Metamorphogenic Au mineralization localized to a chemically favourable dioritic host rock: The Archean Vickers Intrusive Complex, Nunavut, Canada

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Nunavut Mining Symposium

Iqaluit, NU

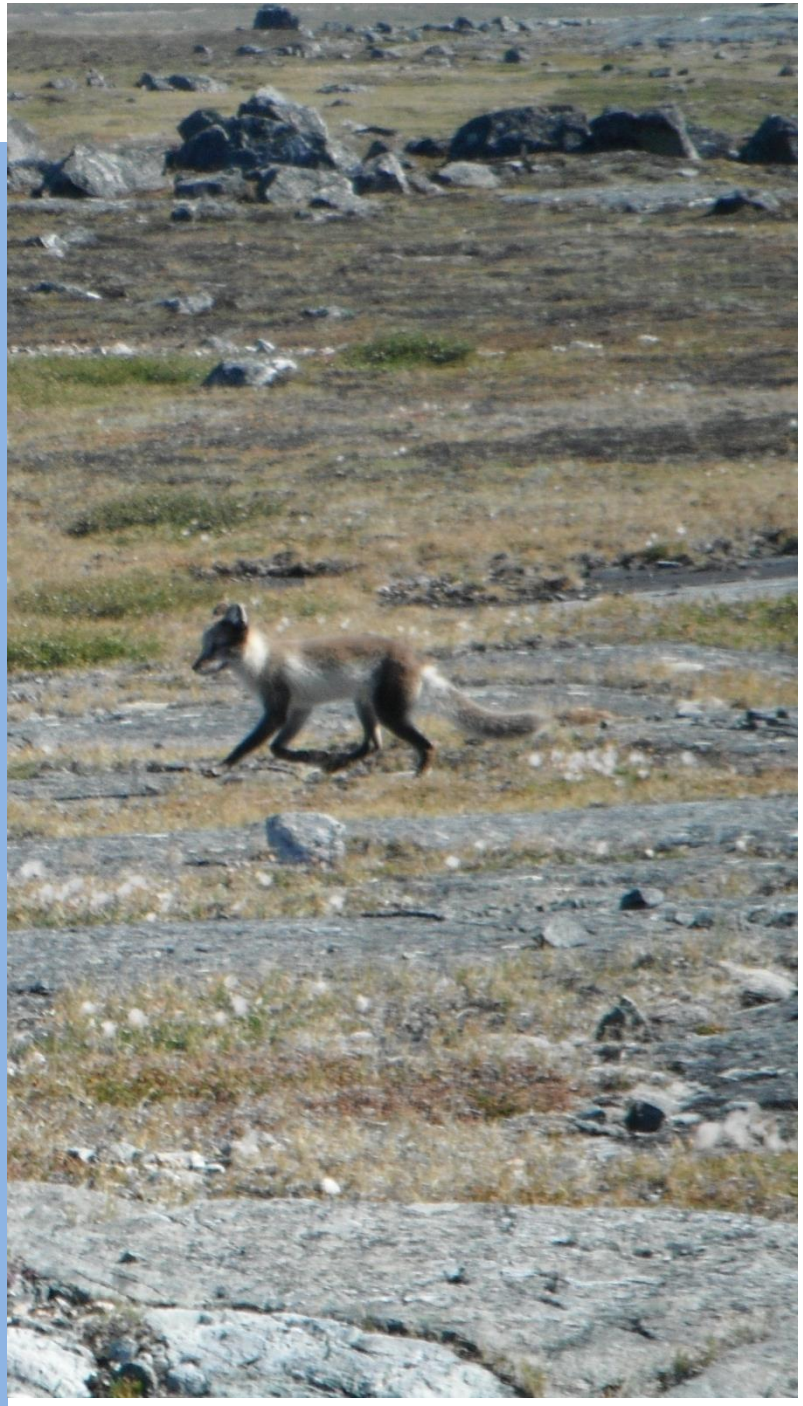
Outline

1. Geological context – Vickers

2. Alteration facies

3. Characterizing the mineralizing fluid (Stable isotopes $\delta^{34}S$ & $\delta^{18}O$**)**

4. Model: Wallrock sulphidation and rheological contrast



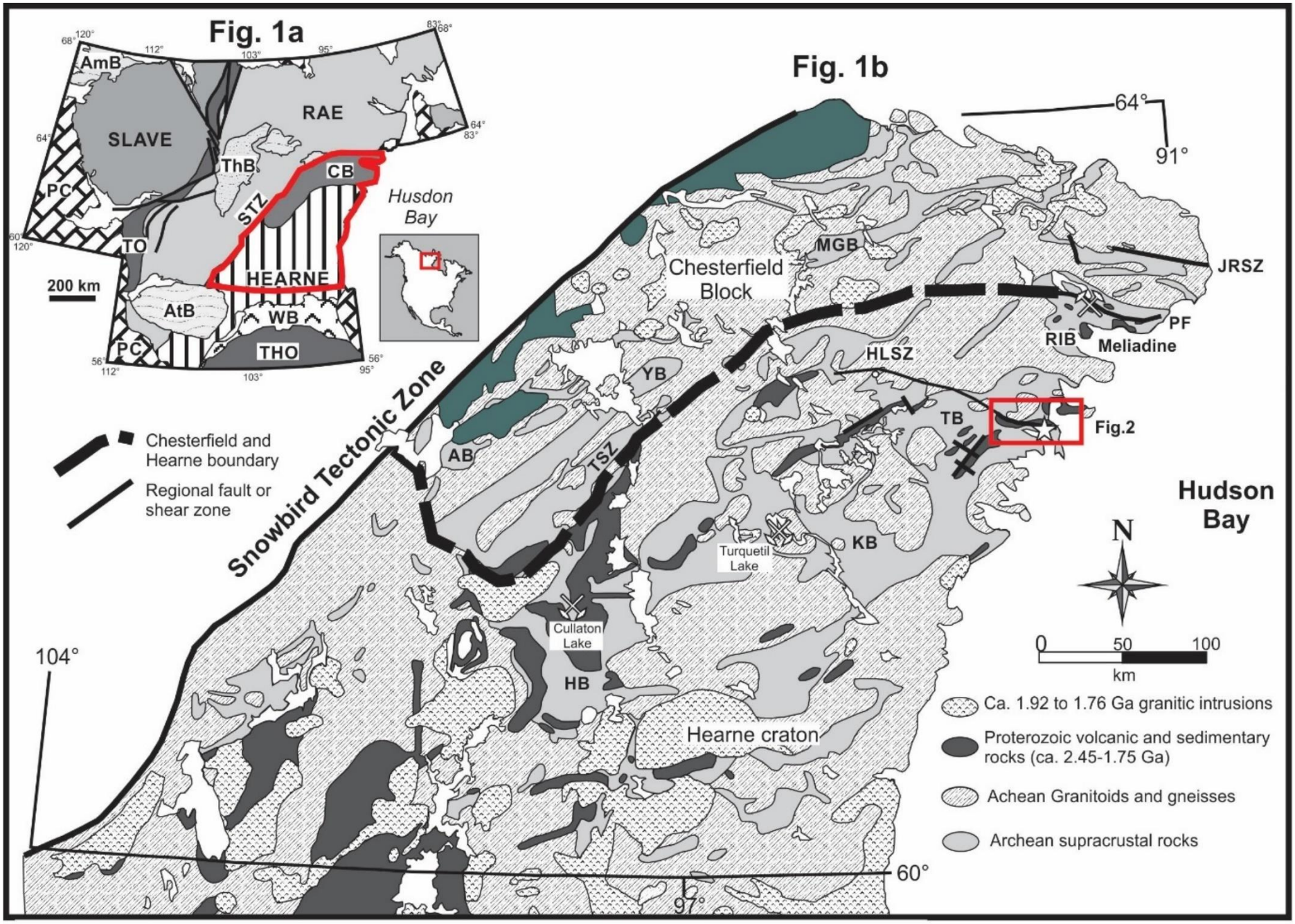
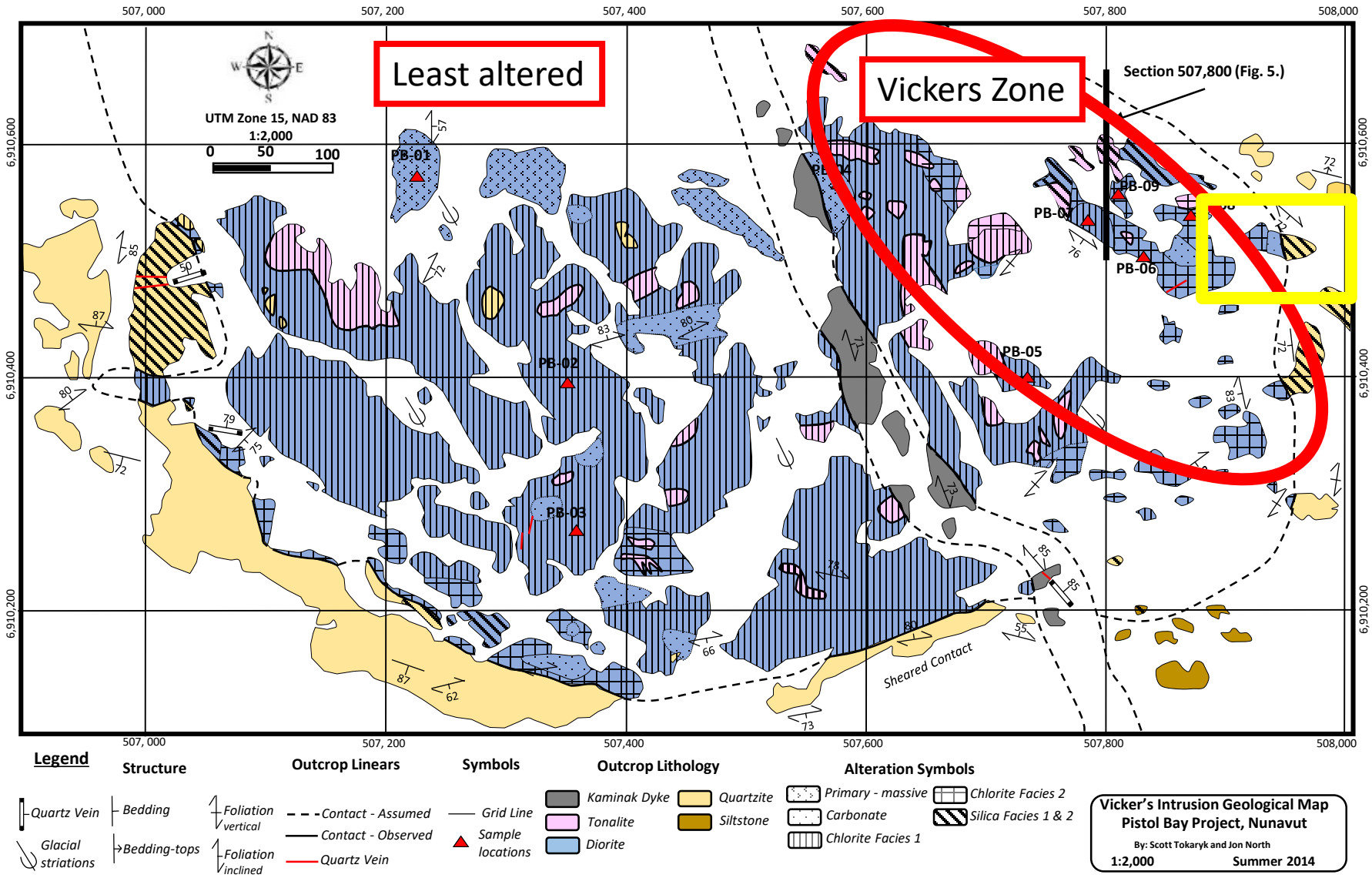
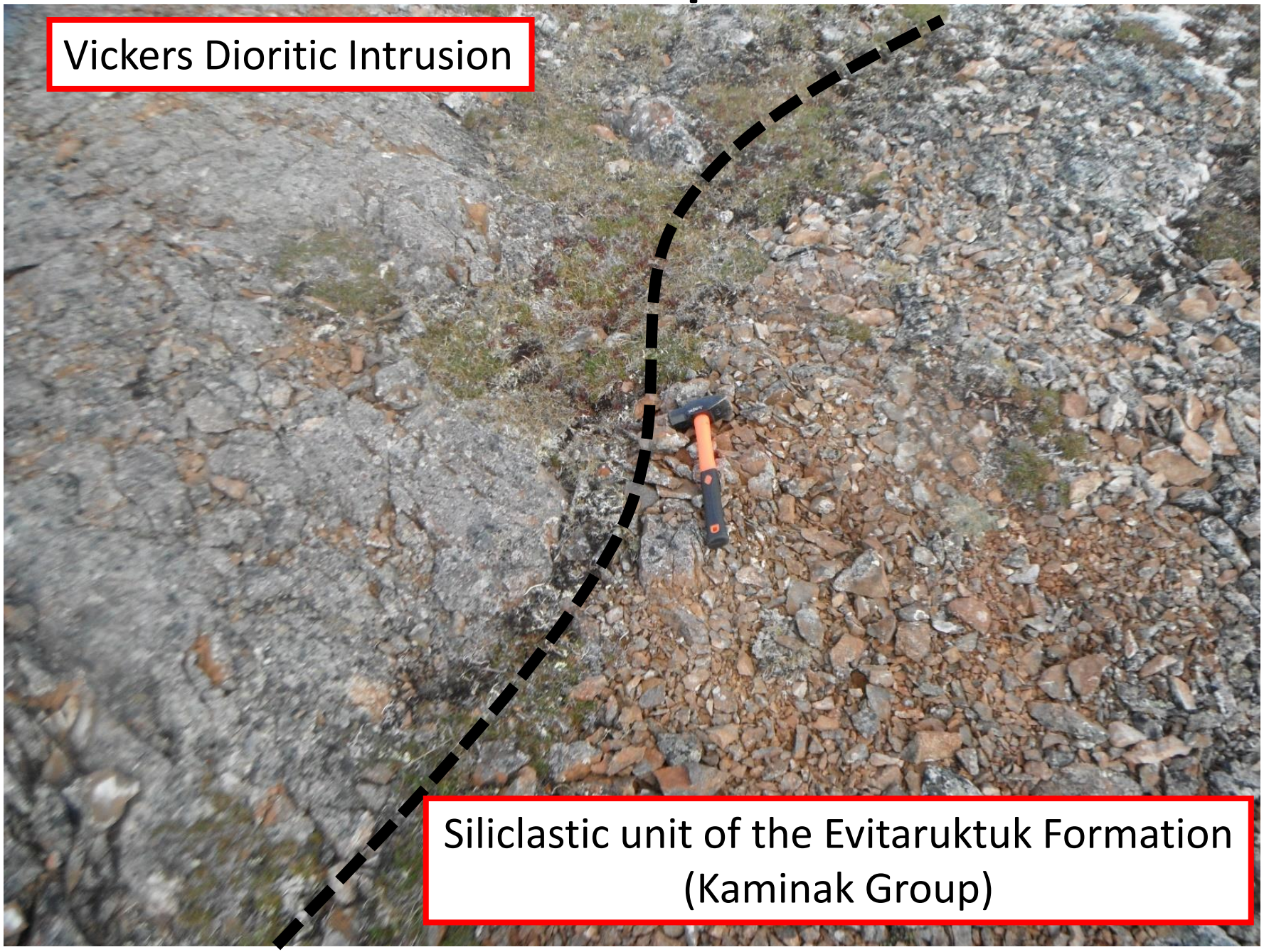


