related to an increase in Sulphur content
- Influence of Sulphur rich mineralizing fluid?



Geochemistry

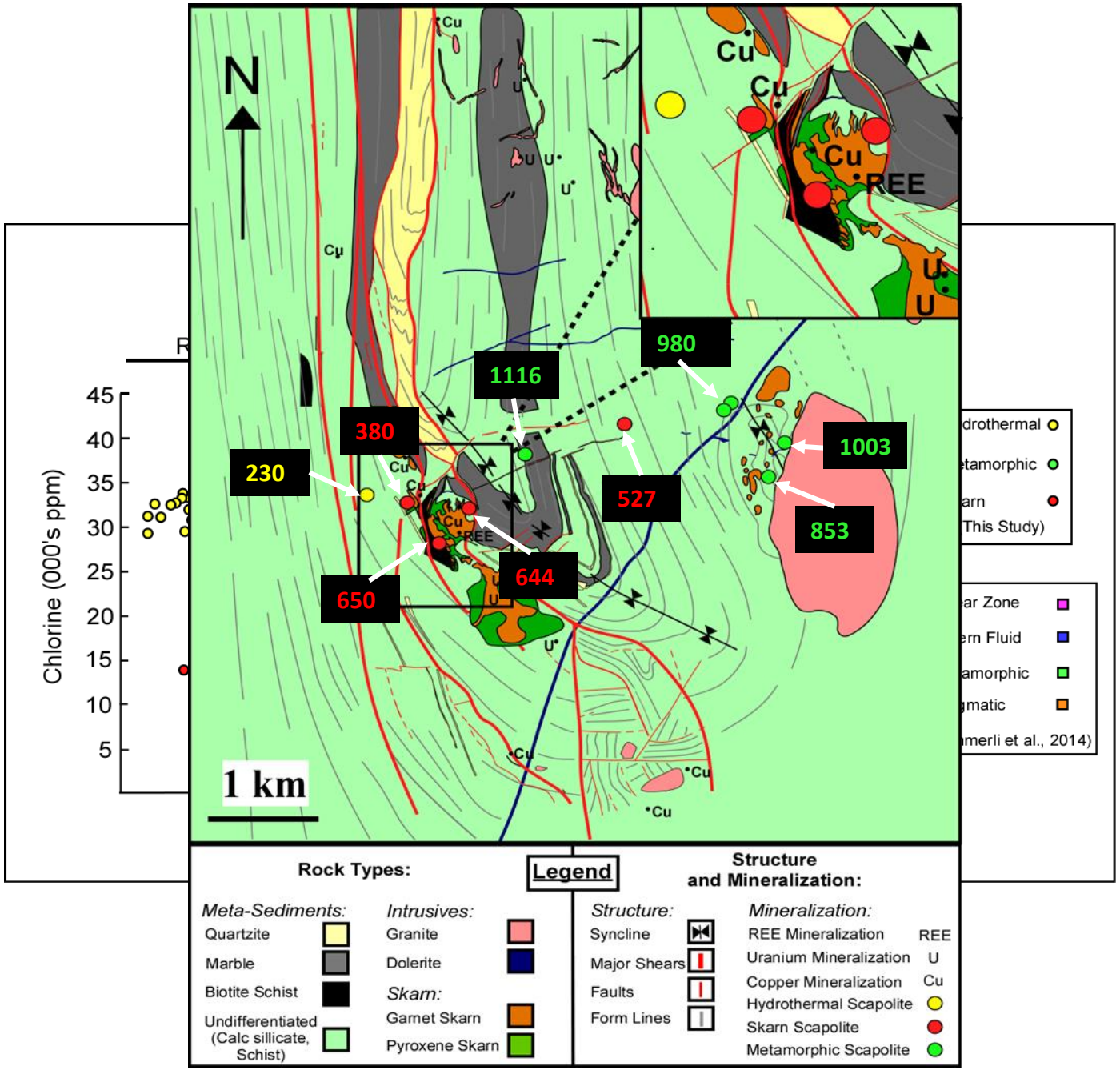
Trace element composition

- Copper present in all scapolite variants
- Particularly elevated in the sulphur depleted skarn sample.
- Possible explanation could be that the lack of S forces Cu into scapolite as opposed to sulphide.



