Mineral deposits in Egypt: A review and recommendations

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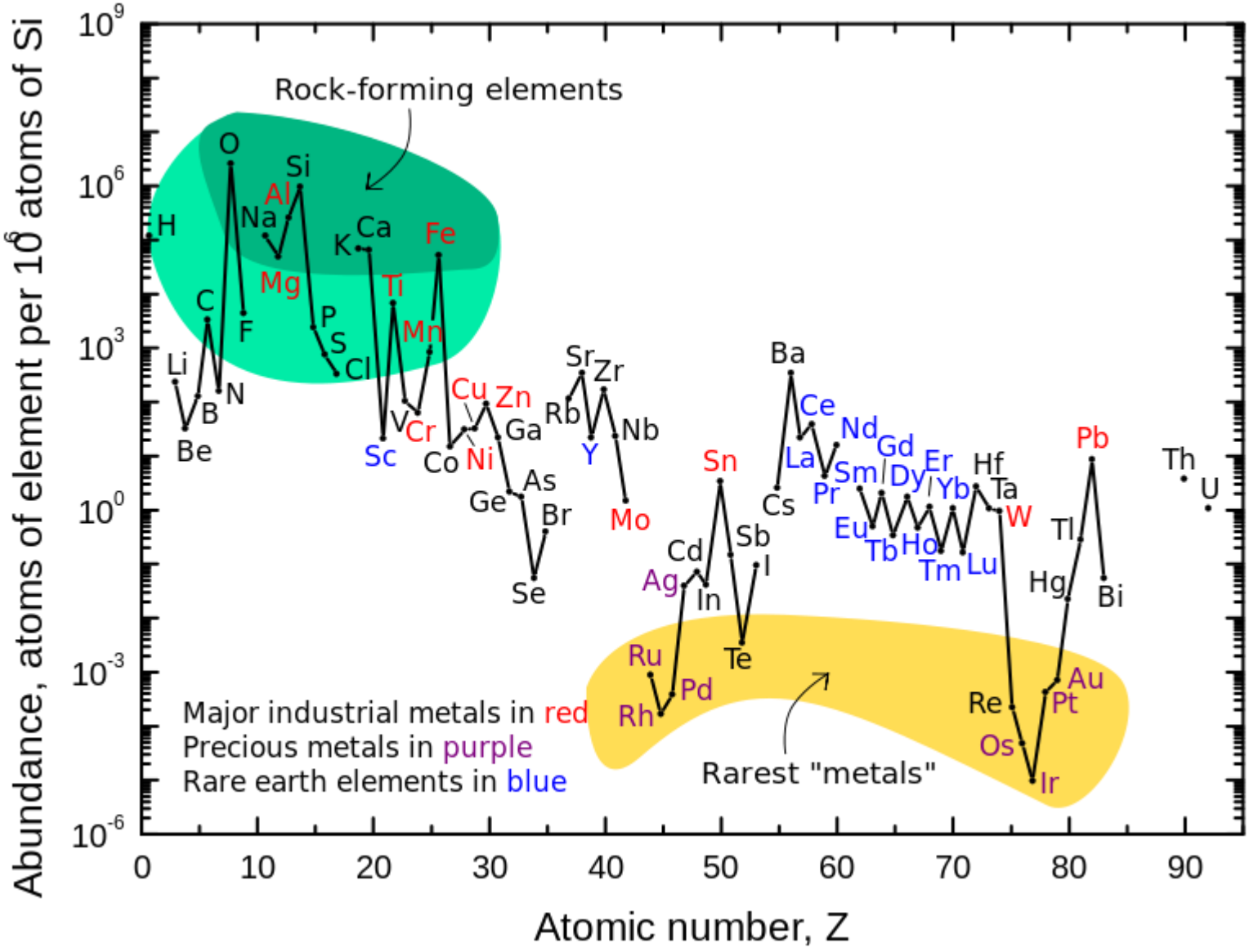
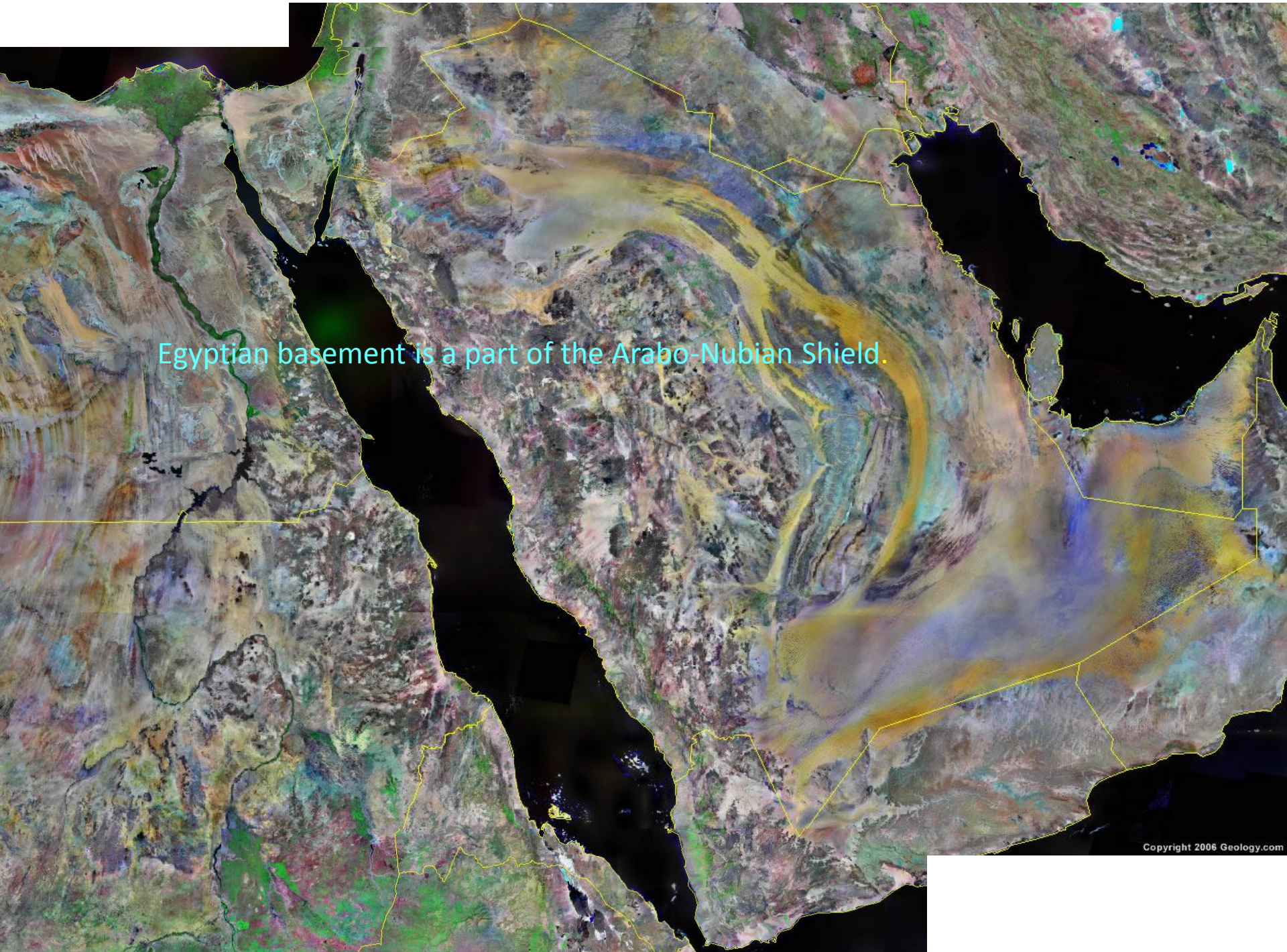

Abundance, atoms of element per 10^6 atoms of Si
Atomic number, Z
Rock-forming elements
Major industrial metals in red
Precious metals in purple
Rare earth elements in blue
Rarest "metals"
H
Li
Be
B
C
N
O
F
Na
Mg
Al
Si
P
S
Cl
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Rb
Sr
Y
Zr
Nb
Mo
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Cs
Ba
La
Ce
Pr
Nd
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Hf
Ta
W
Re
Os
Ir
Pt
Au
Hg
Tl
Pb
Bi
Th
U


Tantalum Scrap 99.9%
Vacuum Processors
5 Years - $/KG
Ta
MetalPrices.com
480
400
320
240
160
80
28 Feb, 2007 - 31 Jan, 2012


London Silver Cash Price
5 Years - $/Troy oz
Ag
MetalPrices.com
50
40
30
20
10
0
20 Feb, 2007 - 20 Feb, 2012

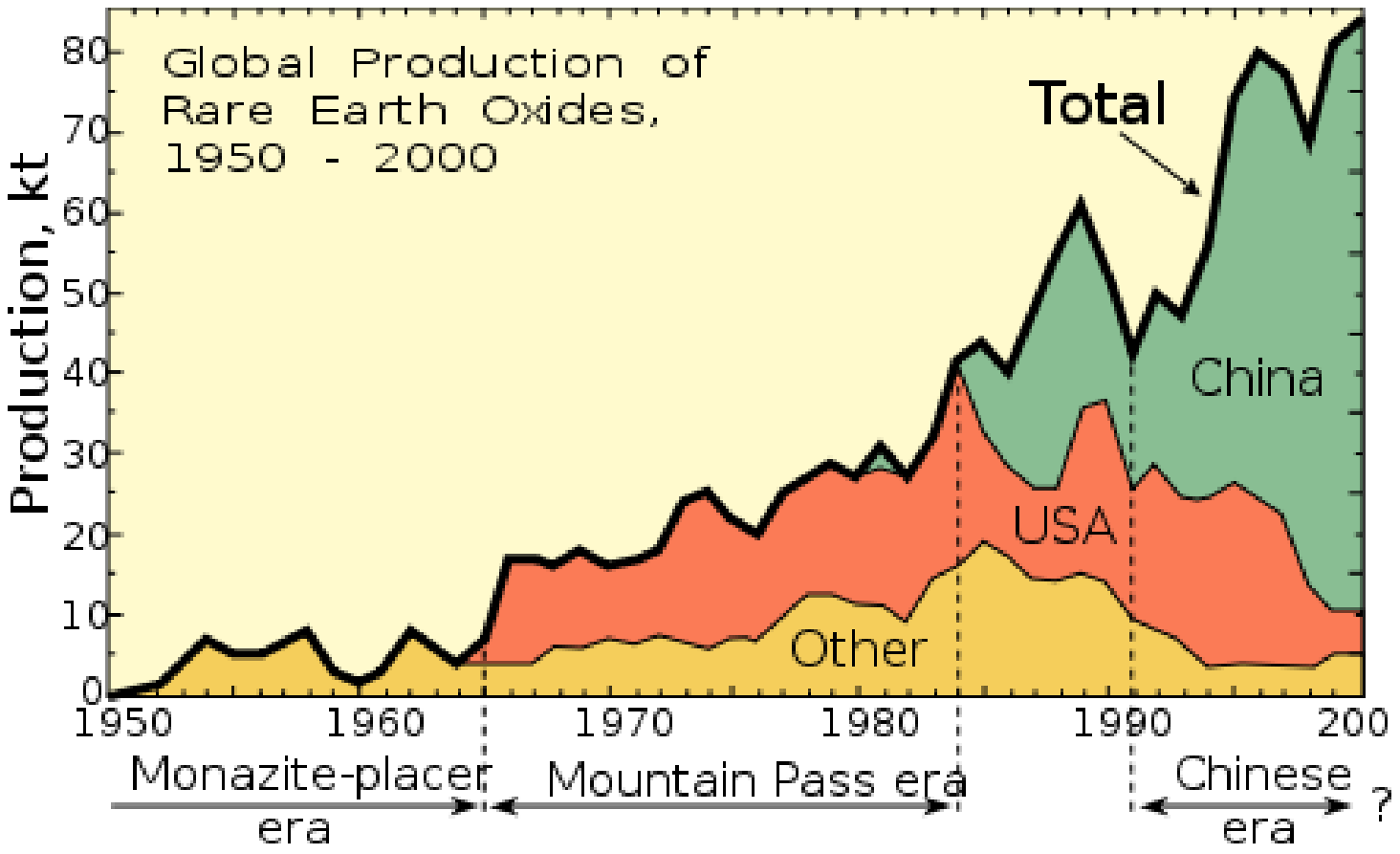

NYMEX Palladium 5 Years - $/Troy oz
Pd
MetalPrices.com
1,000
800
600
400
200
0
20 Feb, 2007 - 17 Feb, 2012