Fig. 1a
AmB
SLAVE
RAE
ThB
CB
PC
STZ
TO
HEARNE
AtB
WB
PC
THO
200 km
Husdon Bay
Fig. 1b
64°
91°
Chesterfield Block
MGB
JRSZ
PF
RIB
Meliadine
HLSZ
YB
TB
Fig.2
Snowbird Tectonic Zone
AB
TSZ
Hudson Bay
KB
Turquetil Lake
N
0
50
100
km
Cullaton Lake
HB
104°
Hearne craton
60°
97°
Chesterfield and Hearne boundary
Regional fault or shear zone
Ca. 1.92 to 1.76 Ga granitic intrusions
Proterozoic volcanic and sedimentary rocks (ca. 2.45-1.75 Ga)
Achean Granitoids and gneisses
Archean supracrustal rocks


507, 000
507, 200
507, 400
507, 600
507, 800
508,000
6,910,600
6,910,400
6,910,200
Least altered
Vickers Zone
Section 507,800 (Fig. 5.)
UTM Zone 15, NAD 83
1:2,000
0 50 100
PB-01
PB-02
PB-03
PB-04
PB-05
PB-06
PB-09
Sheared Contact
Legend
Structure
Quartz Vein
Bedding
Glacial striations
Bedding-tops
Foliation vertical
Foliation inclined
Outcrop Linears
Contact - Assumed
Contact - Observed
Quartz Vein
Symbols
Grid Line
Sample locations
Outcrop Lithology
Kaminak Dyke
Tonalite
Diorite
Quartzite
Siltstone
Alteration Symbols
Primary - massive
Carbonate
Chlorite Facies 1
Chlorite Facies 2
Silica Facies 1 & 2
Vicker's Intrusion Geological Map
Pistol Bay Project, Nunavut
By: Scott Tokaryk and Jon North
1:2,000
Summer 2014

Outcrop contact



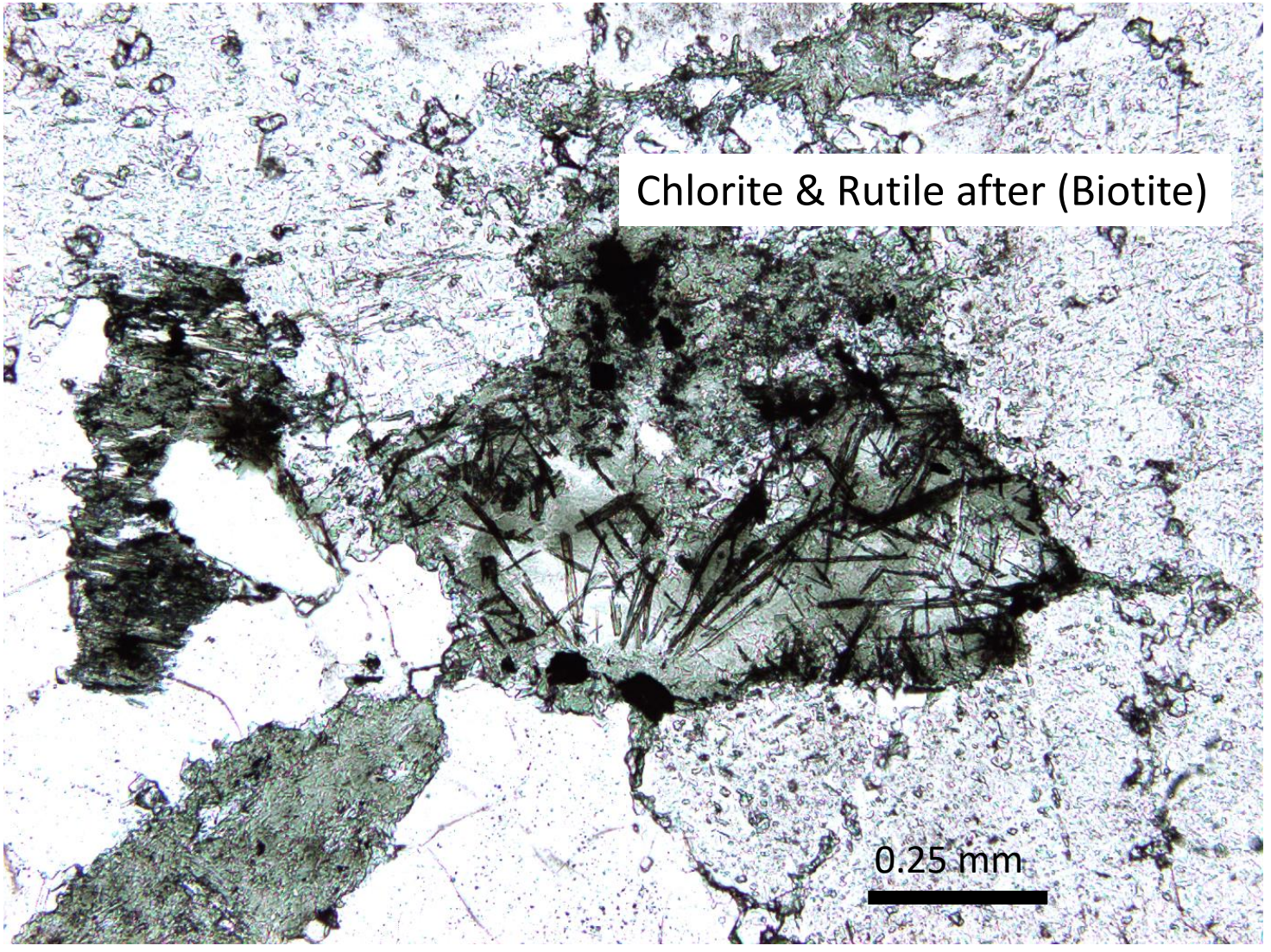
Least altered Diorite -LAD

Plagioclase: **45-65%**; albitized; altered to sericite and replaced by chlorite;
Quartz: **5-10%**; myrmektic **Chlorite**: **15-35%**; after amphibole +/- biotite;
Skeletal ilmenite/rutile tr-3%; **Accessories**: apatite, epidote, allanite, zircon