Geochemistry

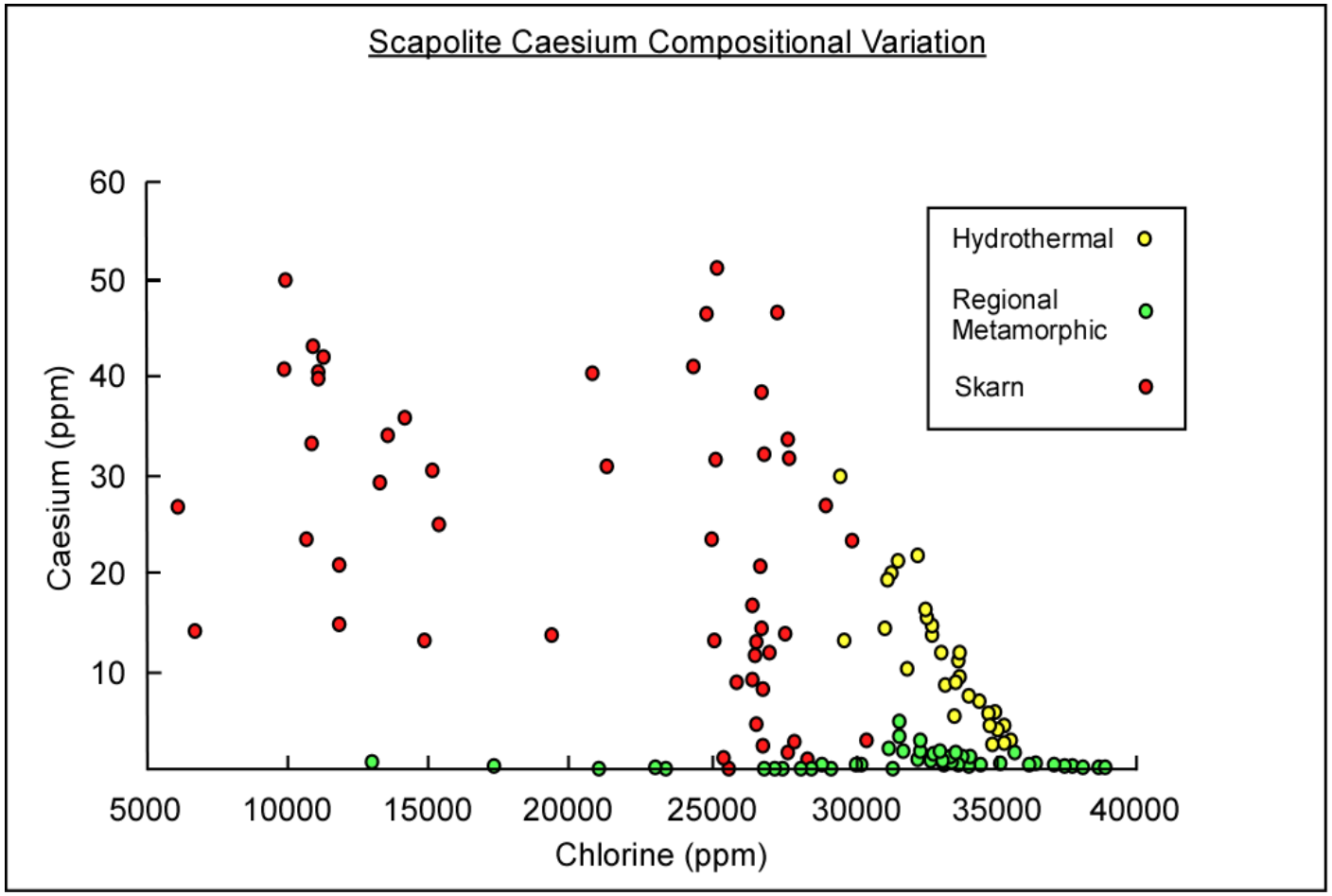
- Chlorine/Bromine Ratios
- Spread of data suggests three different fluids:
  - Metamorphic
  - Skarn
  - Hydrothermal



(Cl/Br fields from Bernal et al., 2017)

Geochemistry

- Caesium vs Chlorine
- Skarn and hydrothermal scapolite closely related to increased caesium
- Where is the caesium coming from?
- Either from the hydrothermal fluid or an even later fluid



Paragenetic Sequence Summary

- Metamorphic scapolite formation
  - Regional metamorphic scapolite formation – Halite dissolution Cl/Br ~ 1000
  - Contact metamorphic scapolite formation – Burstall intrusion Cl/Br ~ 1000
- Skarn scapolite formation – distinct fluid (Cl/Br ~550) or interaction of hydrothermal (~200)
- Hydrothermal scapolite formation – fluid with low Cl/Br ~200 – not magmatic – mineralization possibly not igneous related