London Gold Cash Price
5 Years - $/Troy oz
Au
MetalPrices.com
2,000
1,600
1,200
800
400
20 Feb, 2007 - 20 Feb, 2012


Egyptian basement is a part of the Arabo-Nubian Shield.
Copyright 2006 Geology.com

Rare metal deposits

Rare metal deposits



Rare metal world production

Tantalam mineralization in the Arabian–Nubian Shield

Tantalam mineralization in the Arabian–Nubian Shield

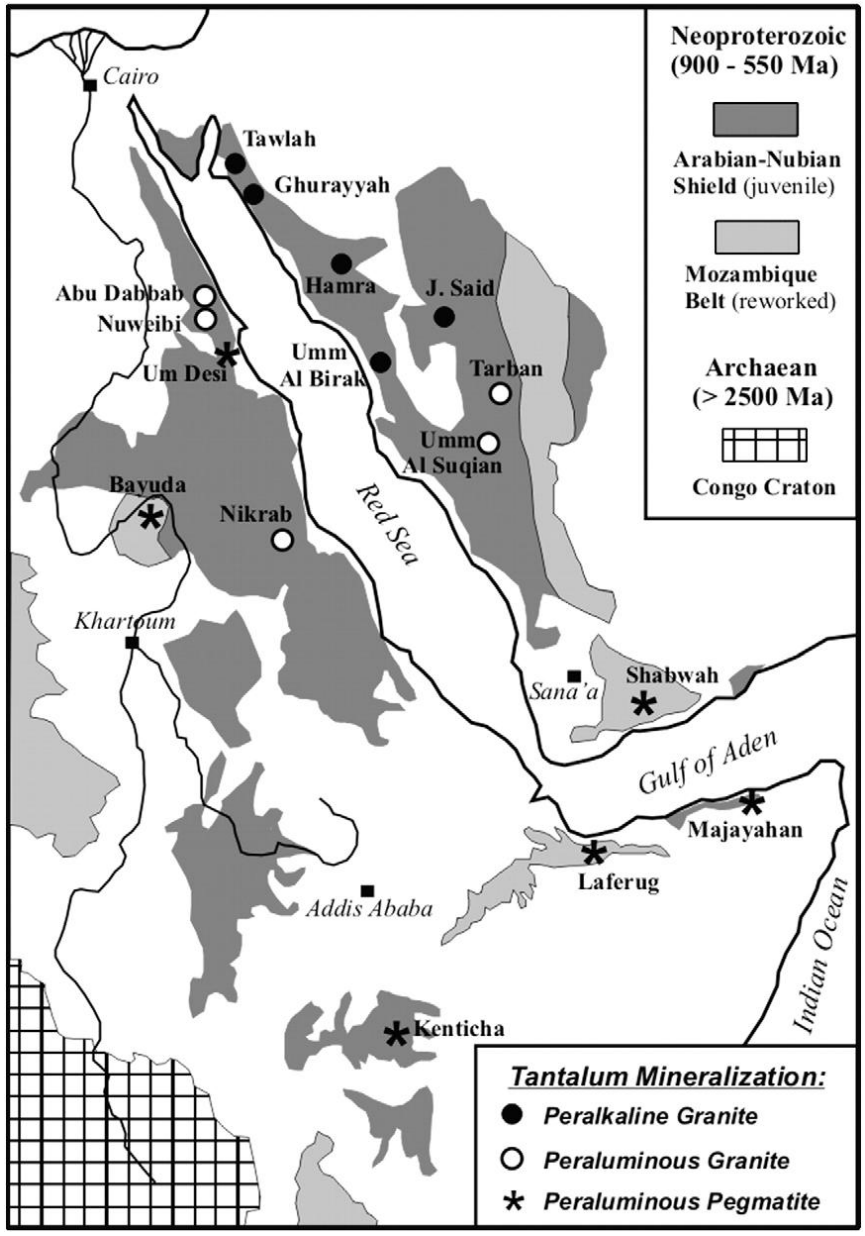
1 ton = 40,000 USD

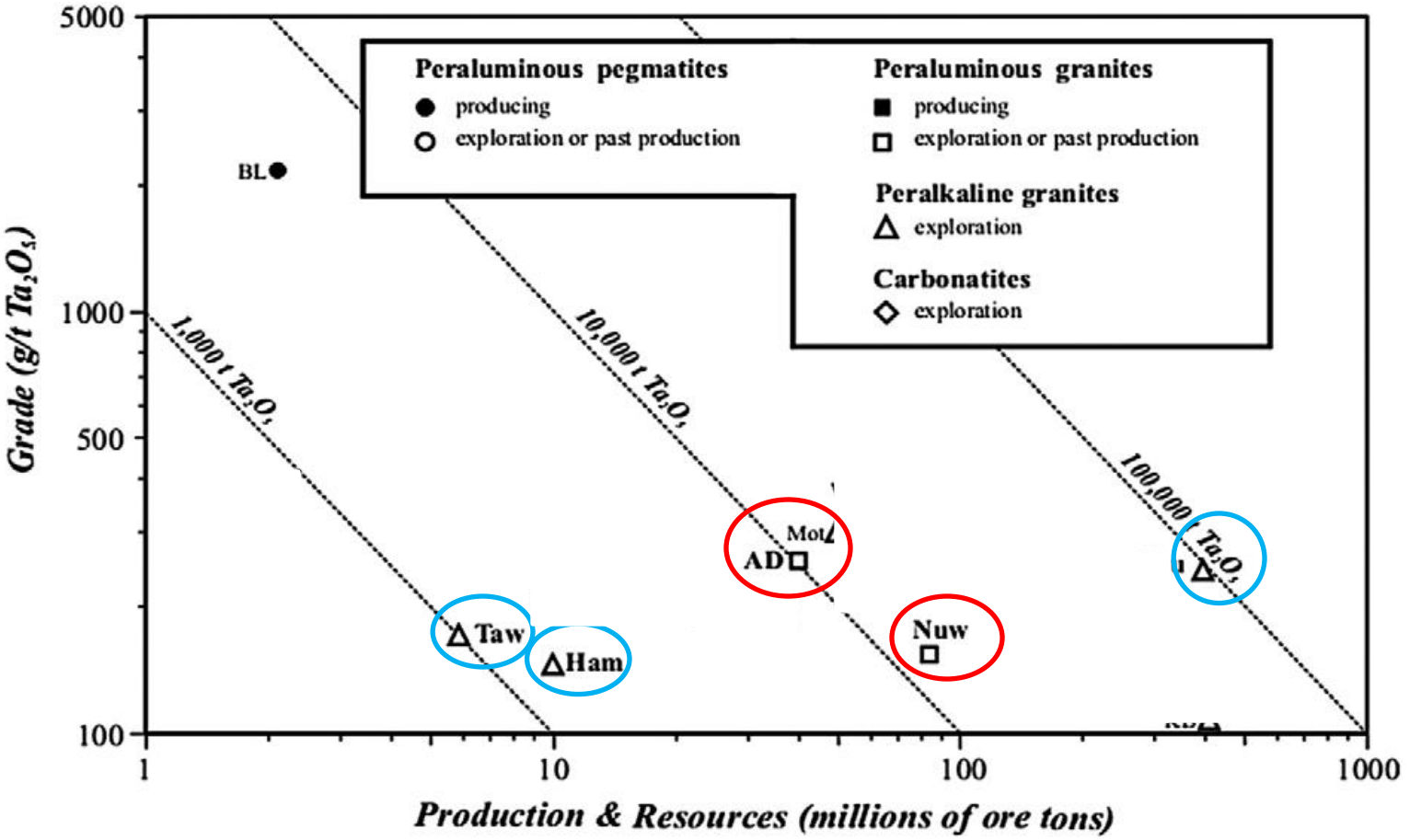
Granitoid-hosted Ta mineralization in the Arabian–Nubian Shield:

Geological sketch map of northeastern Africa and Arabia showing major crustal segments and the locations of tantalum deposits and mineralization.

peraluminous muscovite–albite granite (Abu Dabbab, Egypt)

peralkaline arfvedsonite-alkalifeldspar granite (Ghurayyah, Saudi Arabia)