Greenschist facies alteration

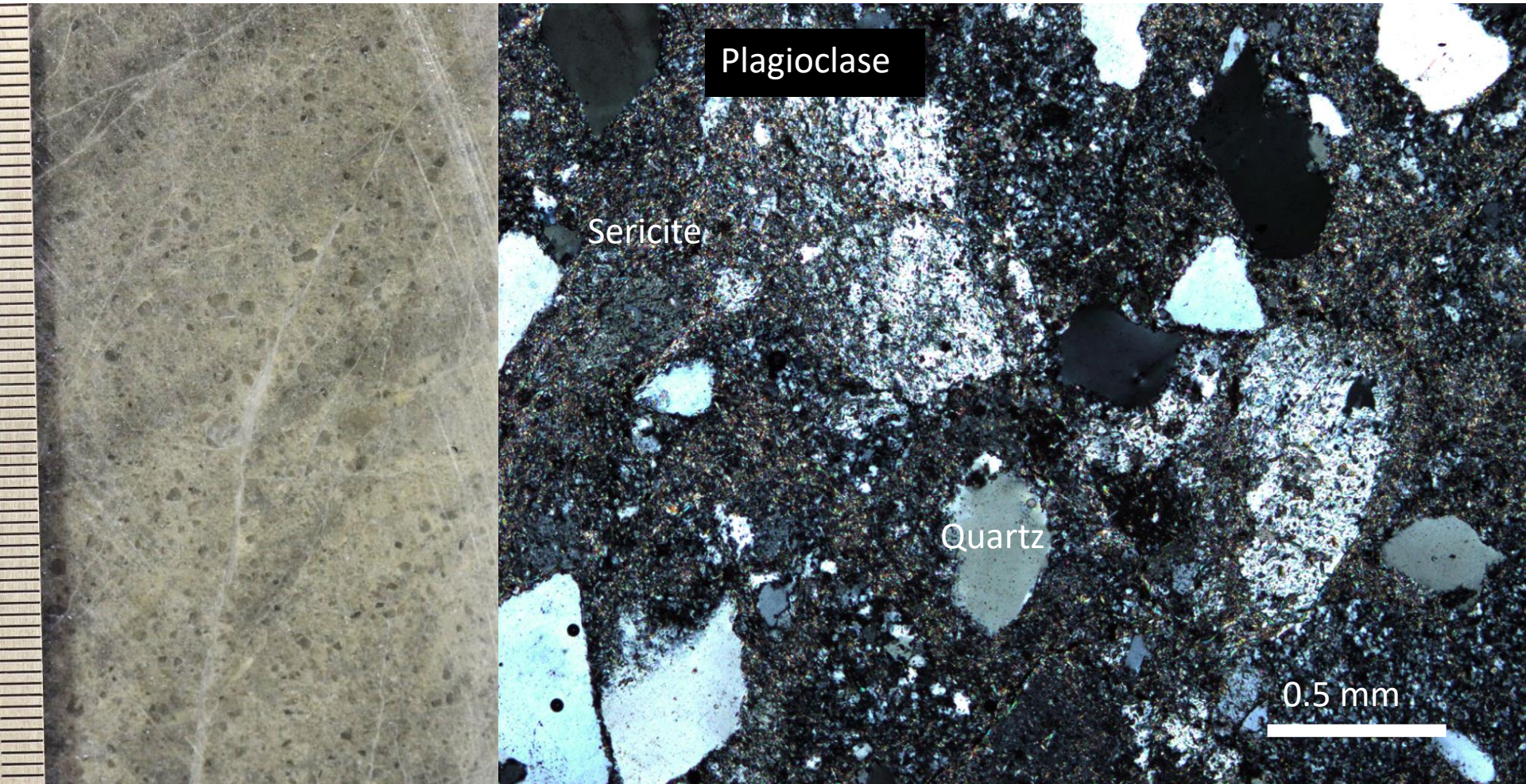
Plagioclase → Sericite + Albite

Amphibole & biotite → Chlorite + precipitation of ***Ilmenite + Rutile***



Siliclastic unit of the Evitaruktuk Formation (Kaminak Group)

Quartz: 20-50%; subangular; 1-3 mm grains sub-angular; **Plagioclase**: 10-30%; severely altered (>60%) to sericite; **Sericite**: 10-30%; groundmass; **Carbonate**: 5-10%; groundmass; **Accessories**: apatite, epidote, zircon