Conclusions

- Scapolite has the potential to be a powerful tool in vectoring towards mineralization
- S in scapolite correlates better than Cu with the location of ED
- Cu in scapolite appears to be much higher in skarn than in any other rock
- No igneous fluids present based on hydrothermal scapolite geochemistry
- Scapolite has the potential to indicate the presence of fertile fluids through the incorporation of economic metals (Cu)

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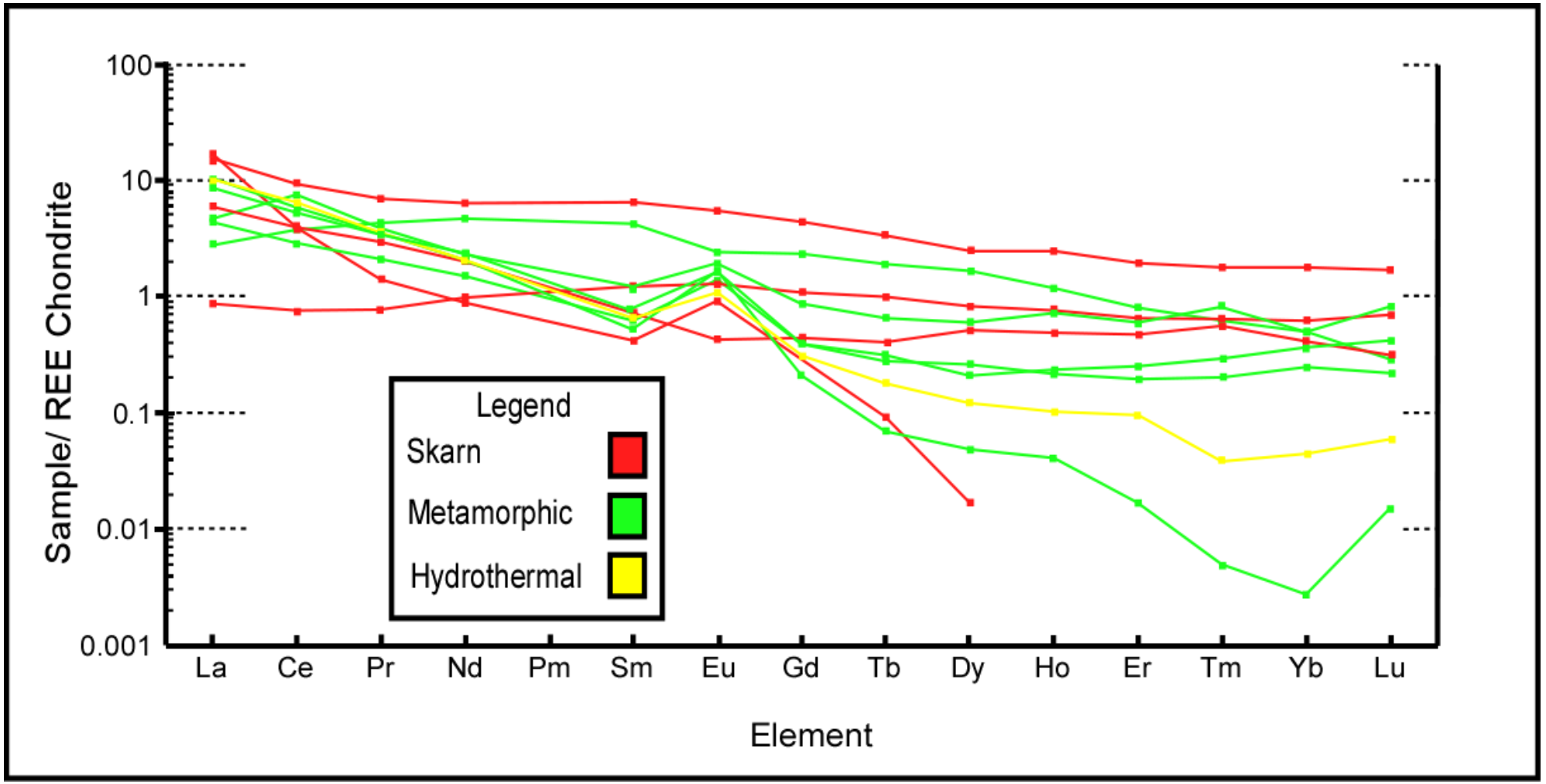
REE Plot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Sample/ REE Chondrite
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Nd
Pm
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Element
Legend
Skarn
Metamorphic
Hydrothermal