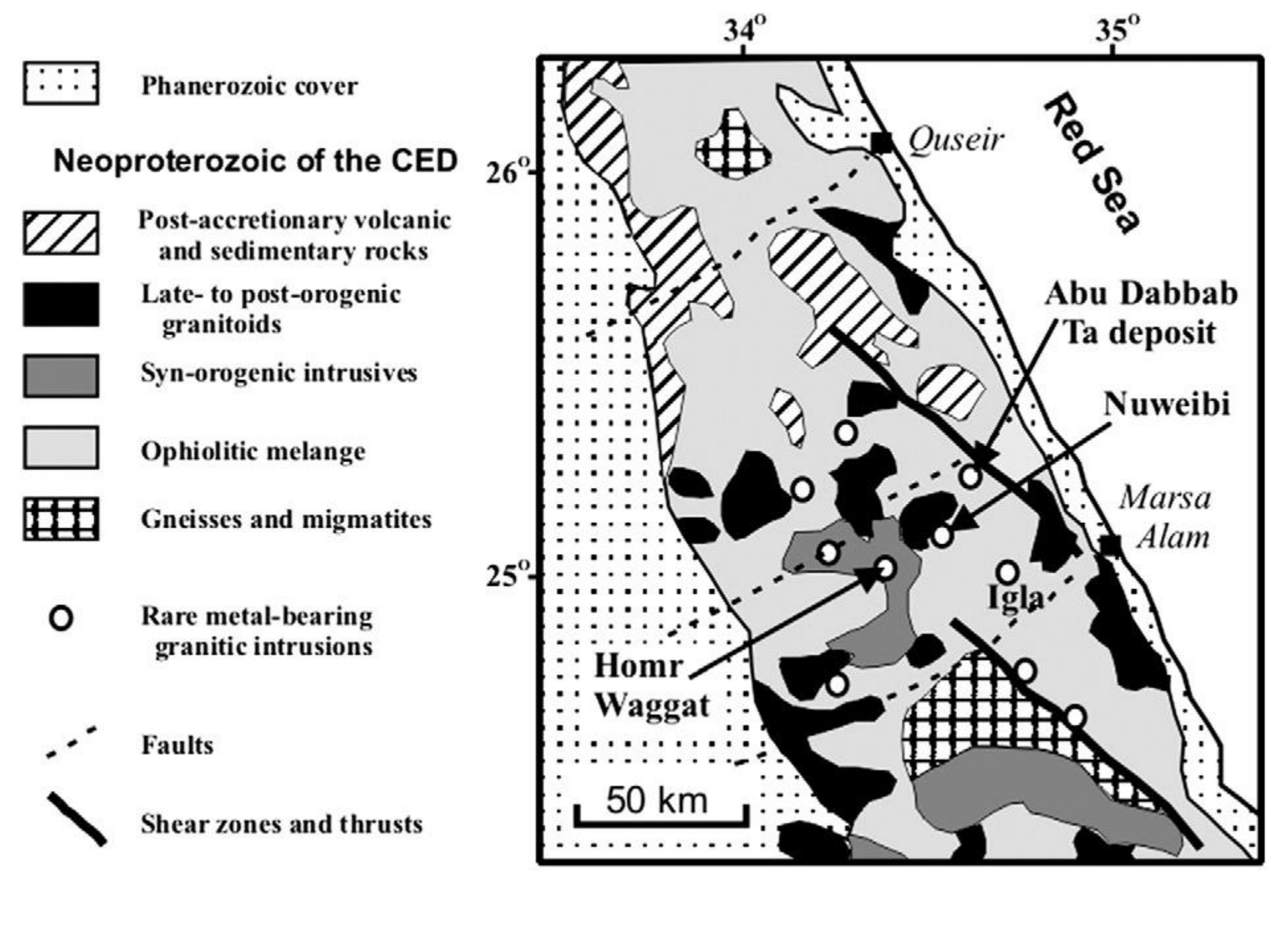


Peraluminous Pegmatites:
Ken = Kenticha, Ethiopia
Maj = Majayahan, Somalia

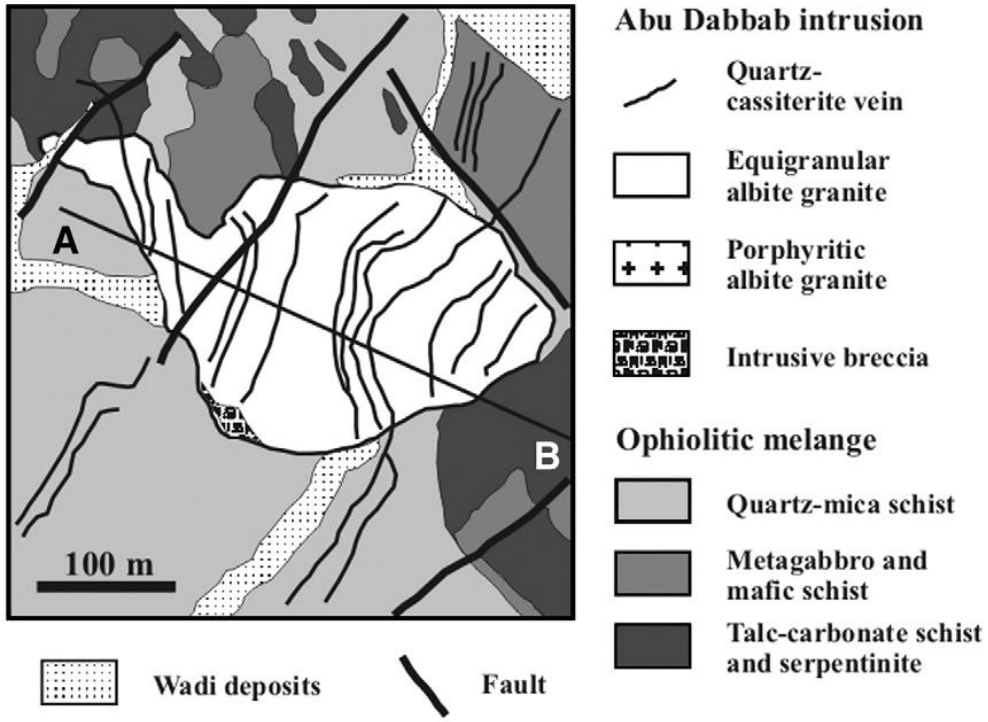
Peraluminous Granites:
AD = Abu Dabbab, Egypt
Nuw = Nuweibi, Egypt

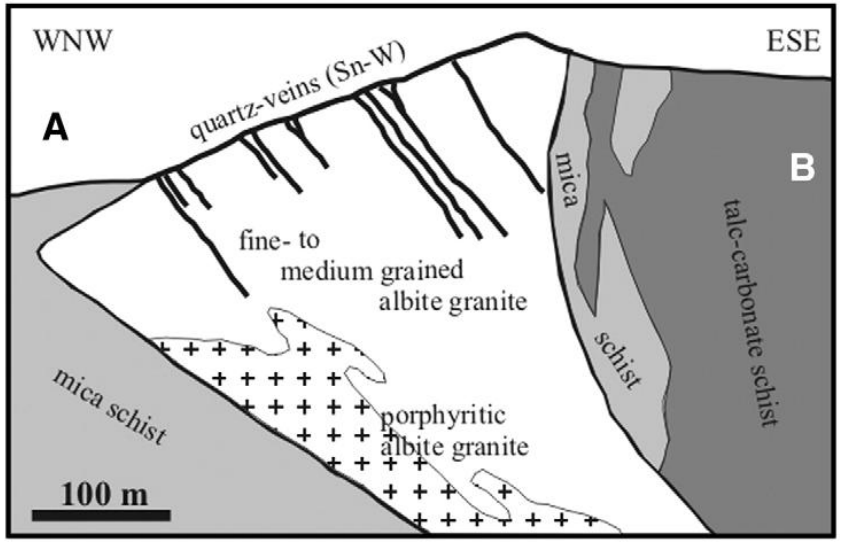
Peralkaline Granites:
Ghu = Ghurayyah, Saudi Arabia
Taw = J. Tawlah, Saudi Arabia
Ham = J. Hamra, Saudi Arabia

Plot of grade versus tonnage for major tantalum deposits of different genetic types


Phanerozoic cover
Neoproterozoic of the CED
Post-accretionary volcanic and sedimentary rocks
Late- to post-orogenic granitoids
Syn-orogenic intrusives
Ophiolitic melange
Gneisses and migmatites
Rare metal-bearing granitic intrusions
Faults
Shear zones and thrusts
34°
35°
26°
25°
Quseir
Red Sea
Abu Dabbab
Ta deposit
Nuweibi
Marsa Alam
Igla
Homr
Waggat
50 km

Geological sketch map and cross-section of the Abu Dabbab albite granite

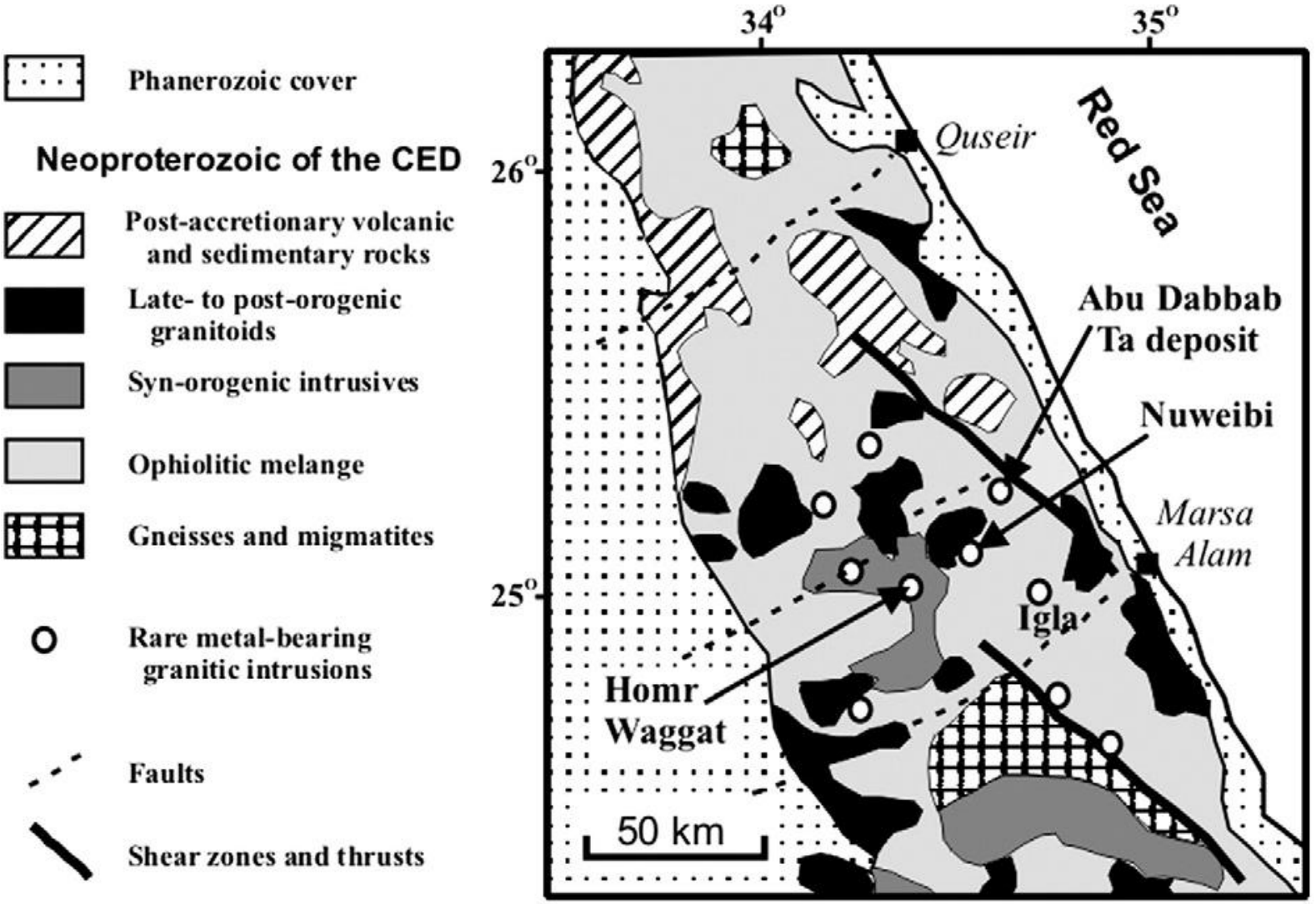




Recommendations:

All peraluminous granite masses should be investigated

Concessions on rare metal deposits

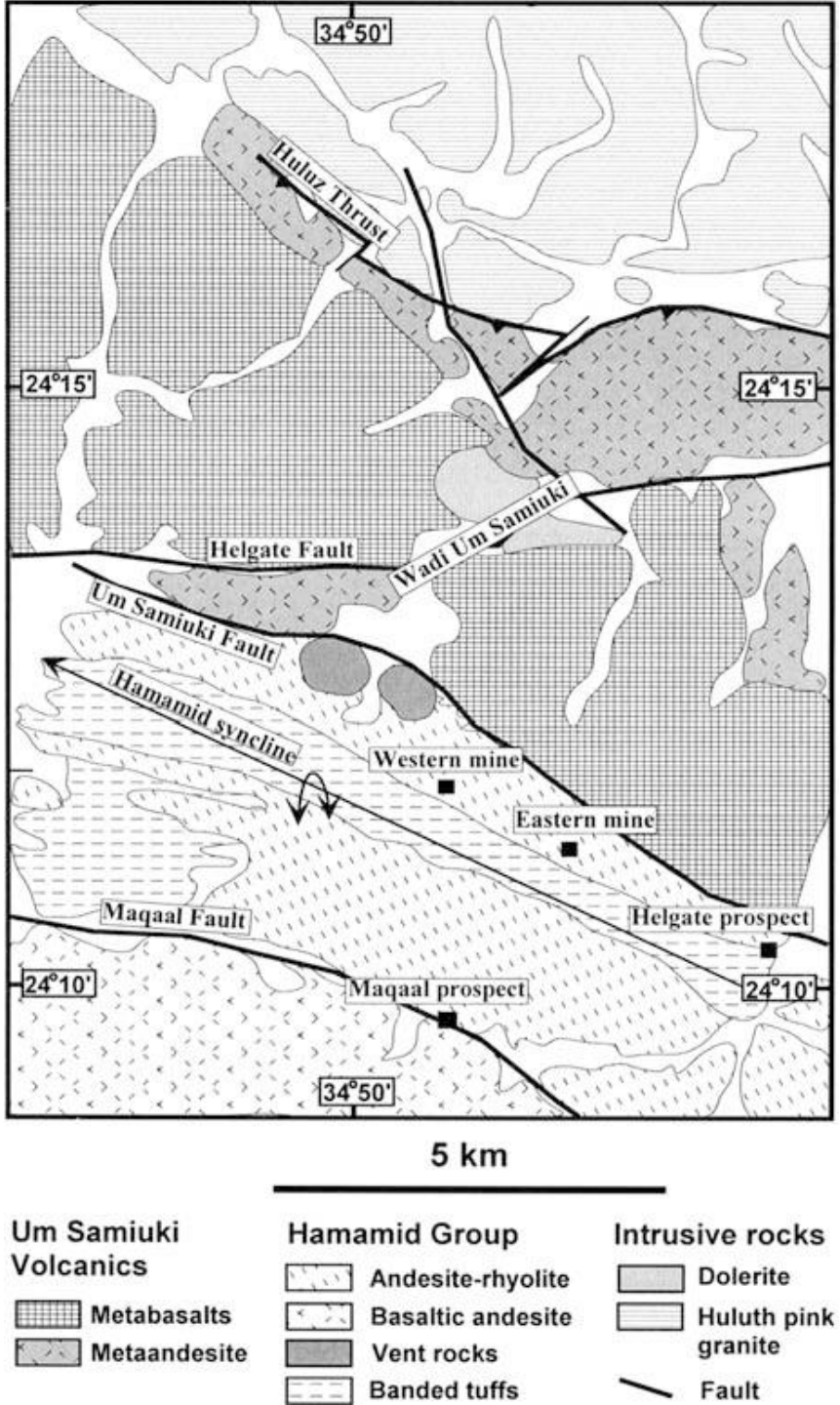


Copper-Lead-Zinc-Silver deposits

- More than 6 localities
- Hosted in the Shadli metavolcanic belt
- Massive ores with high tonnage at Um Samiuki
- Very high silver content (hundreds ppm)