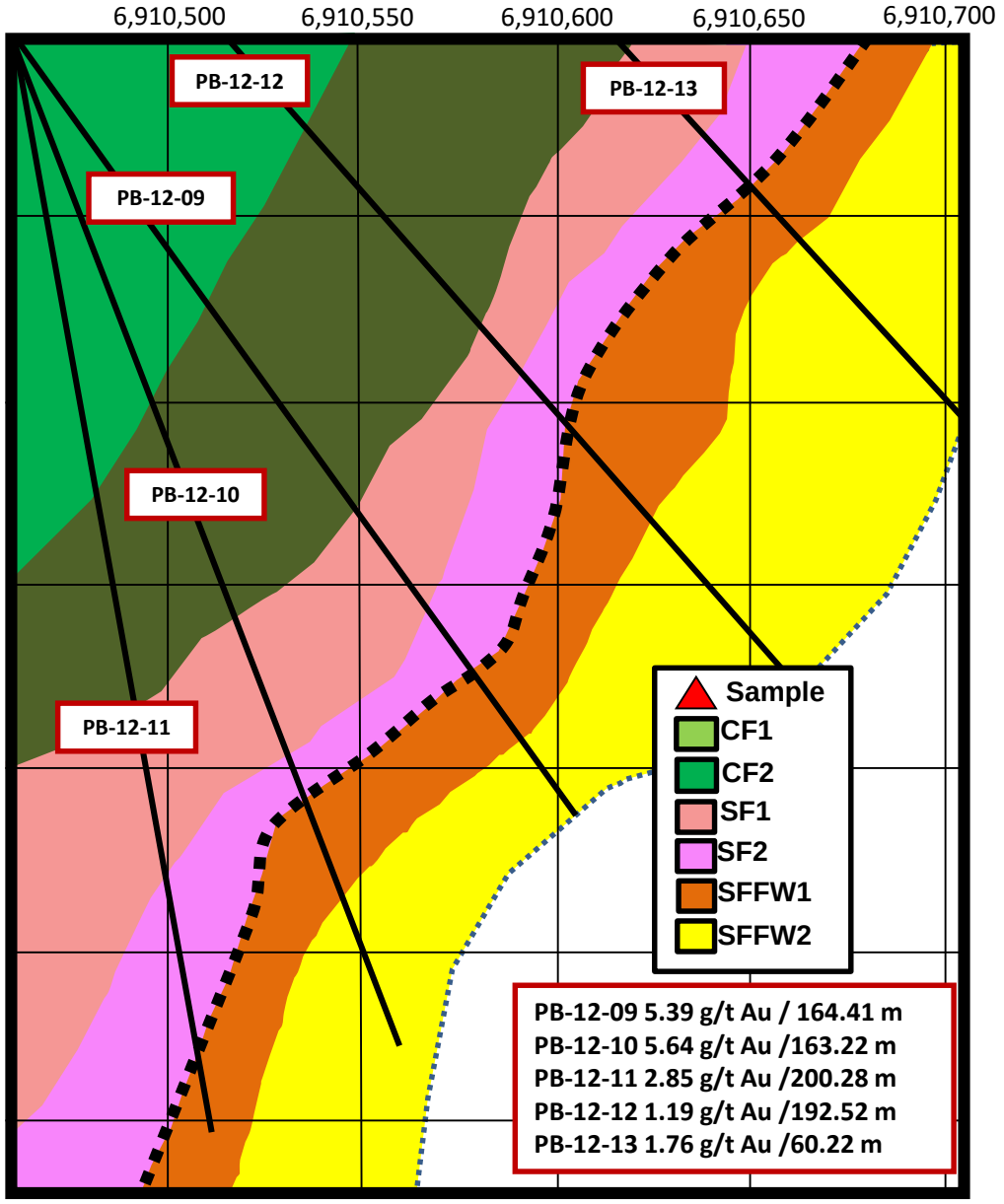


6 Alteration Facies:

CF 1 & 2
Chlorite facies

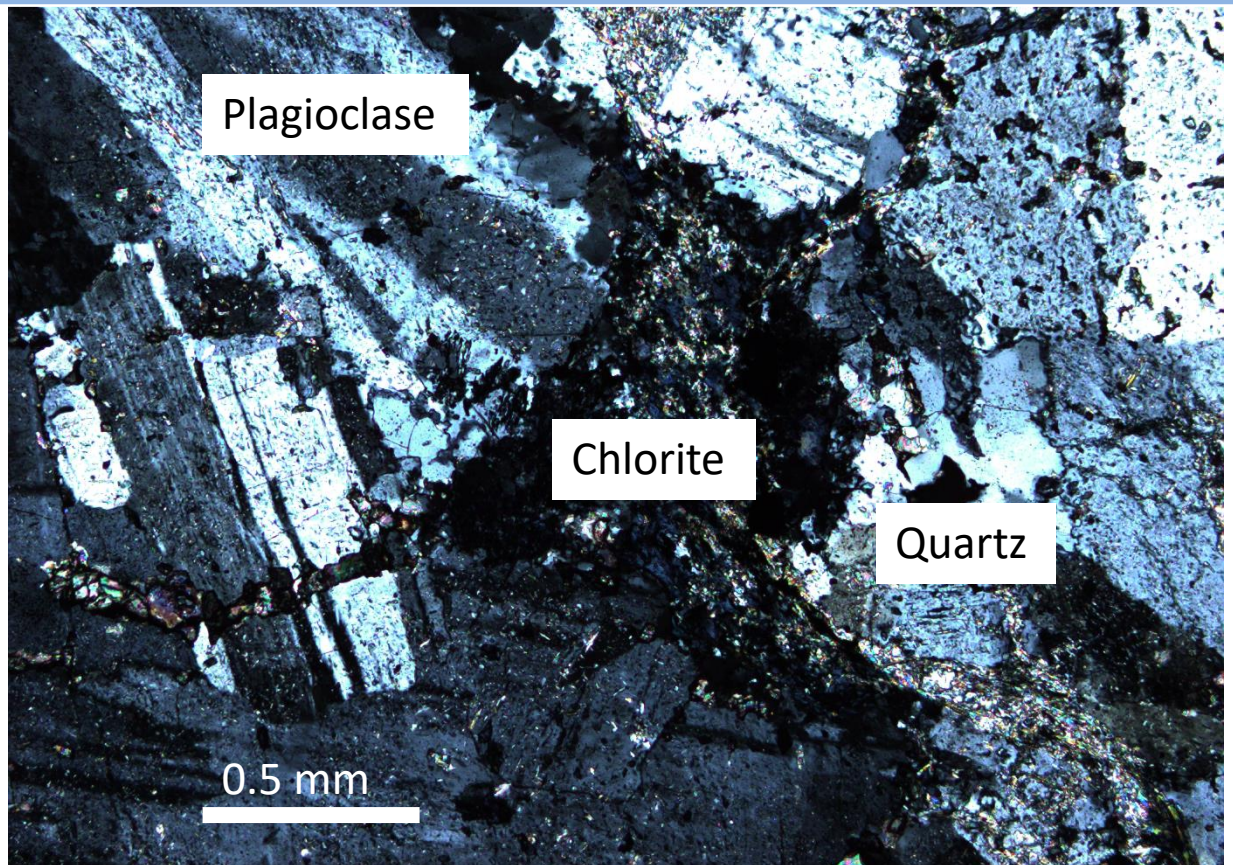
SFI 1 & 2
Silica facies

SFFW 1 & 2
Sericite facies



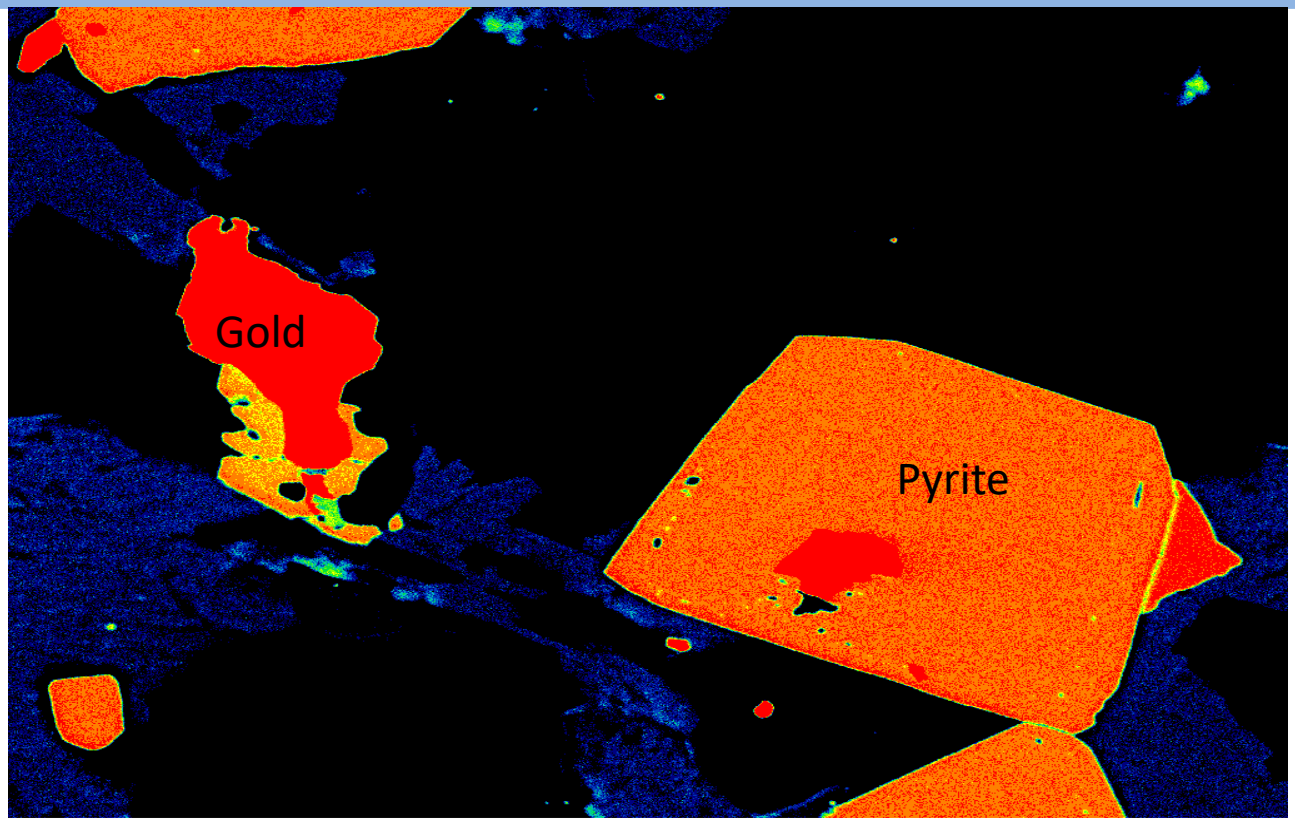
3. Alteration - Chlorite Facies 1 (CF1)

MINERAL ASSEMBLAGE	***Plagioclase (albitized) > Chlorite > > Quartz (Primary)***
DISTINGUISHING CHARACTERISTICS	**Plagioclase "ghosts"; chlorite >25% (disseminated and mm stringers); *complete replacement of primary mafic phases***
MINERALIZATION	***< 2%* (disseminated or in mm-cm stringers); *pyrite >> arsenopyrite***



3. Alteration - Chlorite Facies 2 (CF2)

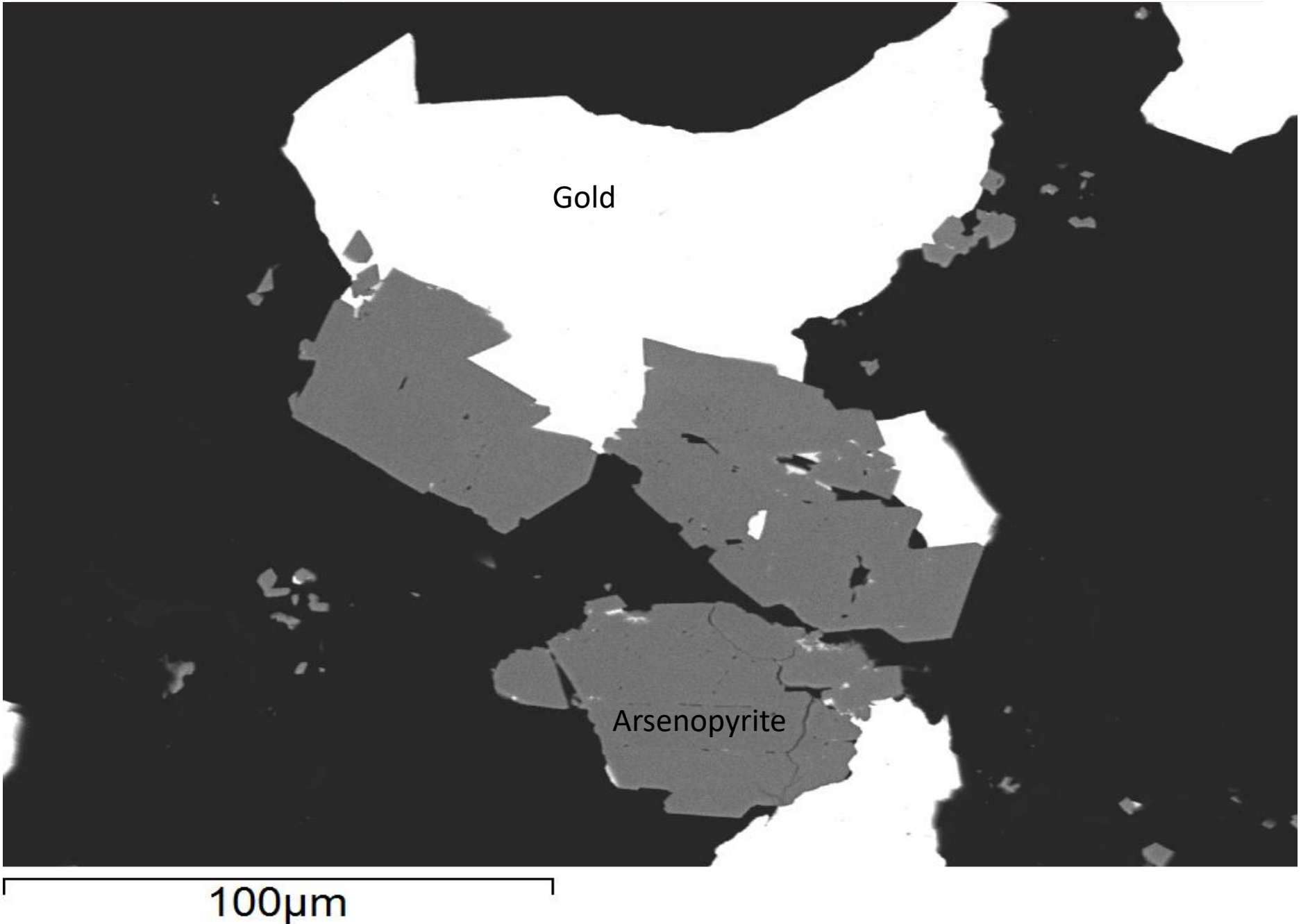
MINERAL ASSEMBLAGE	***Plagioclase (albitized) > Chlorite (Fe-rich) > Carbonate >Quartz (hydrothermal) > Quartz (Primary)***
DISTINGUISHING CHARACTERISTICS	***Appearance of planar fabric*, increased abundance of *secondary silica and carbonate***
MINERALIZATION	***>2%* (disseminated or in mm-cm stringers); *pyrite > arsenopyrite> gold***



3. Alteration – Silica Facies Intrusive (SF1I)

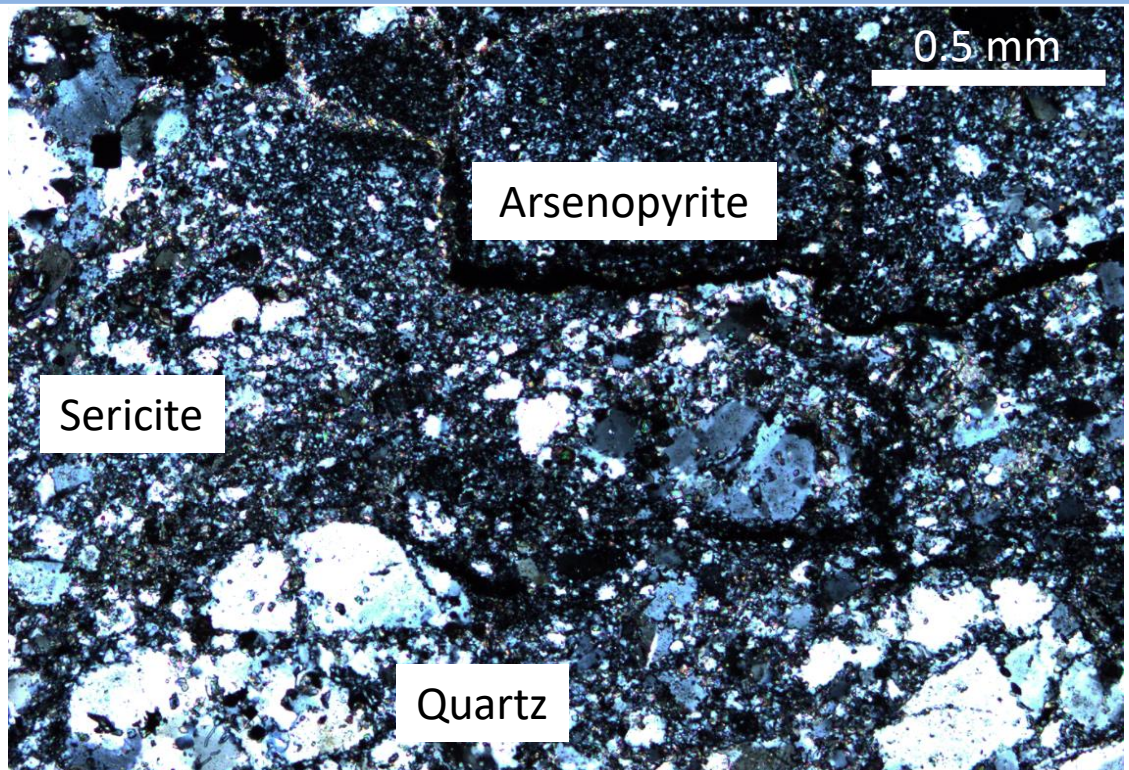
MINERAL	*Plagioclase → Quartz (hydrothermal) > Chlorite (Fe-*

3. Alteration – Silica Facies 2 Intrusive (SF2I)



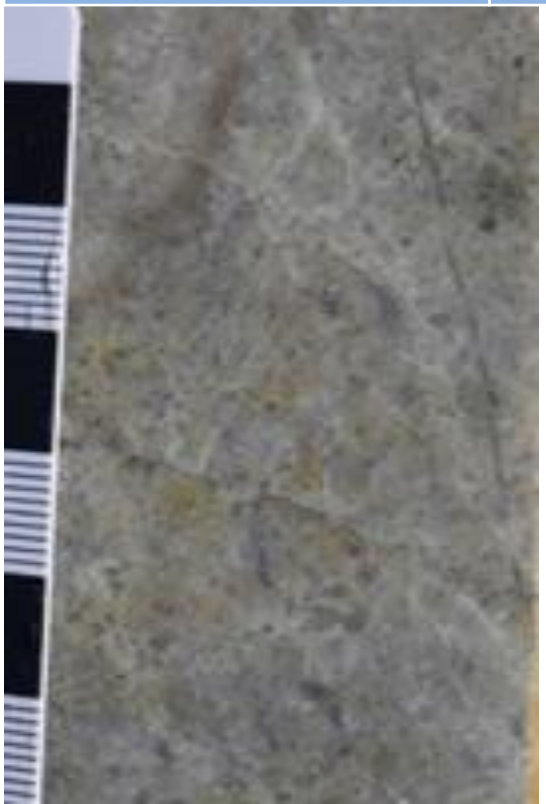
3. Alteration – Sericite Facies Foot-wall (SF1FW)

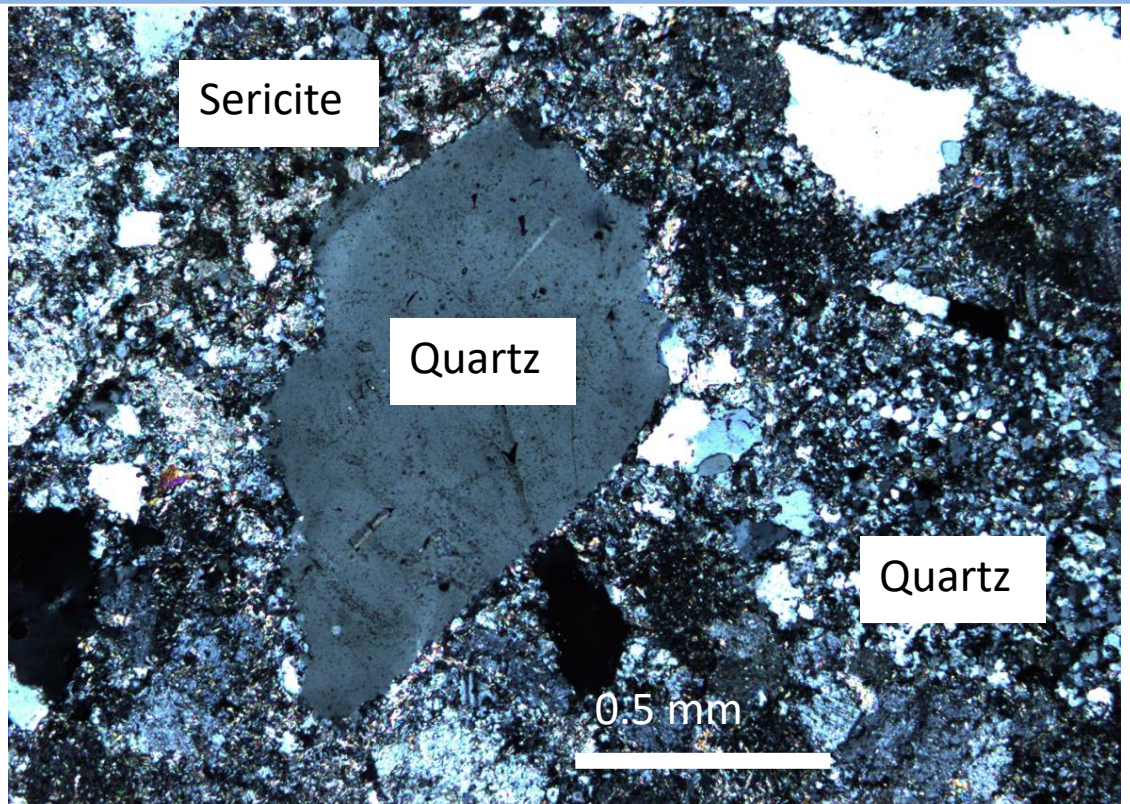
MINERAL ASSEMBLAGE	***Sericite > Quartz (Primary)> Quartz (hydrothermal) > Plagioclase > Carbonate***
DISTINGUISHING CHARACTERISTICS	***Presence of discrete, sub-angular quartz phenocrysts*; *intensely foliated intervals* (10s cm wide); cherty intervals (i.e., secondary silica)**
MINERALIZATION	***>3%* (disseminated or in mm-cm stringers); *arsenopyrite> pyrite > gold***



3. Alteration – Sericite Facies 2 Foot-wall (SF2FW)

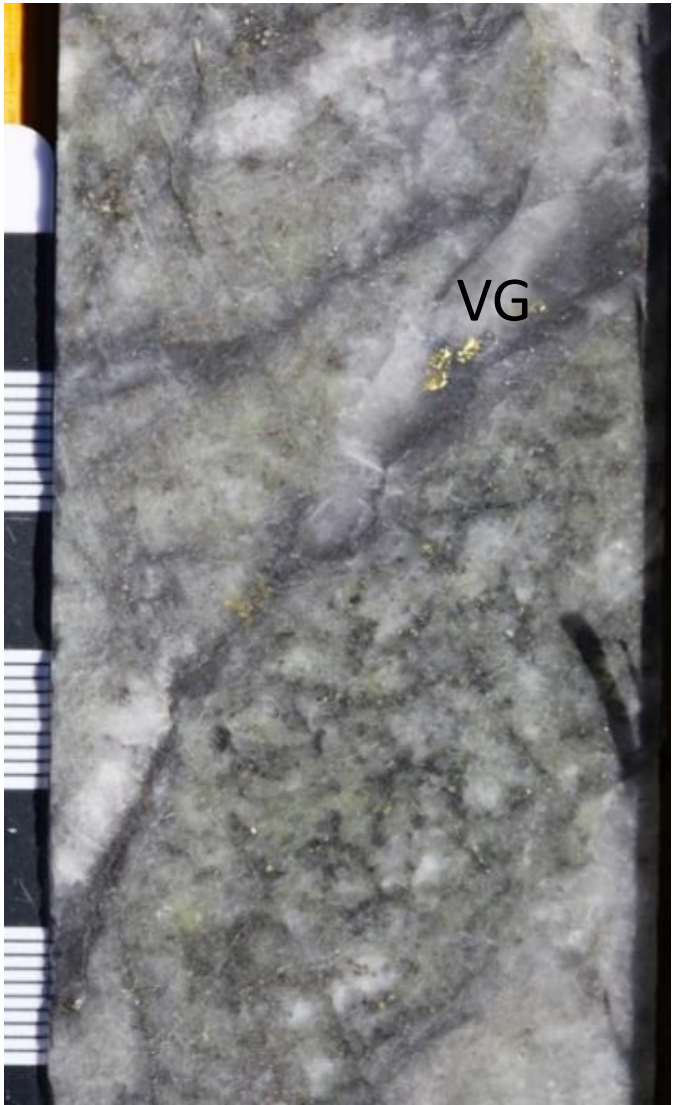
MINERAL ASSEMBLAGE	***Quartz (Primary) > Sericite > Carbonate > Quartz (secondary)***
DISTINGUISHING CHARACTERISTICS	***Moderate planar fabric*;** **Presence of discrete sub-angular quartz grains**
MINERALIZATION	***< 2%*** **(disseminated or in mm-cm stringers);** ***arsenopyrite > pyrite > gold***