Um Samiuki Zn-Cu-Pb-Ag deposit

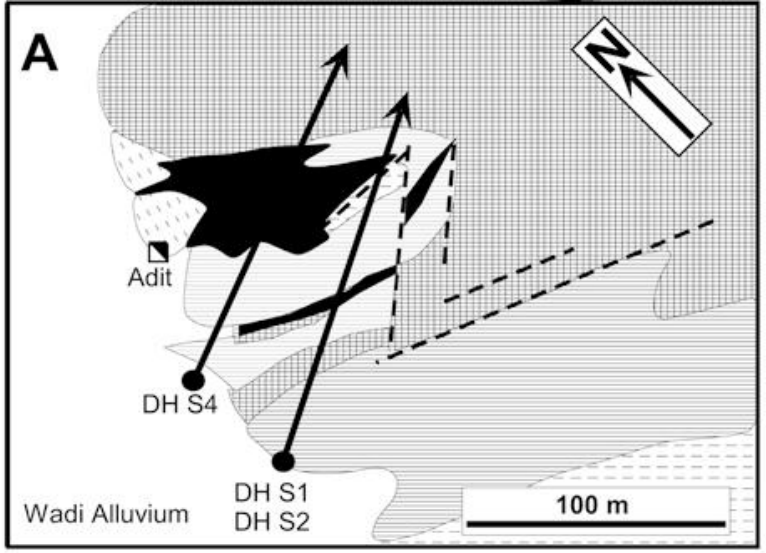
Host rocks: Shadli volcanics

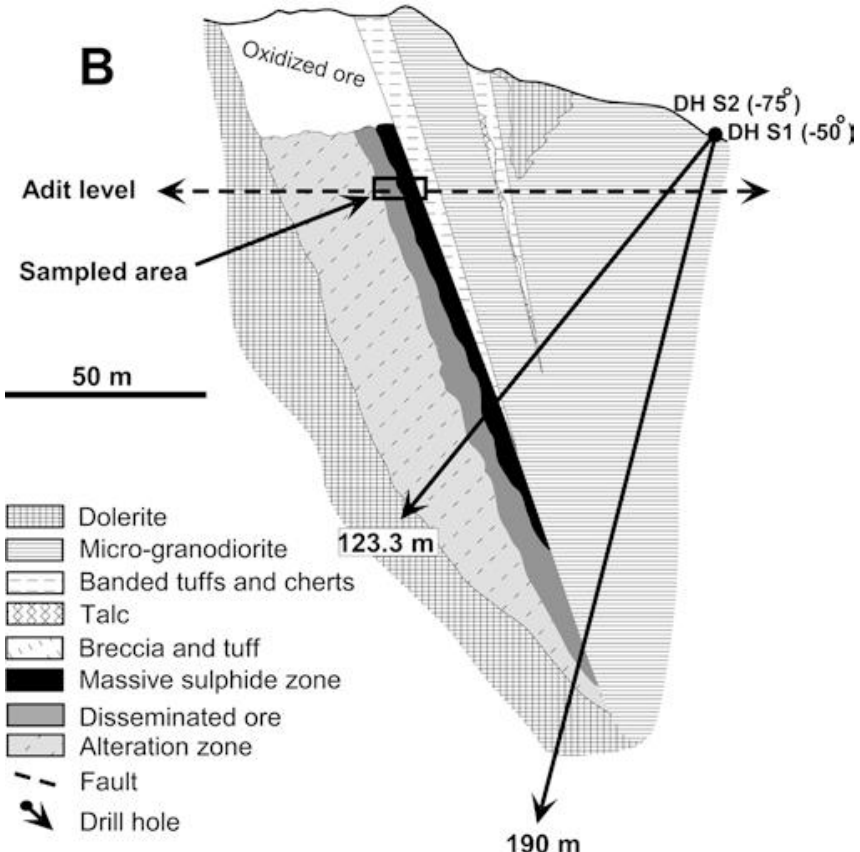


Um Samiuki Zn-Cu-Pb-Ag deposit

Previous exploration activities

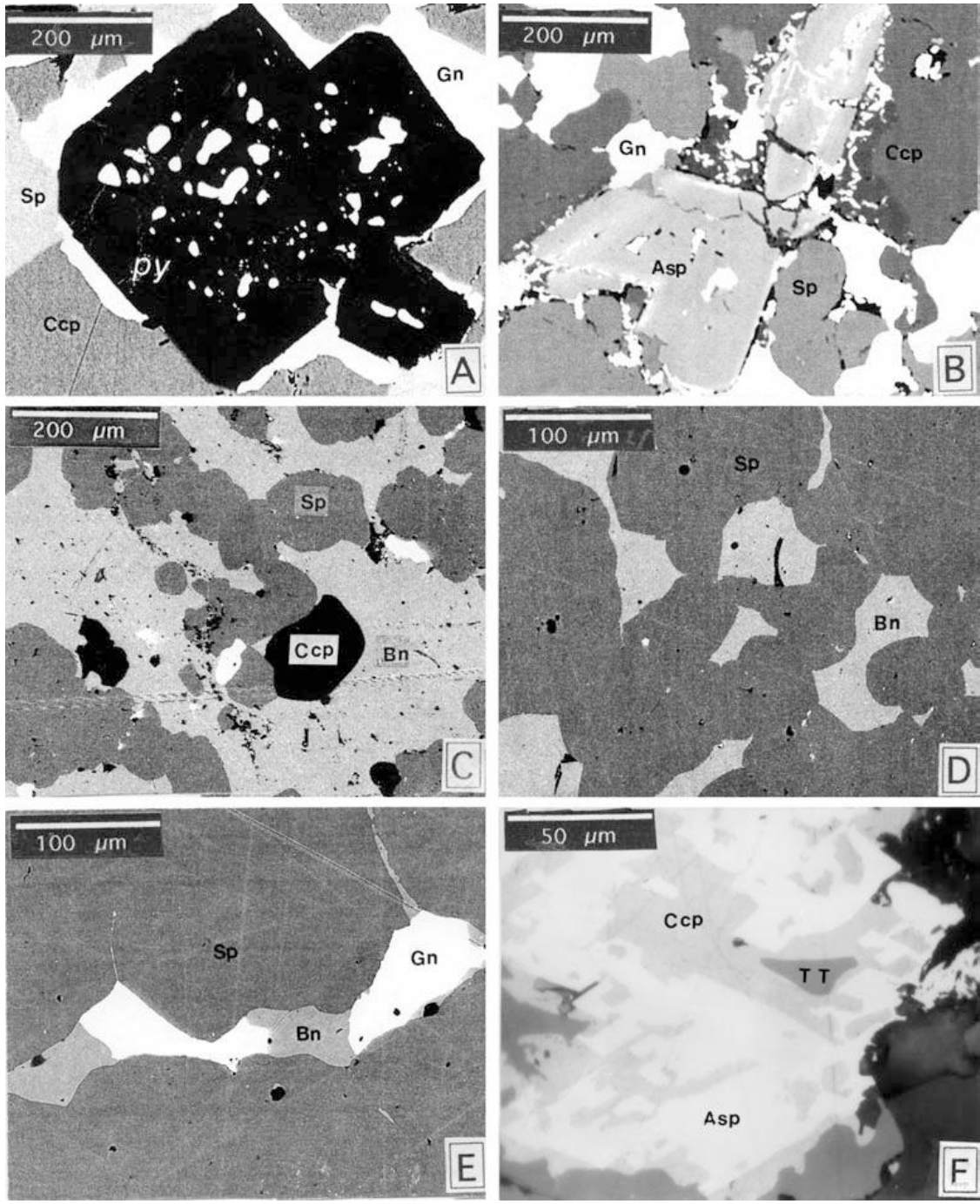
Reserves:
300,000 ton of massive ore



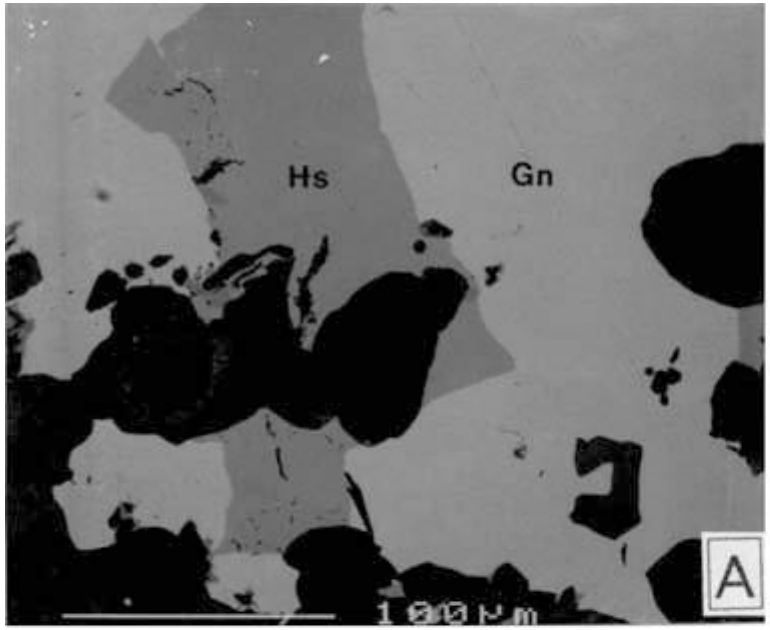