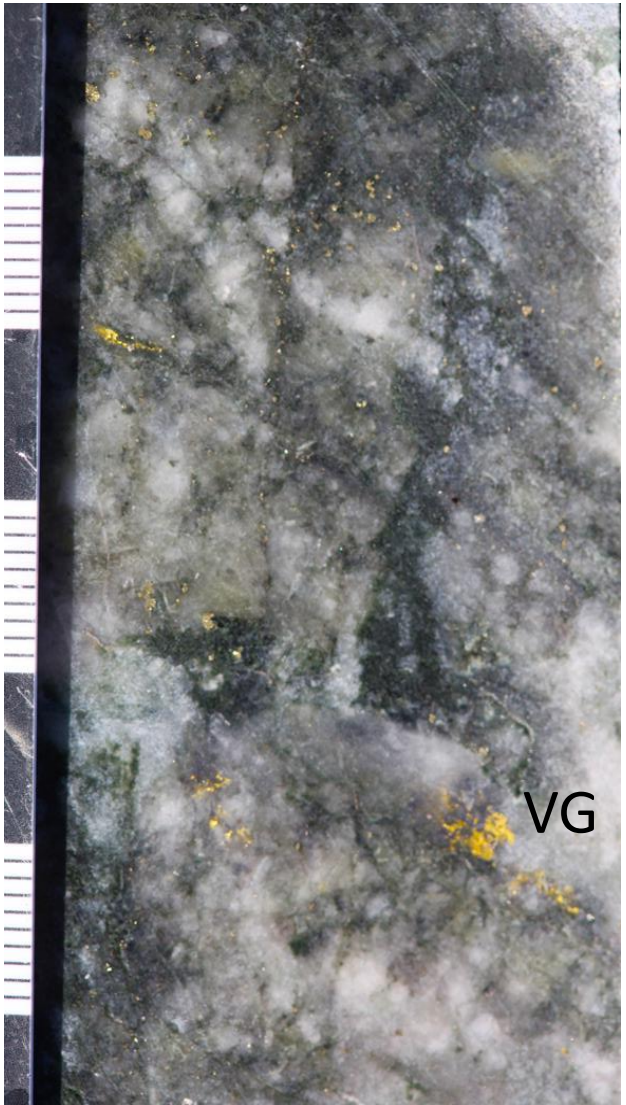


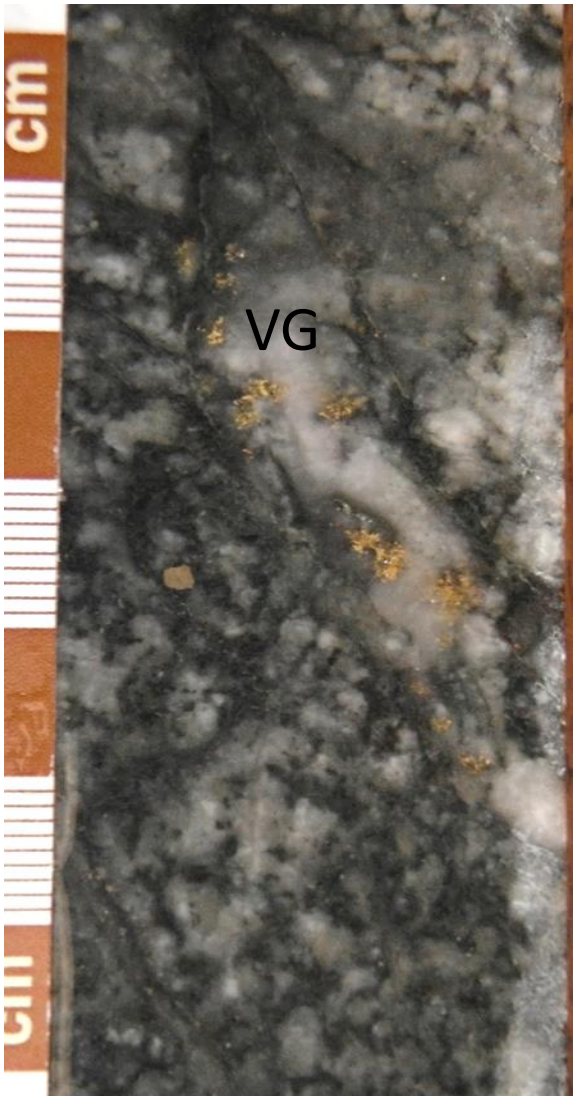


Characterizing the mineralizing fluid

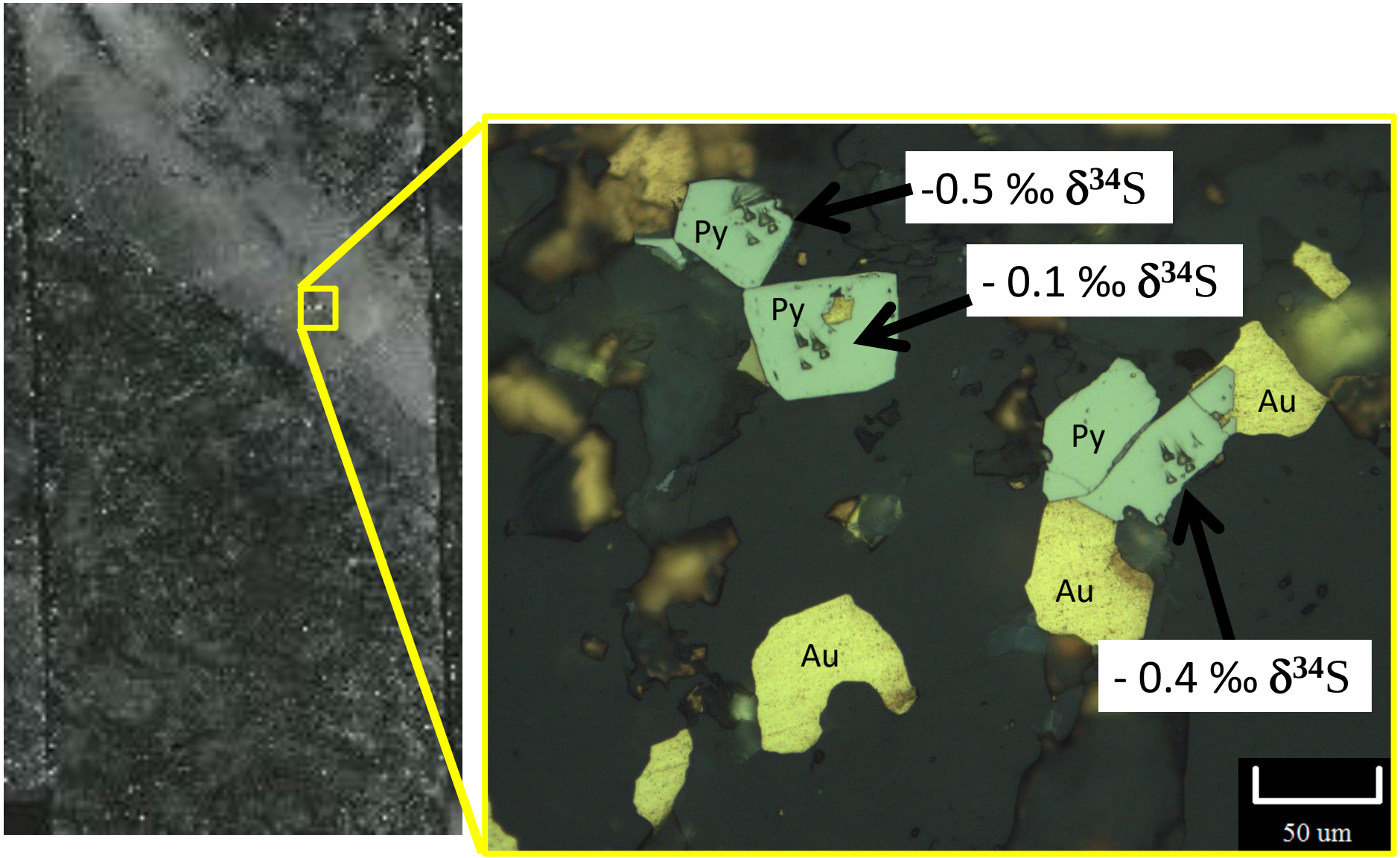
- What is the source of S and O within the fluid?
- How do these values compare with other deposit types?



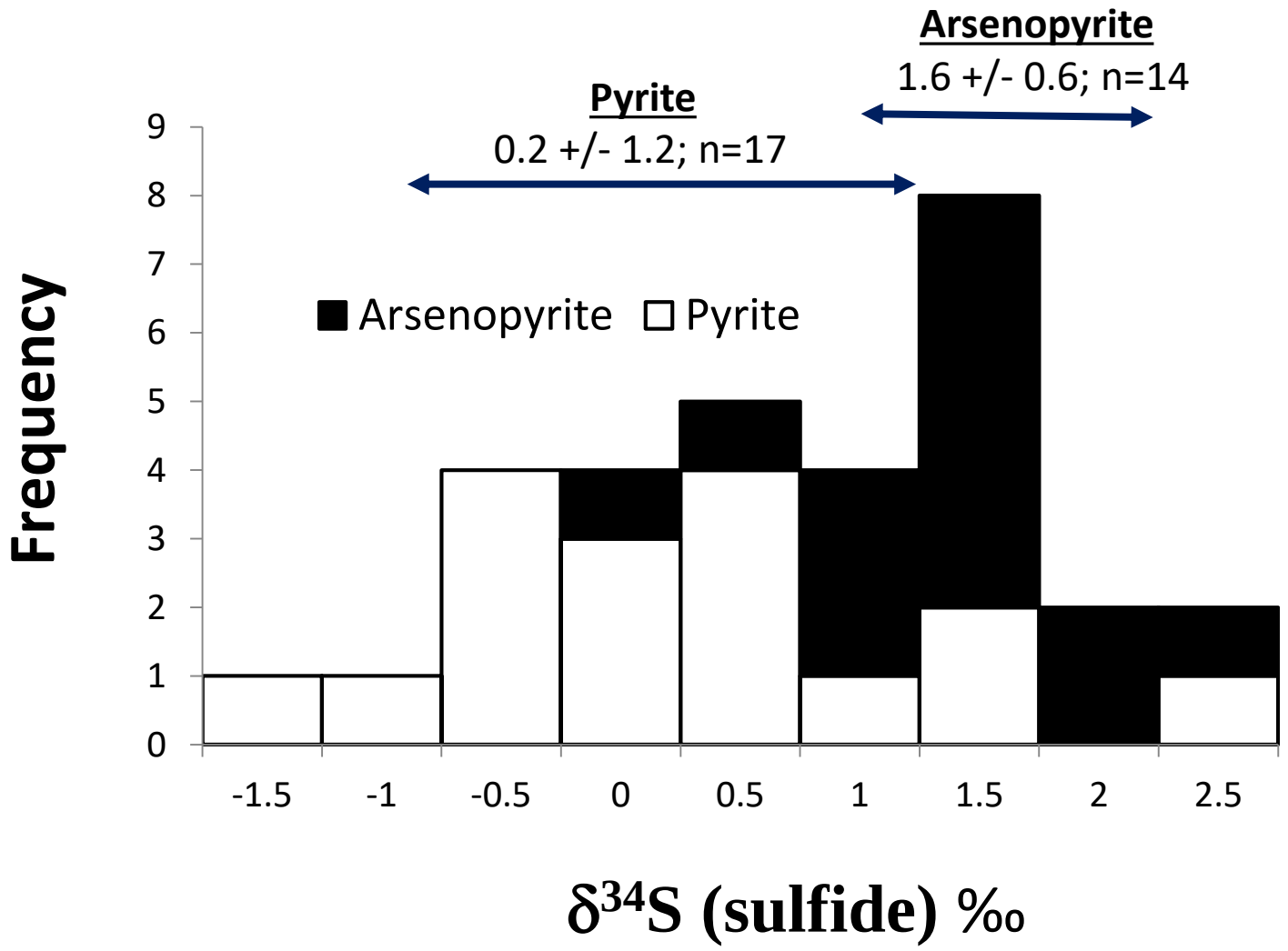




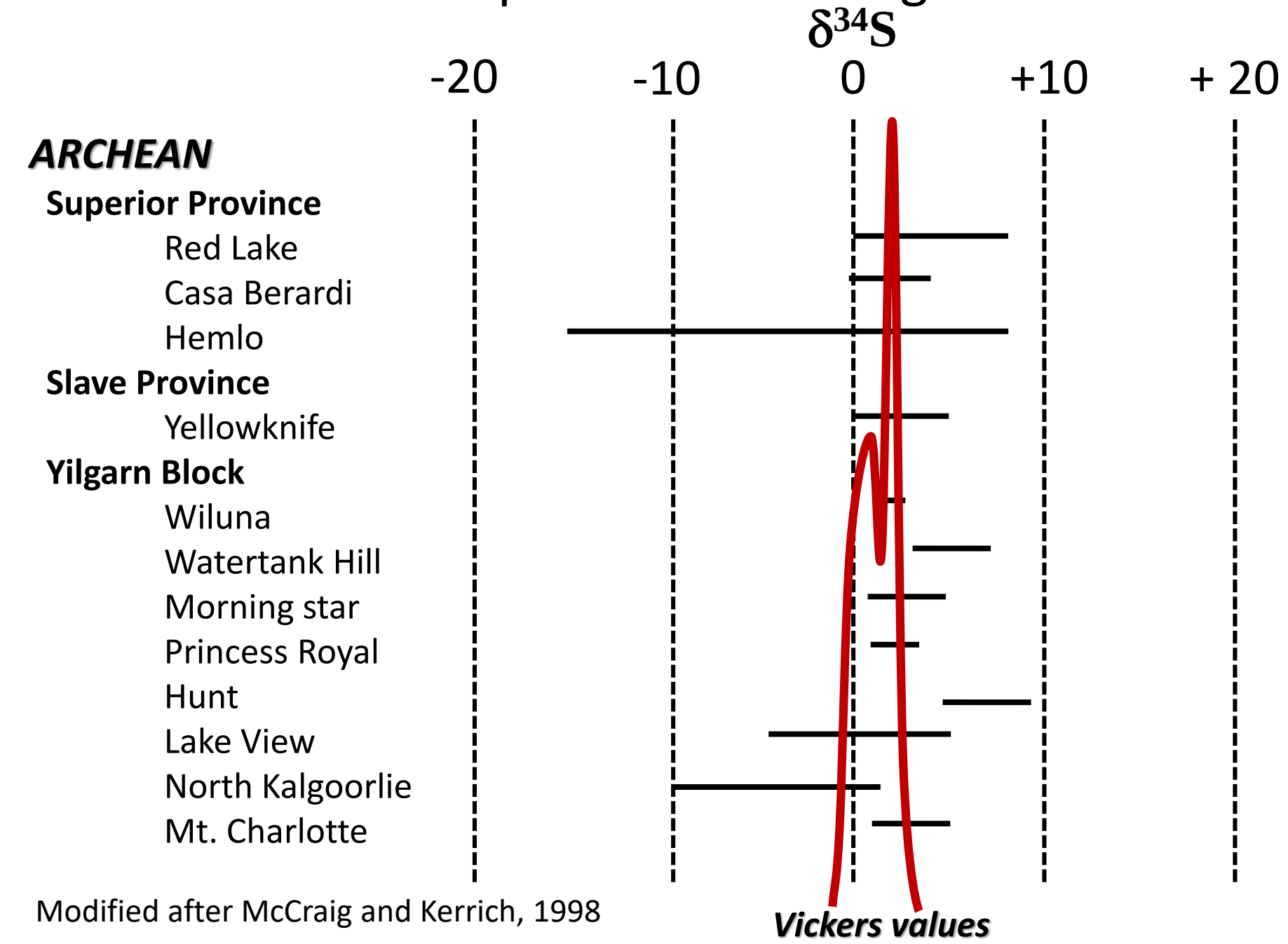
In situ sulphur isotopes ($\delta^{34}S$)



$\delta^{34}S$ from Vickers sulphide

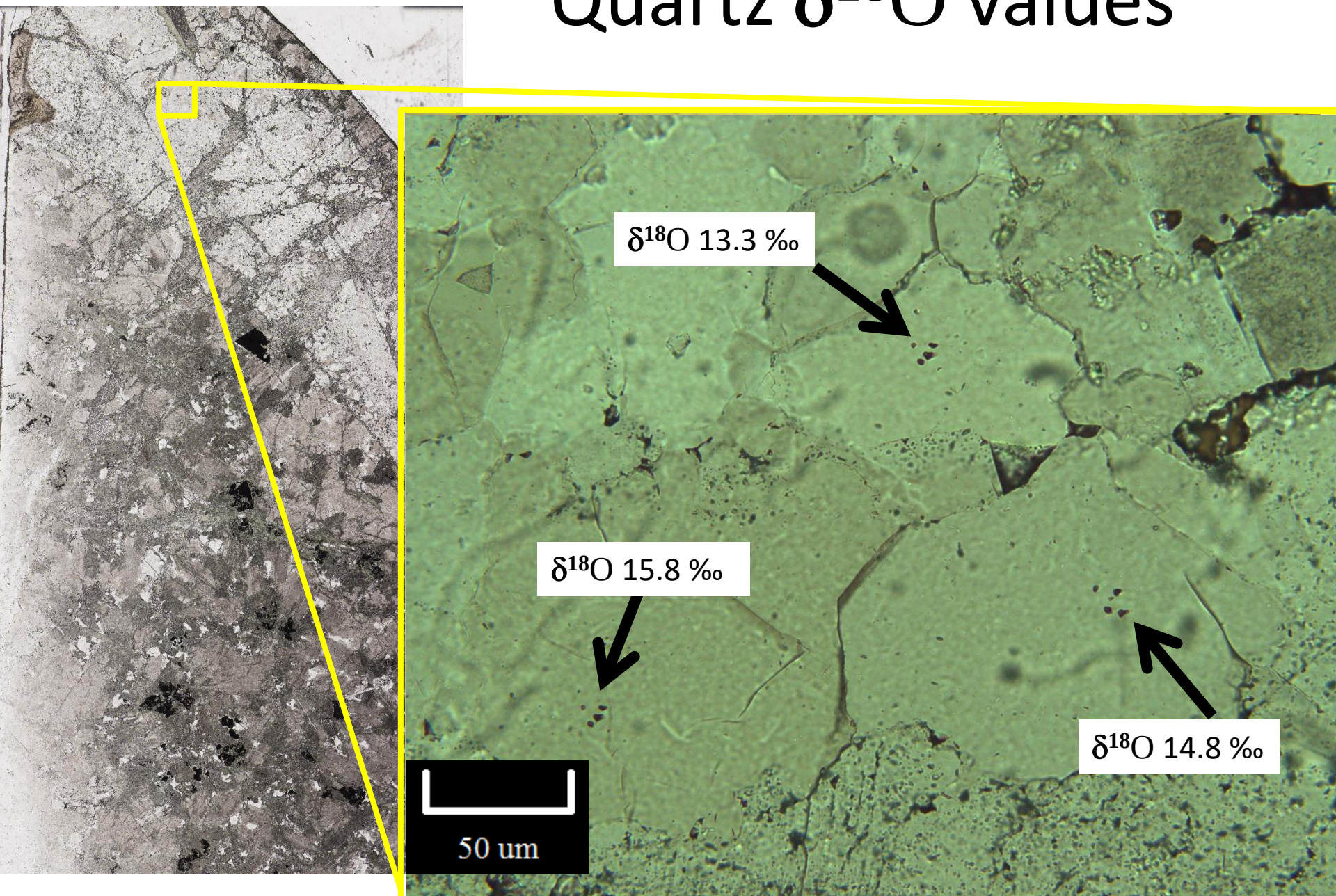


Reservoirs for sulphur in Archean greenstone belts



Modified after McCraig and Kerrich, 1998

Quartz $\delta^{18}O$ values



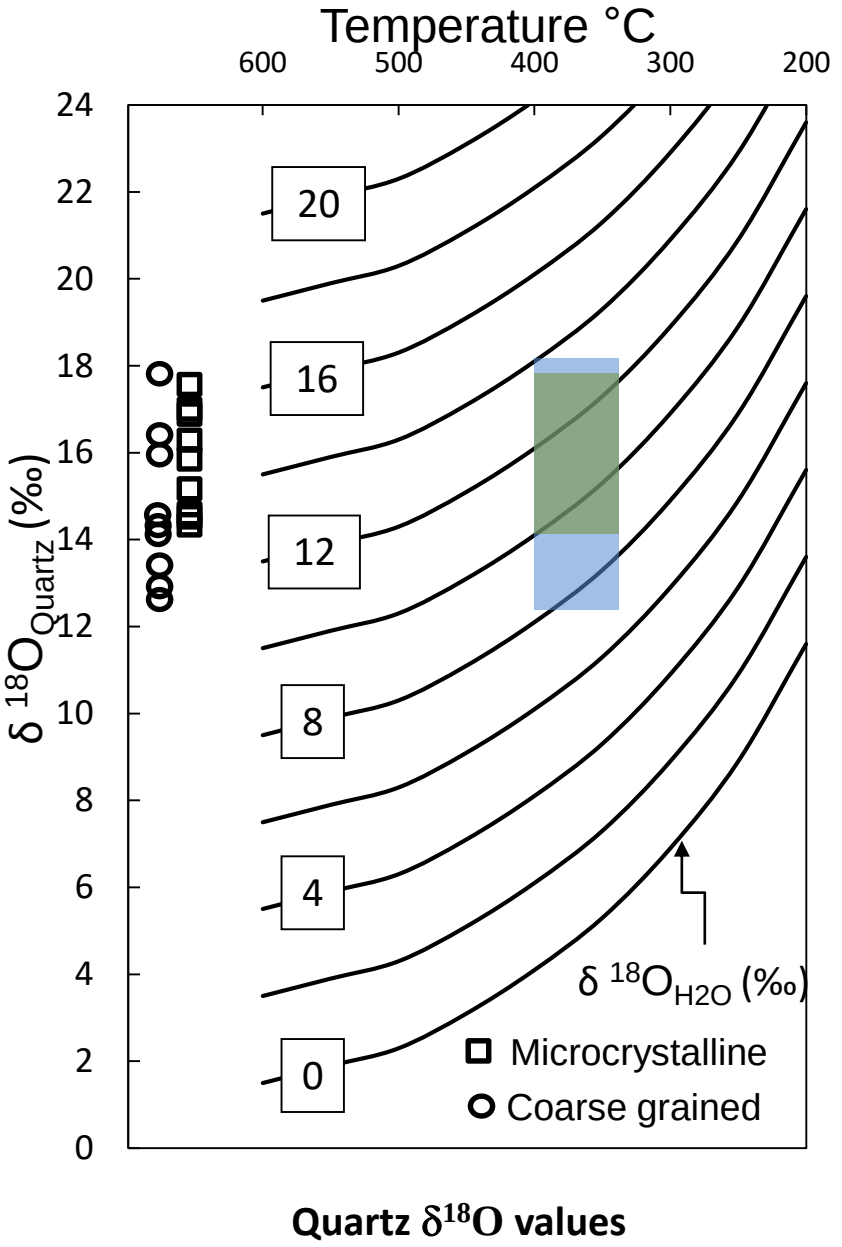
Matisuha temperature calculations

Convert measured values an entrapment temperature of 350-400°C using the quartz – H_2O fractionation equation.