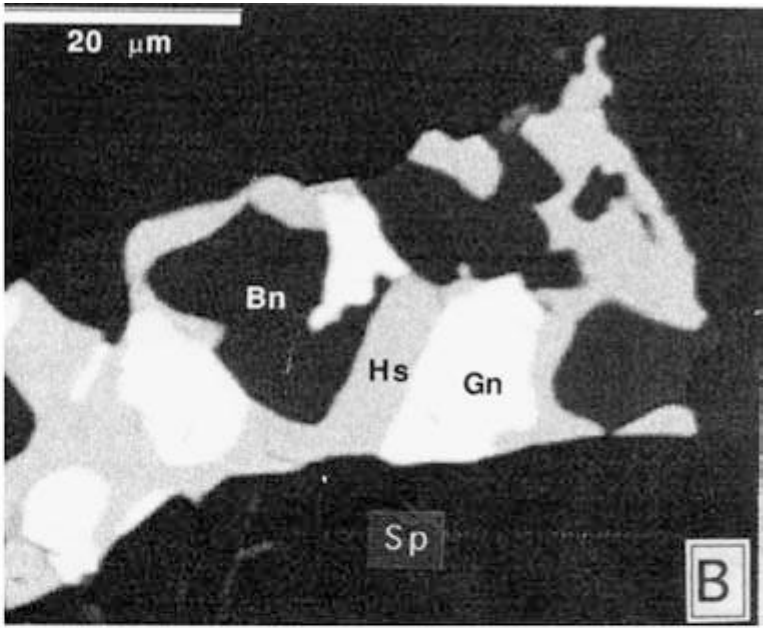
Um Samiuki

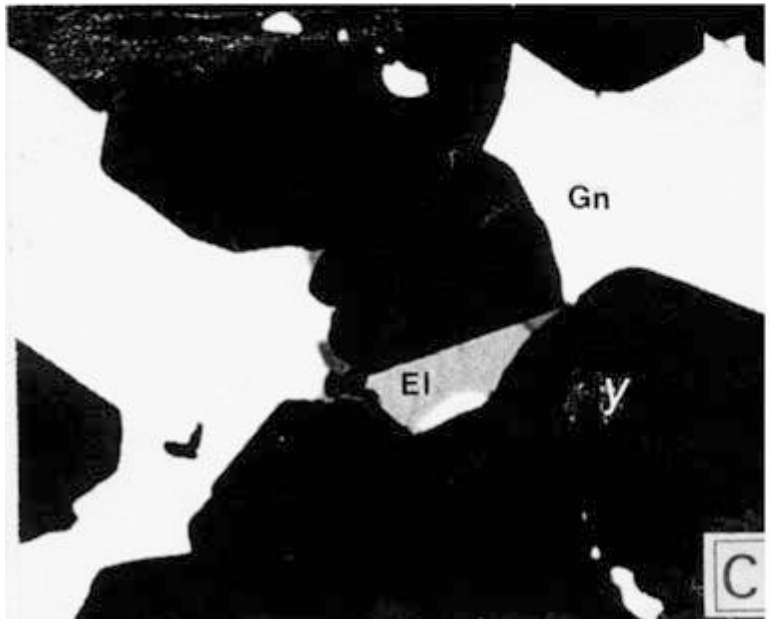
Massive ore textures

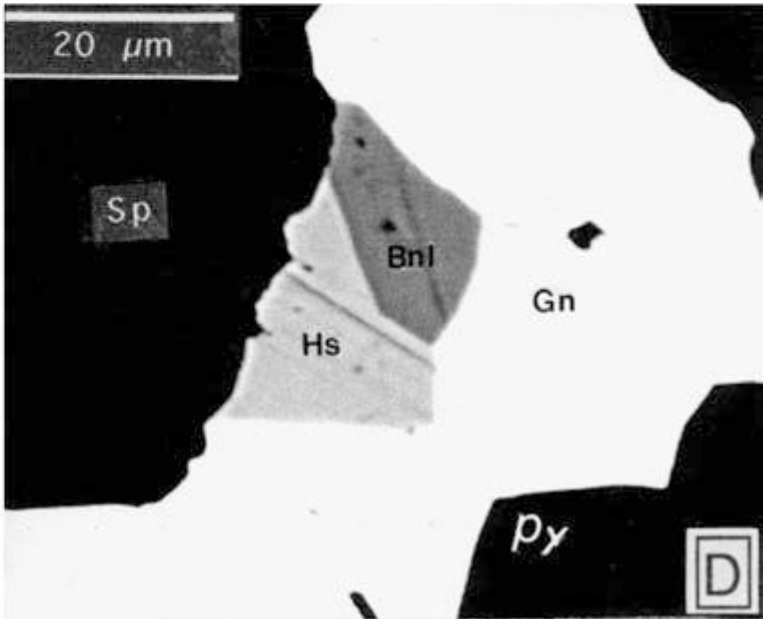


Um Samiuki: Silver minerals

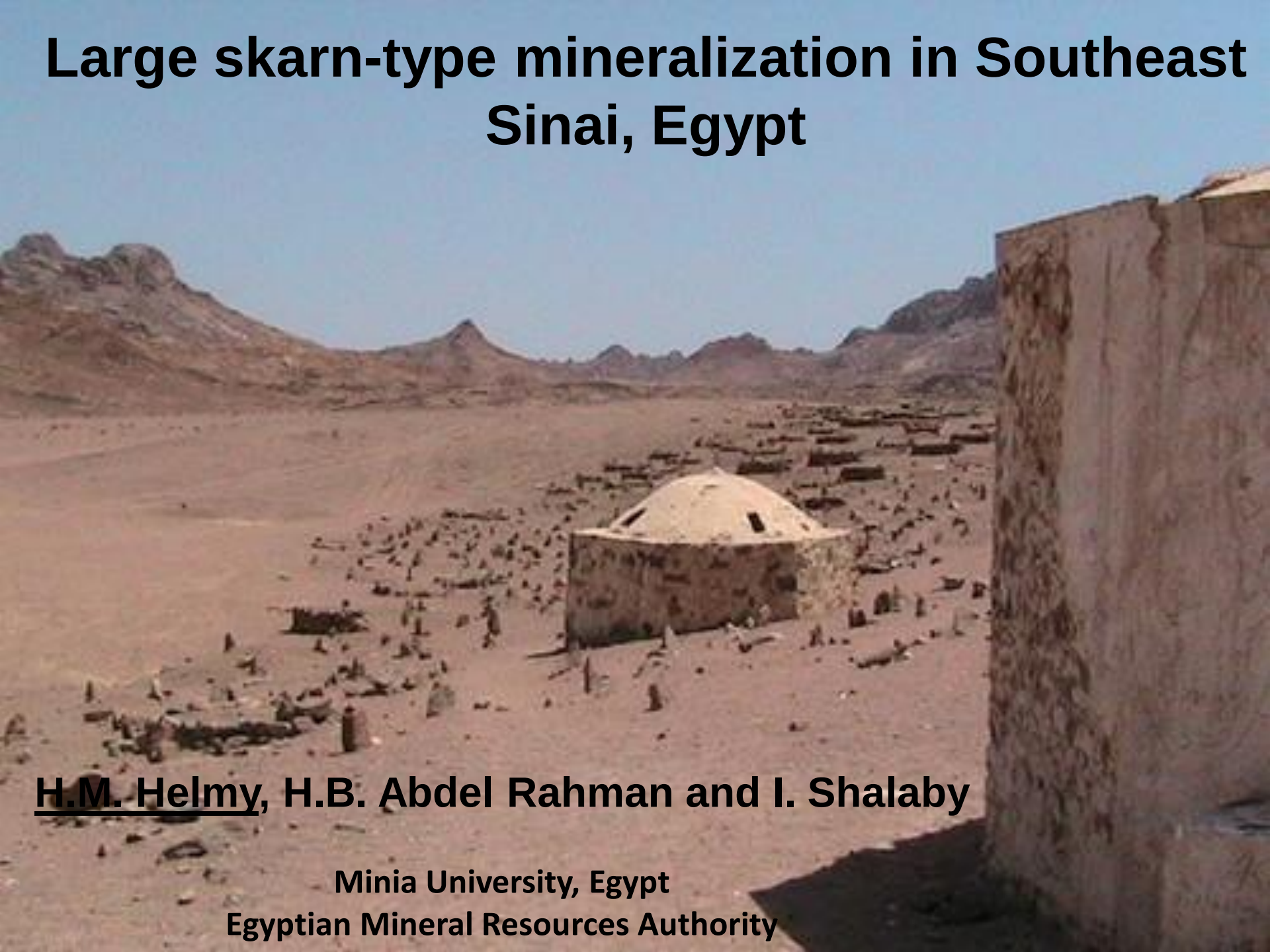








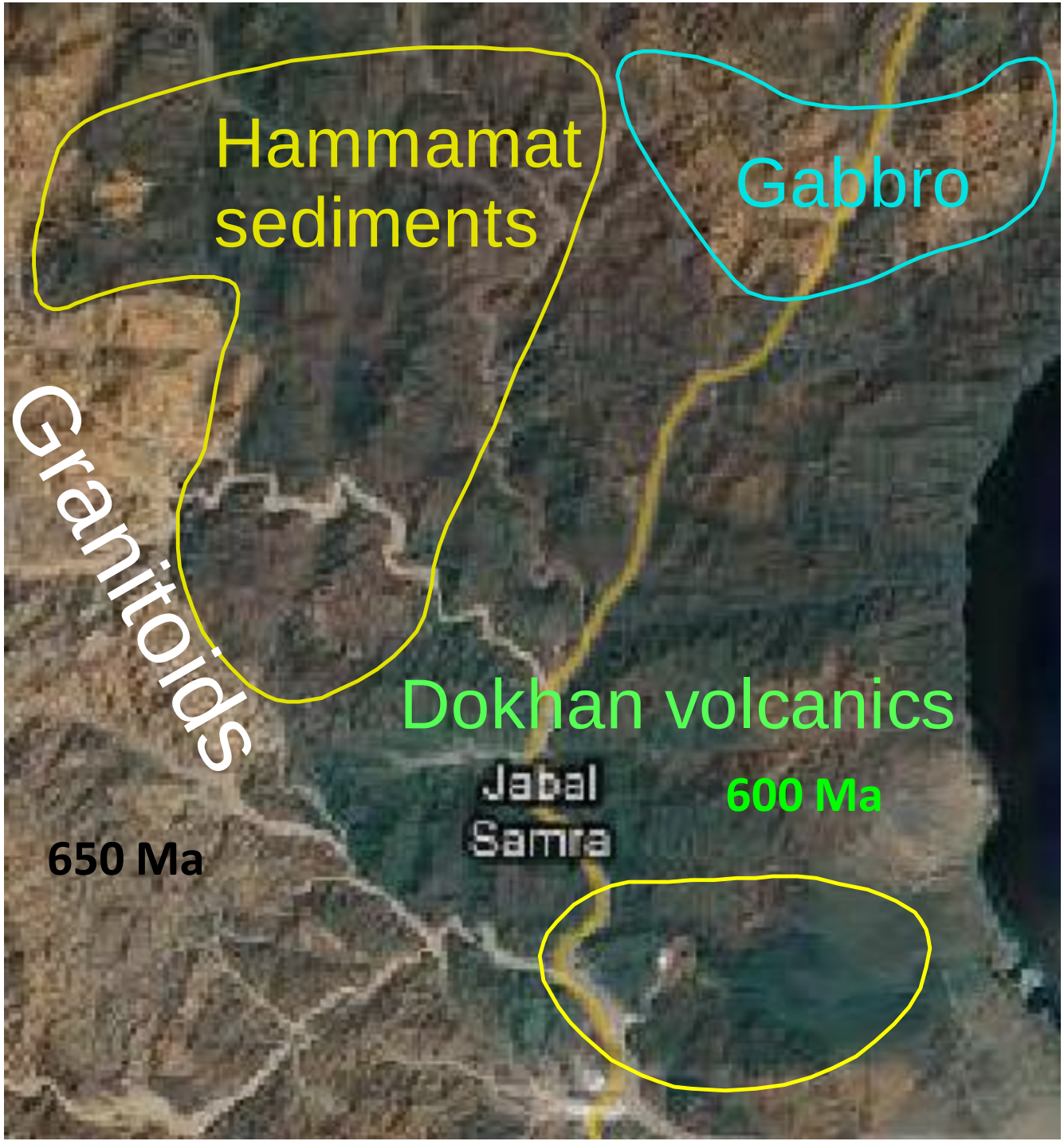
Large skarn-type mineralization in Southeast Sinai, Egypt