Yielding range of $\delta^{18}O_{H2O}$

Coarse – 8.1 to 13.7 ‰

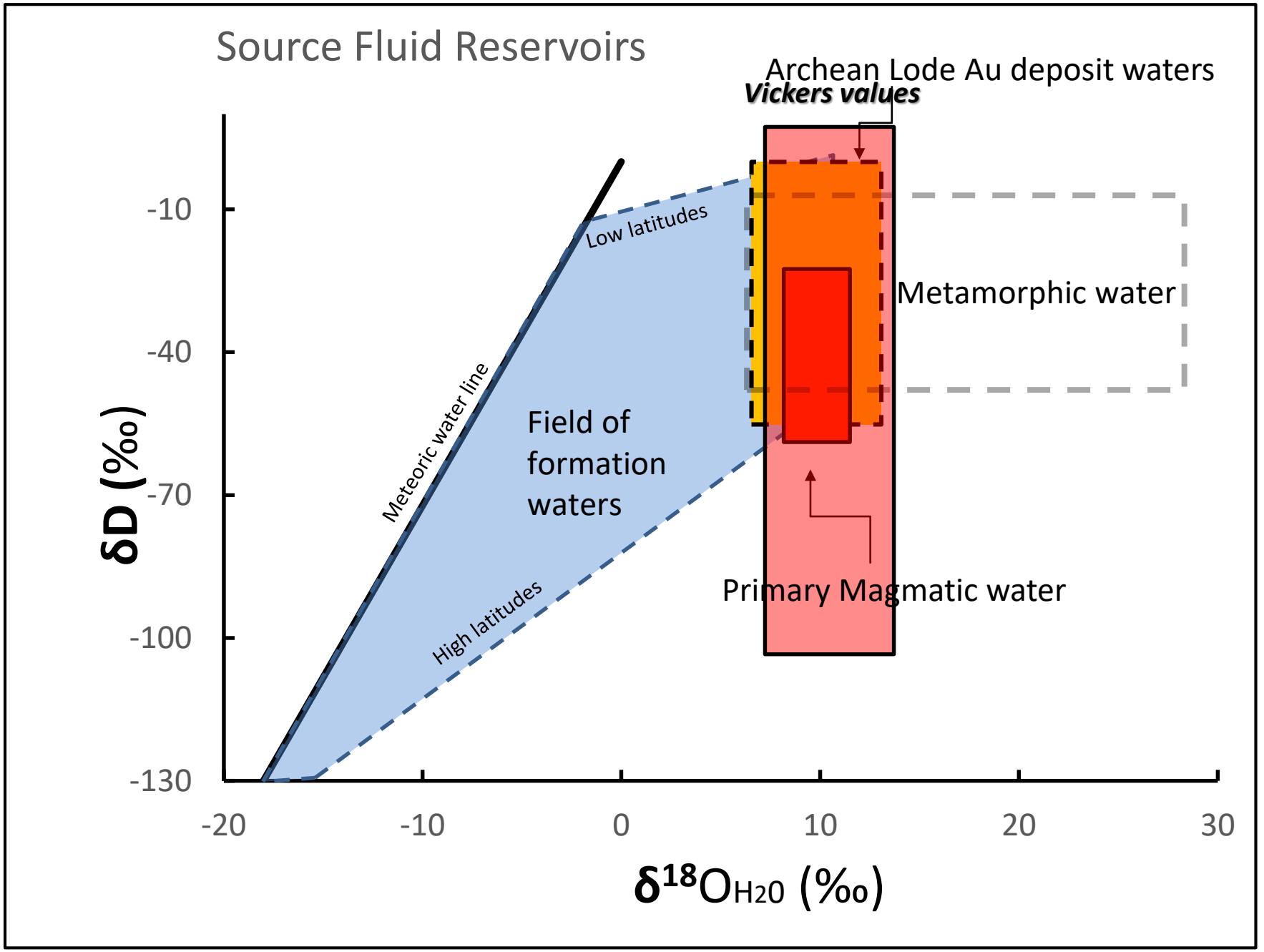
Microcrystalline – 9.4 to 13.6 ‰



Quartz $\delta^{18}O$ values

Microcrystalline: n = 9 x = 14.7 ‰ σ = 1.6 ‰

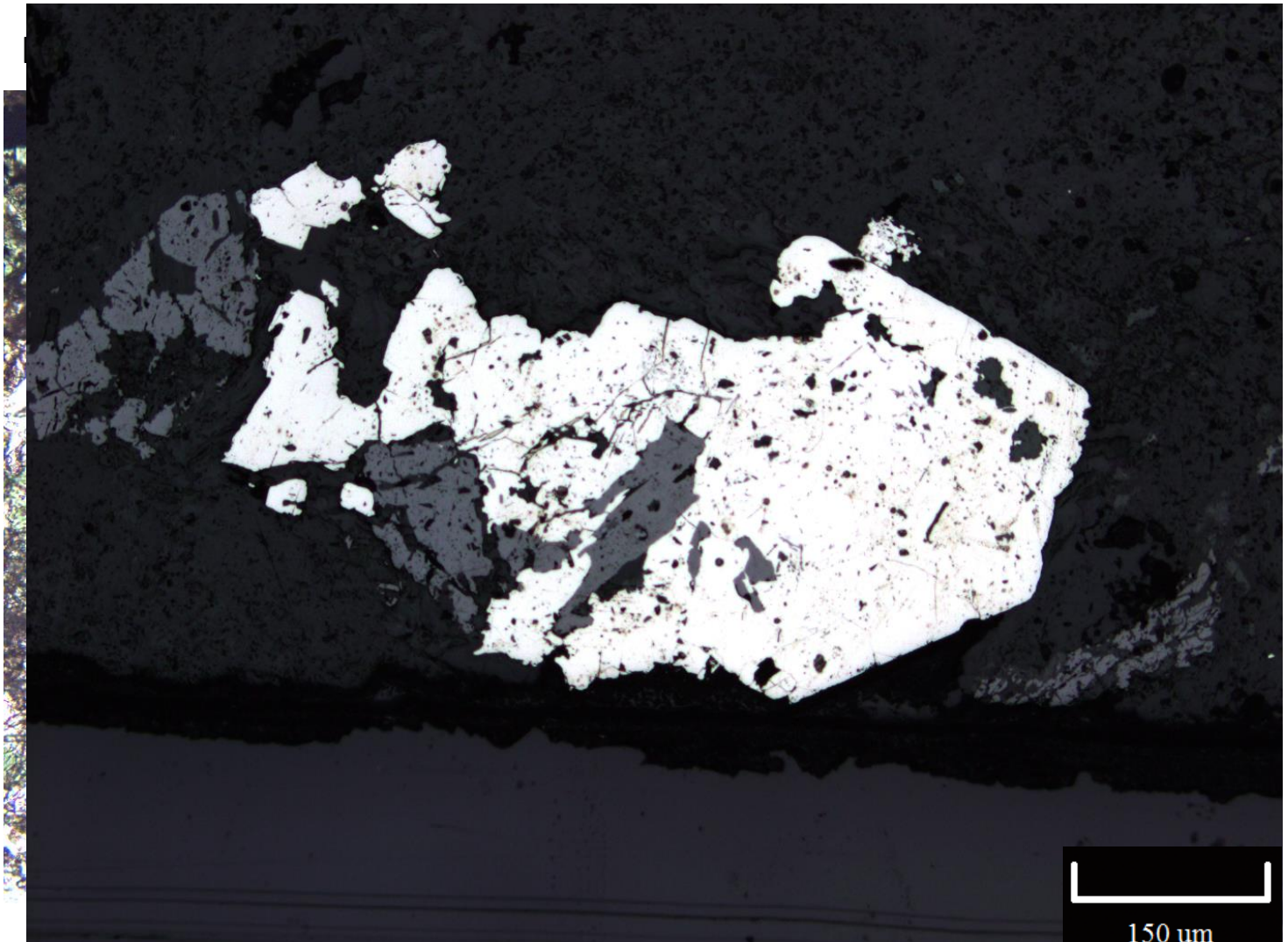
Coarse: n = 10 x = 14.4 ‰ σ = 1.1 ‰



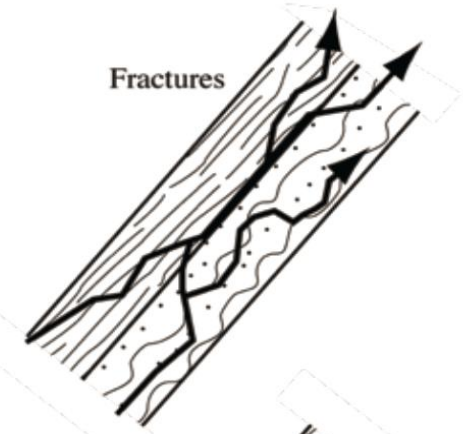
Modified from McCuaig and Kerrich, 1998

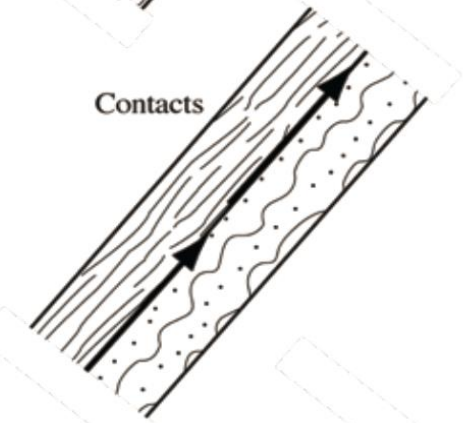
Gold deposition – Wallrock sulphidation

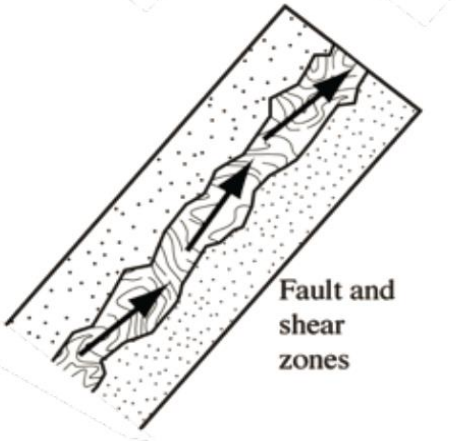
- $Fe\ Silicates_{Pyx+Amph+Biot} + xH_2S = xFeS_2 + xH_2O + xH_2$
- $Fe\ Oxide_{Ilm} + xH_2S = xFeS_2 + xH_2O + xH_2$



Rheological anisotropy



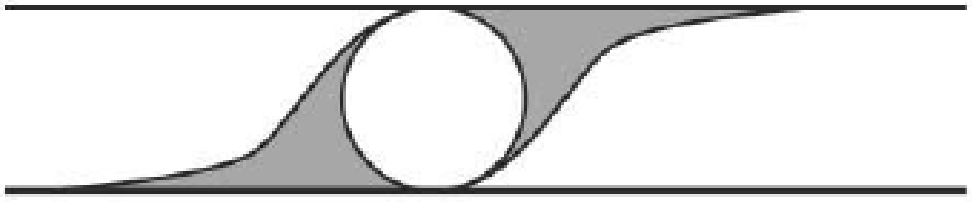




Geologic contacts and/or factures served as conduits for focused fluid

These fluids reacted with wall rocks, resulting in silica and carbonate alteration assemblages

Alteration intensity is most pervasive along the north-west and south-east contacts. Suggesting, that these areas were preferentially dilalatent during the influx of mineralising fluid



Model – Vickers

- A metamorphic fluid carried sulphur + Au from a source that had magmatic ($\delta^{34}S$ ~0 ‰) signature.

- This metamorphic fluid at a temperature of 350-400^{o}C was focused along the contact between the Vickers intrusion and the Kaminak Group sediments, resulting in hydrothermal alteration

- The fluid reacted with the Fe from the intrusion destabilizing Au out of solution, resulting in Au contained within refractory phases or as electrum.

Acknowledgments

Dr. Kontak