H.M. Helmy, H.B. Abdel Rahman and I. Shalaby

Minia University, Egypt
Egyptian Mineral Resources Authority

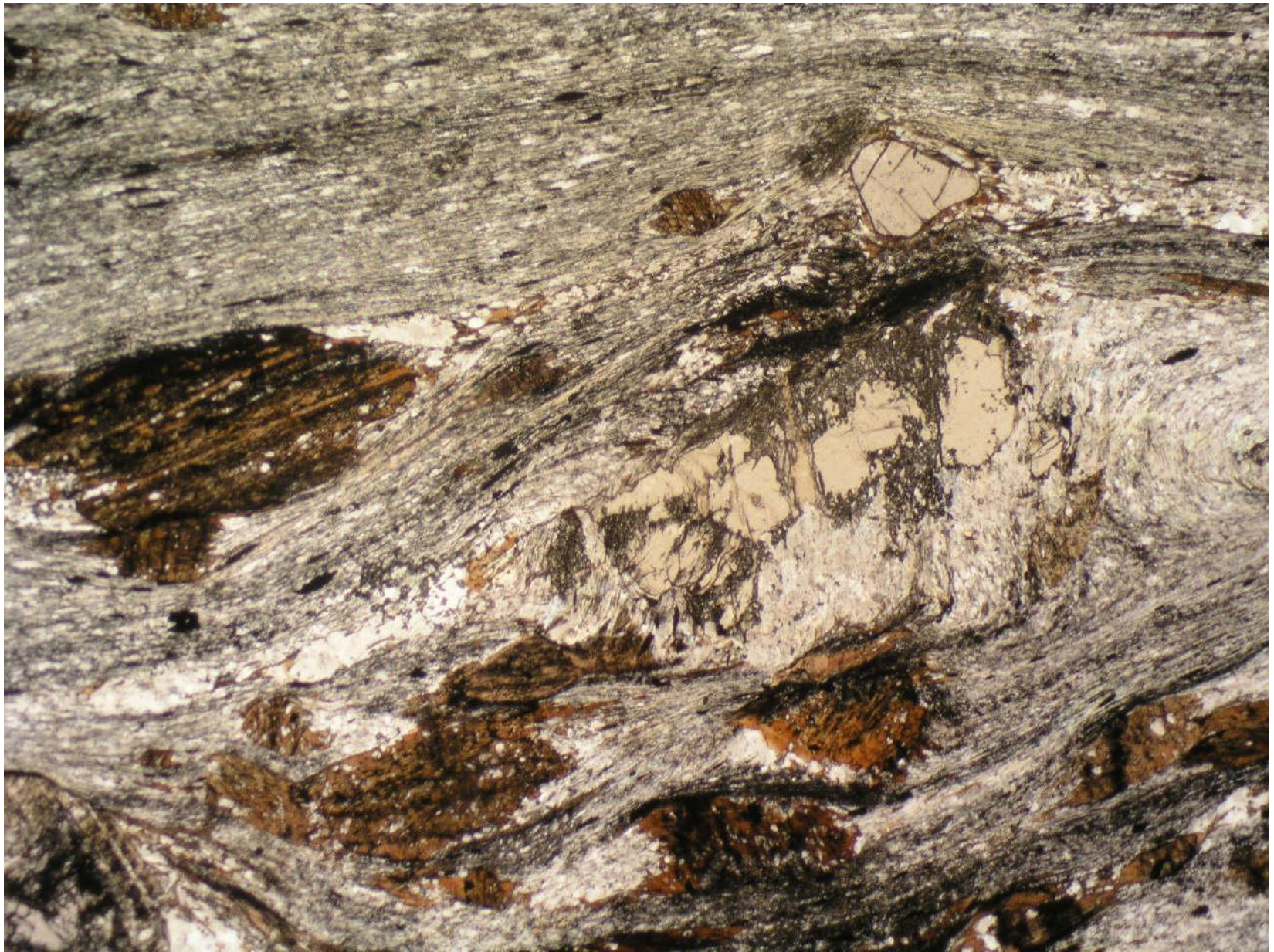
Geological map of SE Sinai



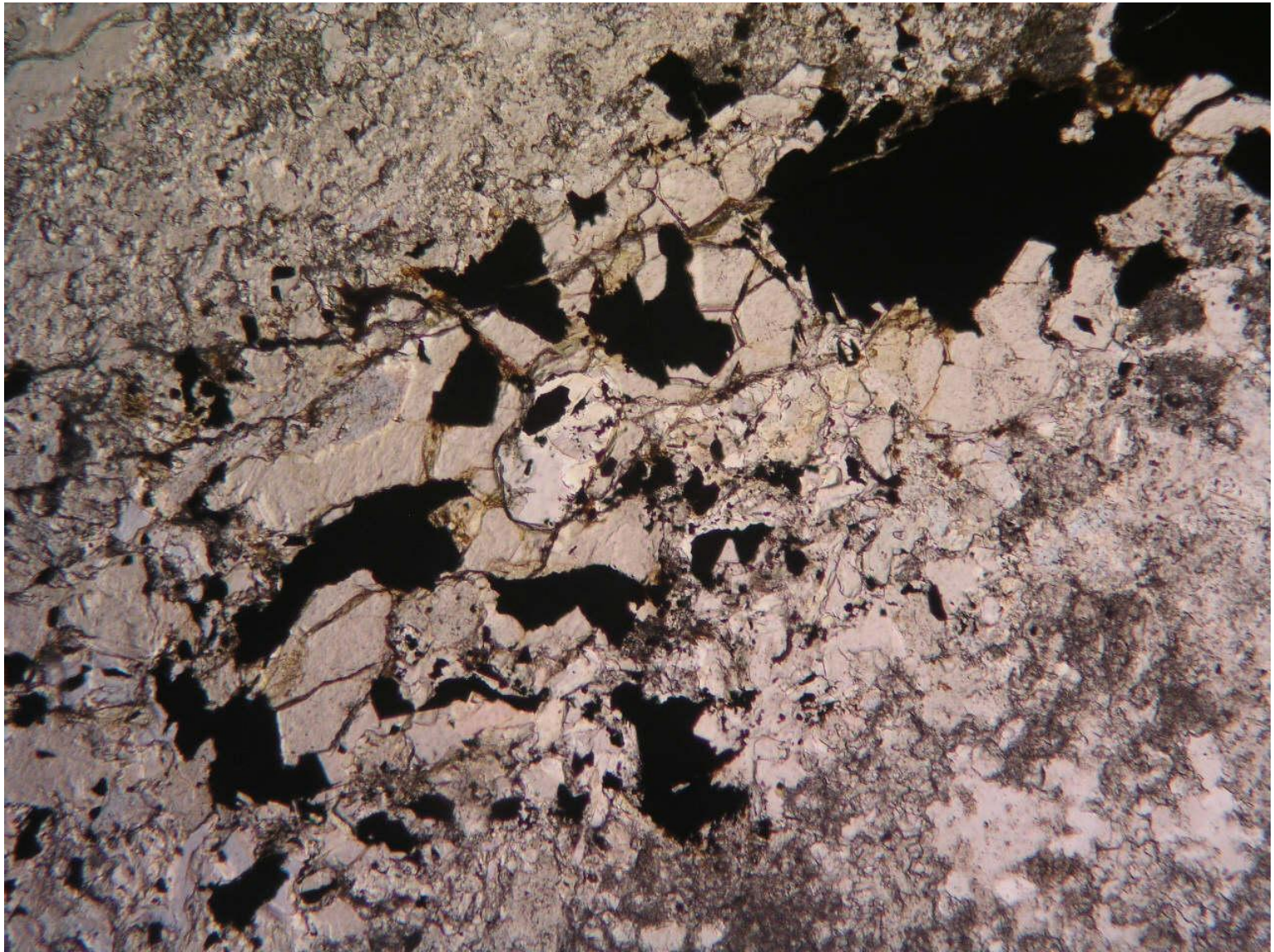
A continental margin setting is suggested

Granitoid intrusion effects: Thermal metamorphism

garnet-biotite-muscovite-andalusite-staurolite

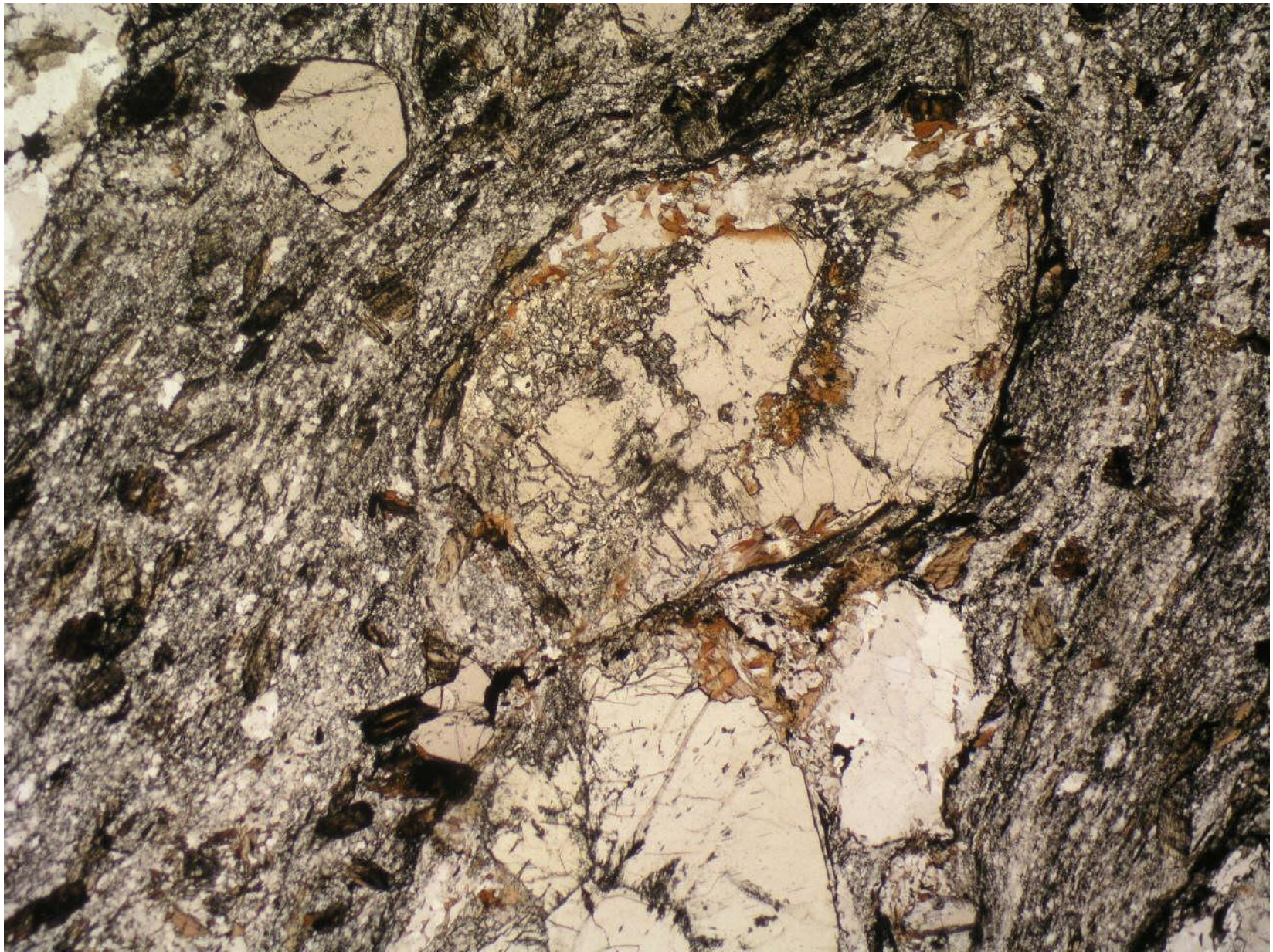


Gangue mineralogy:
Zeriq I: Wollastonite-hedenbergite-grossular-prehnite-biotite



Granitoid intrusion effects: Thermal metamorphism

garnet-biotite-muscovite-andalusite-staurolite



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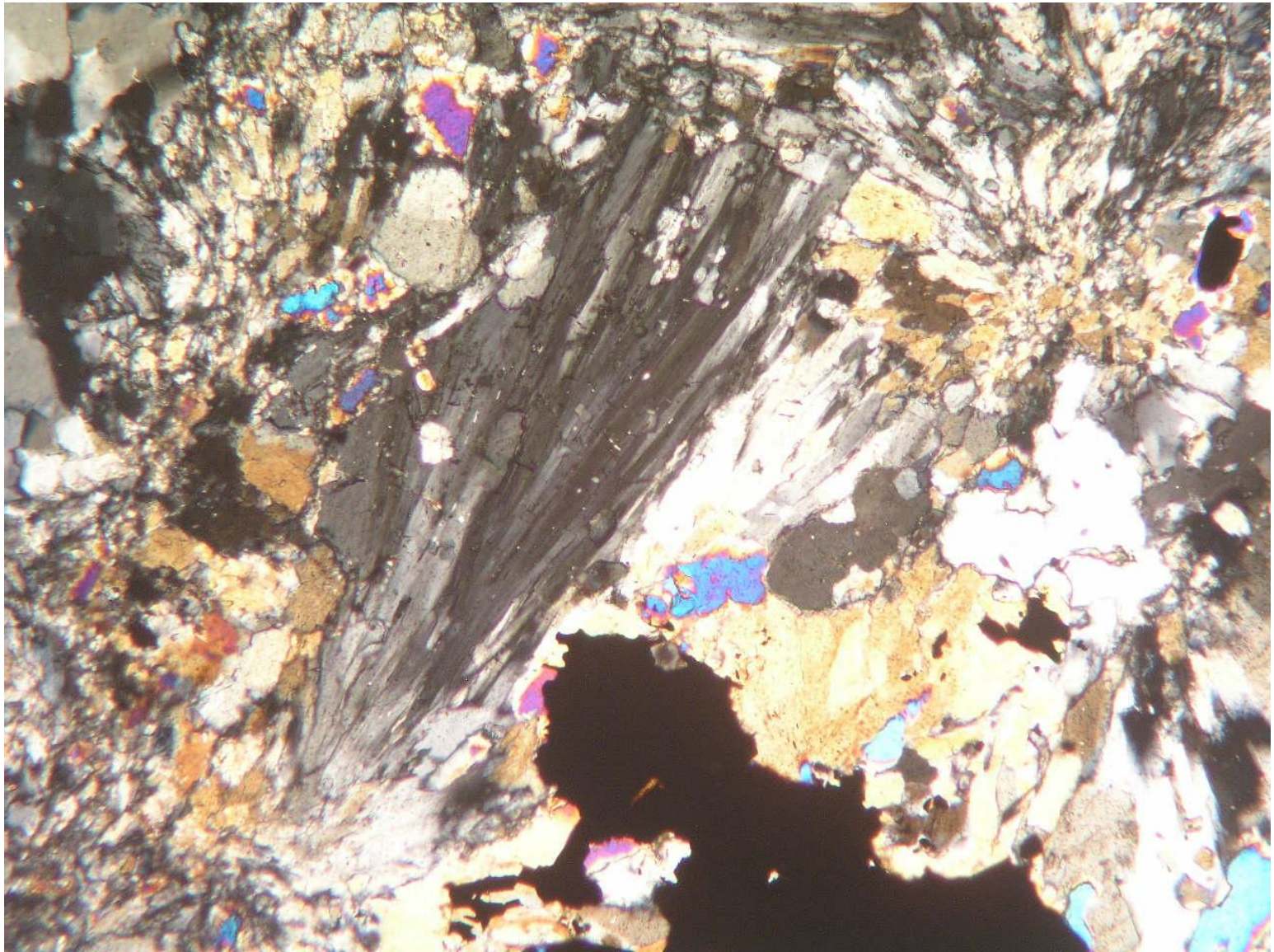
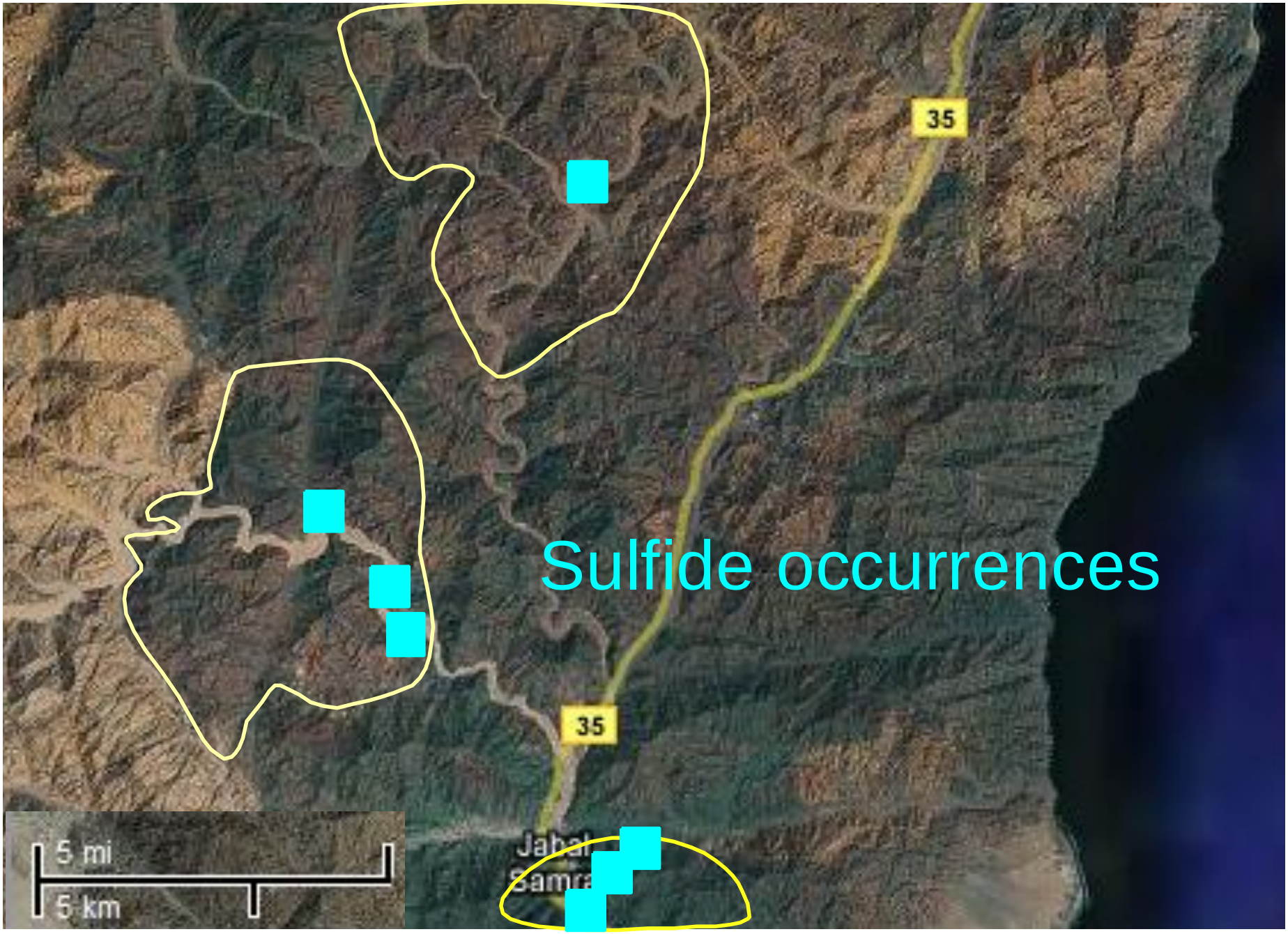


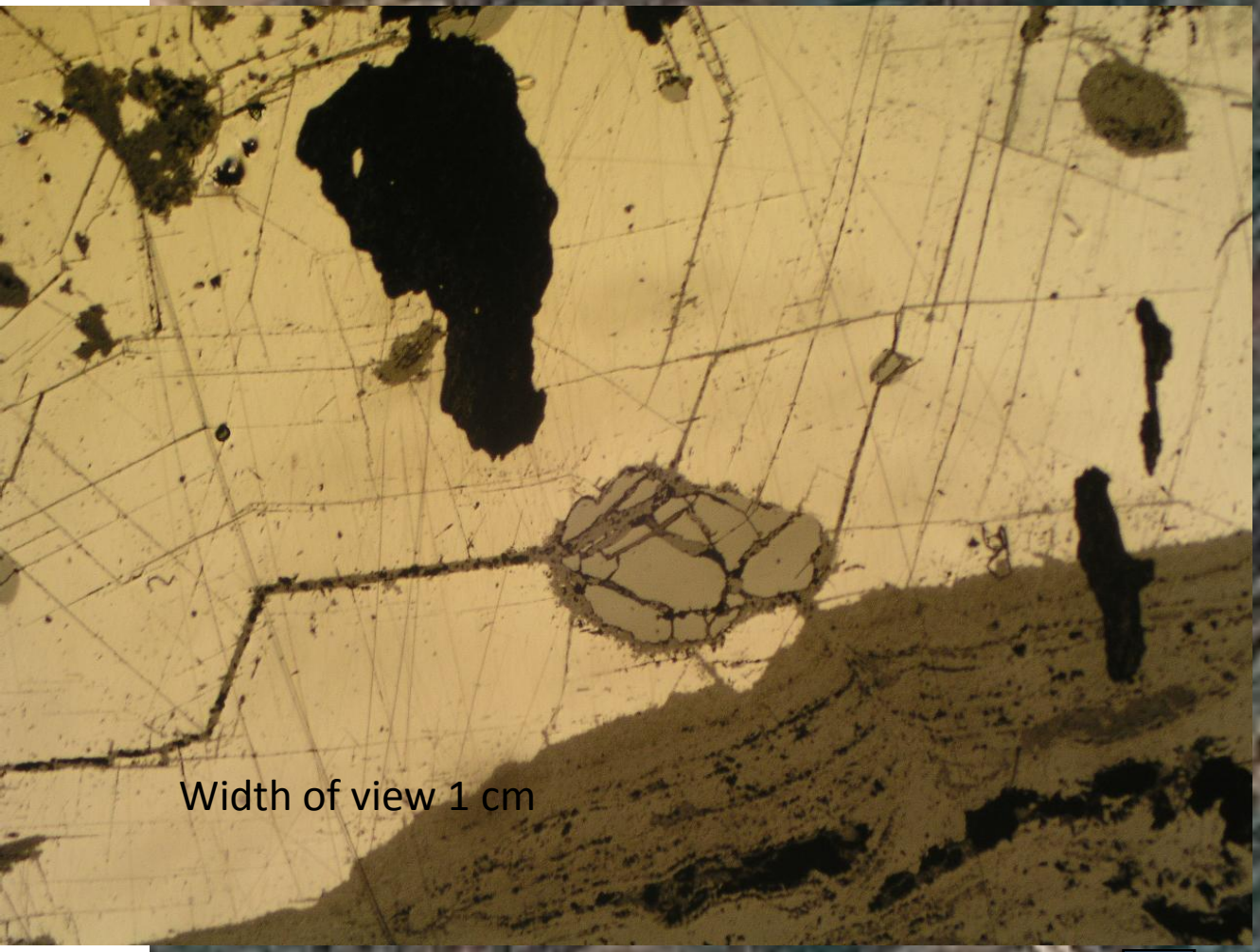
Sulfide mineralizations




Structural control of sulfide mineralization
Zeriq 1: Cu-Zn-Co
Zeriq II, III:
Pb-Zn-As-Ag

Mode of occurrence of sulfide ores: Zeriq III

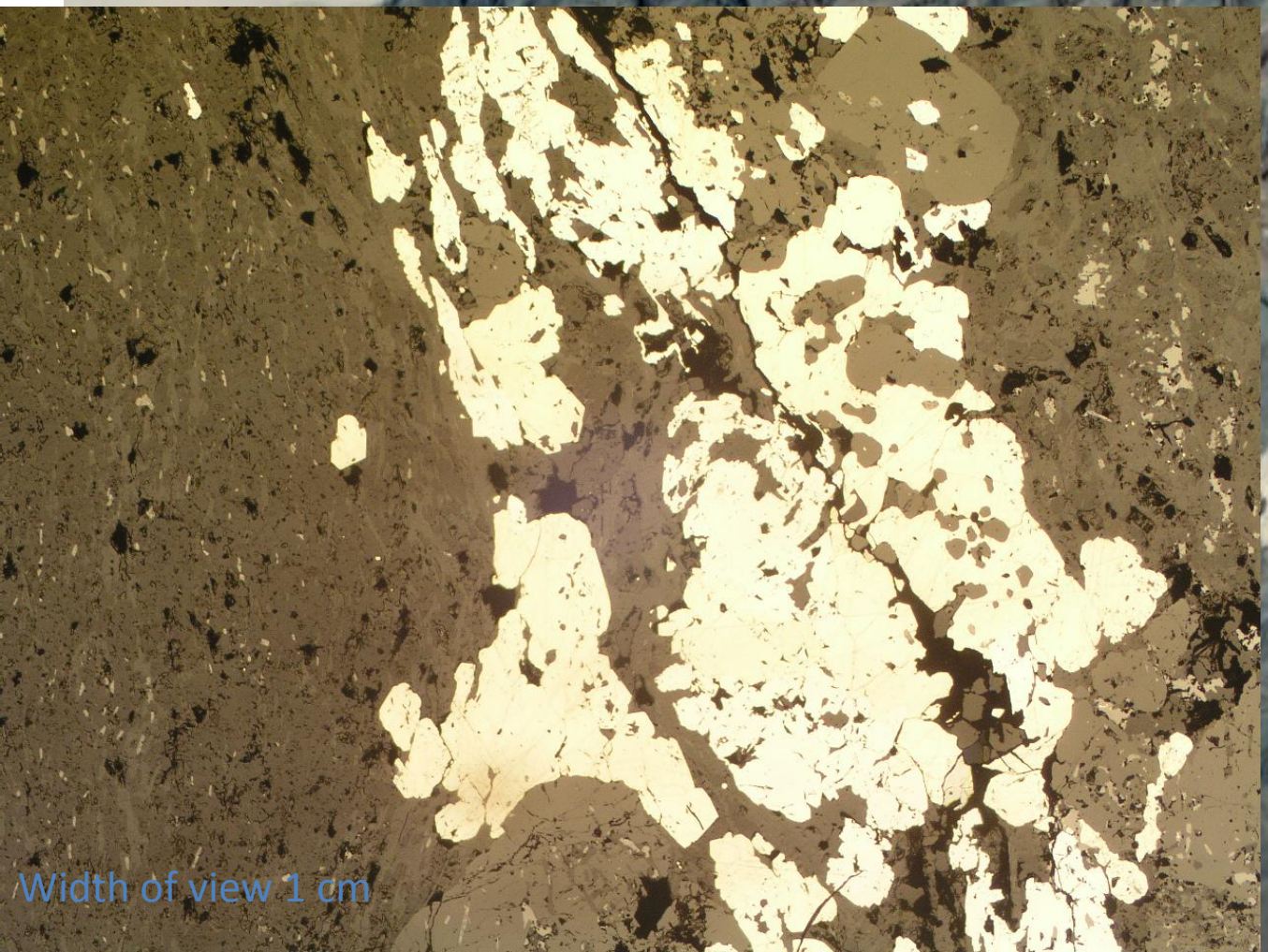
Lenses and veins of massive galena in sheared schist



Zeriq III

Mode of occurrence: Zeriq II

Disseminated sulfides in gossans



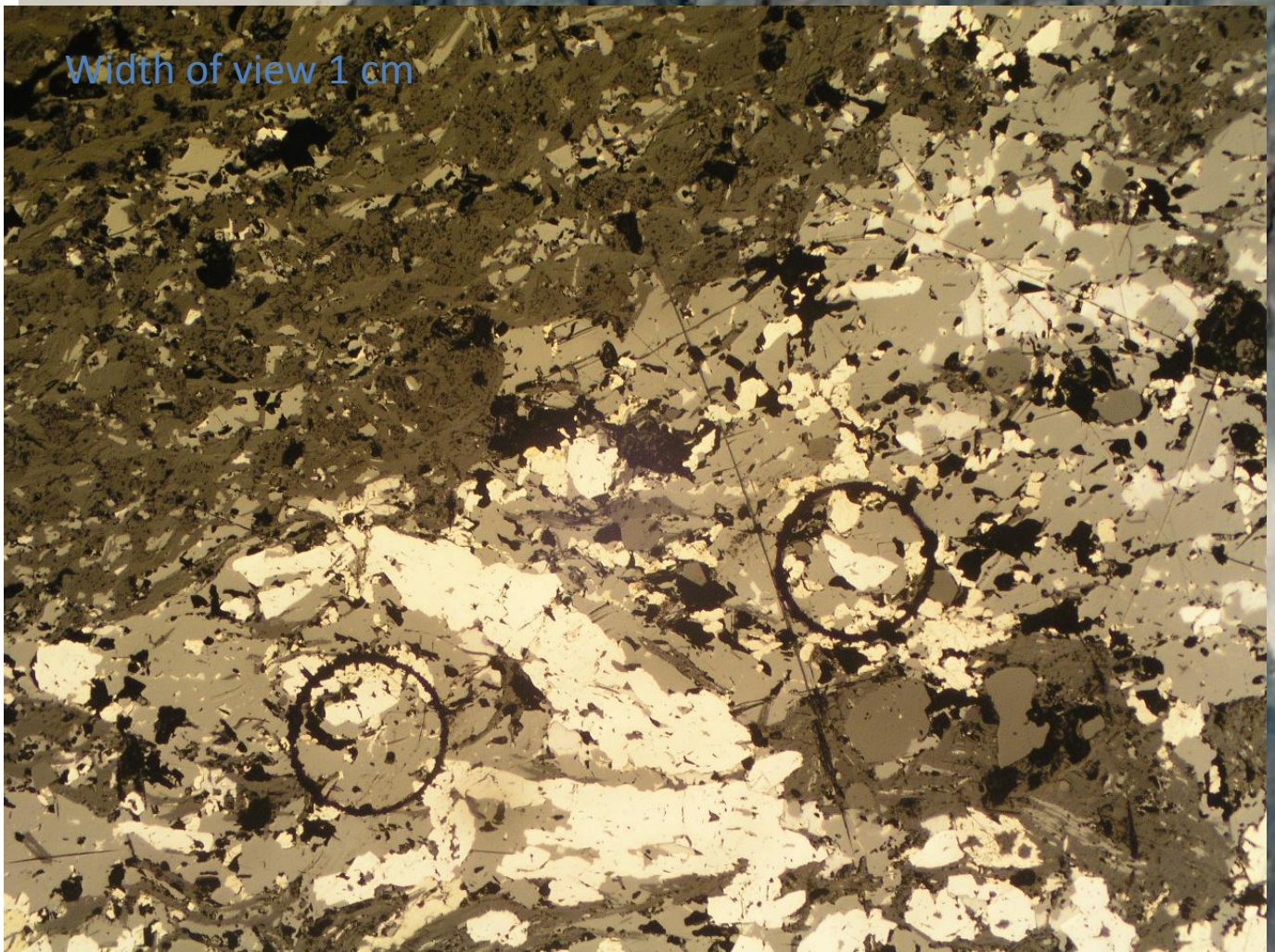
Width of view 1 cm

Zeriq II

Google

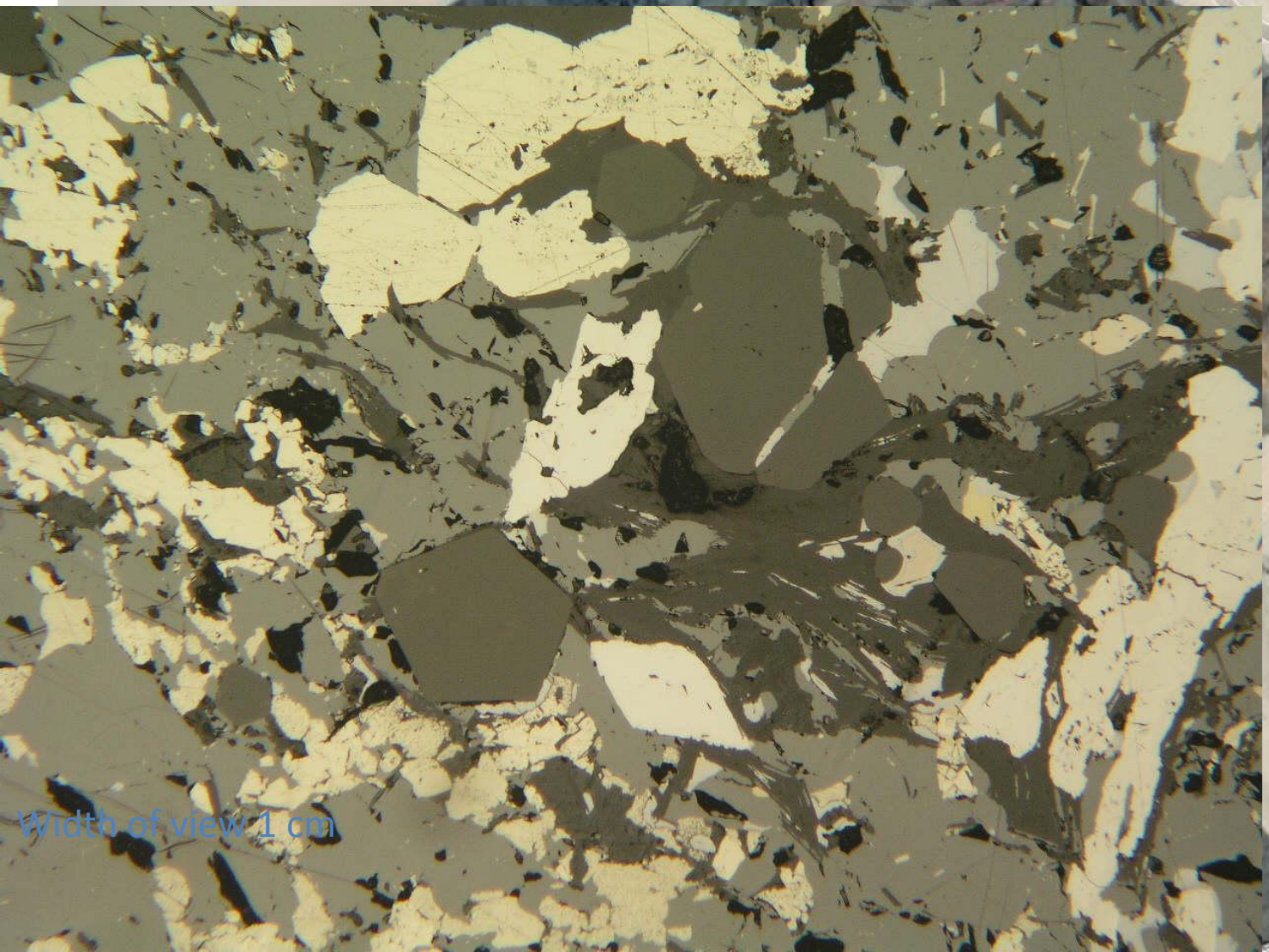
Mode of occurrence

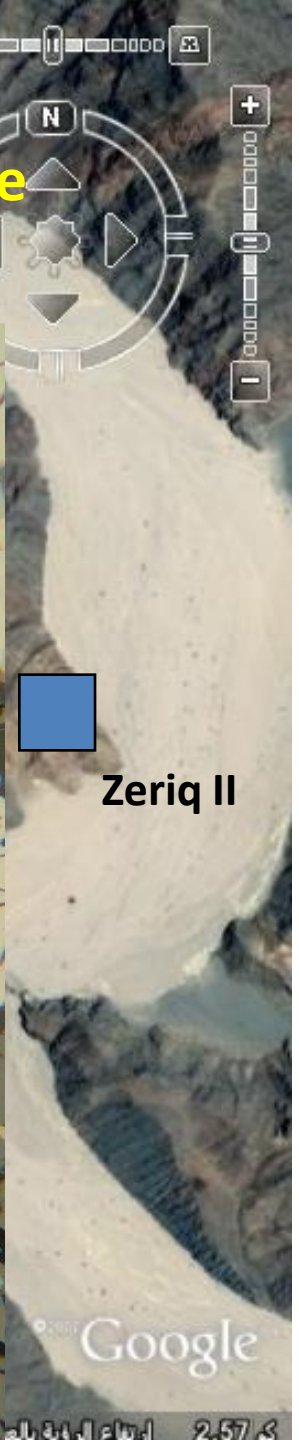
Massive sulfide ore in drill core



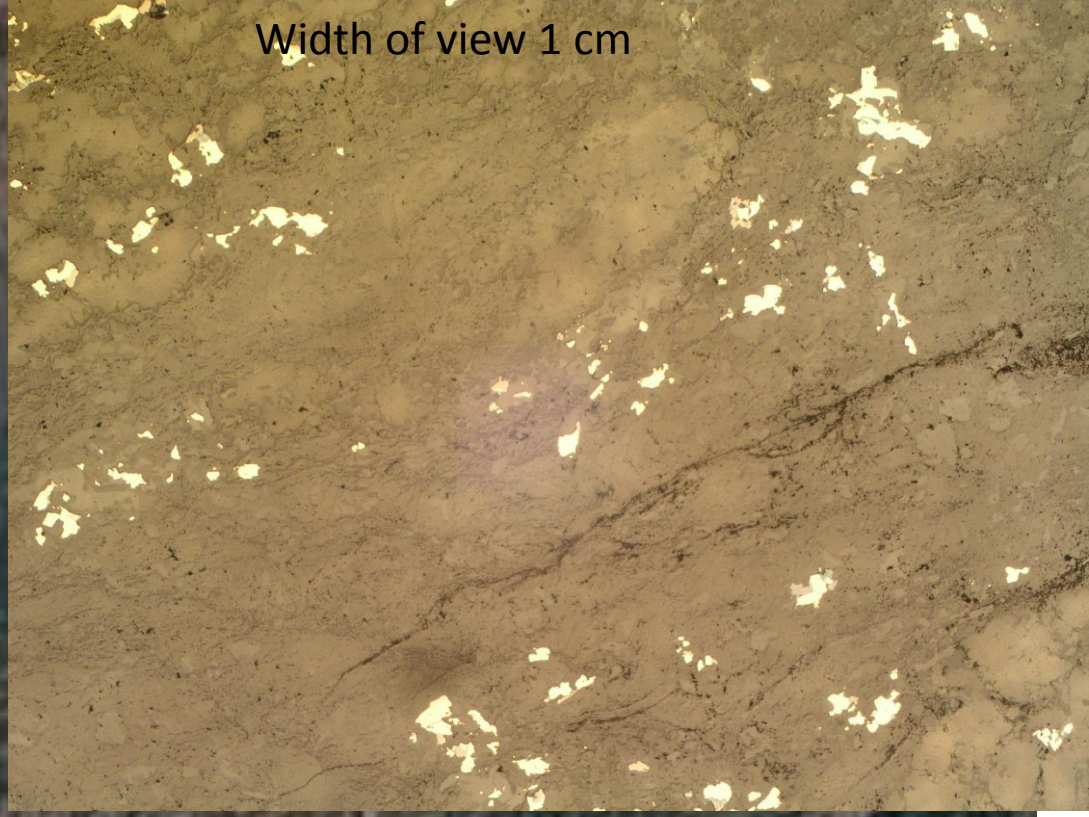
Mineralogy

Zeriq II, III: Sphalerite-galena-arsenopyrite-loellingite





Mode of occurrence: Zeriq I



Mineralogy: Zeriq I

Chalcopyrite-bornite-sphalerite-cobaltite

Zeriq I

Silver minerals

Size and distribution

Silver minerals

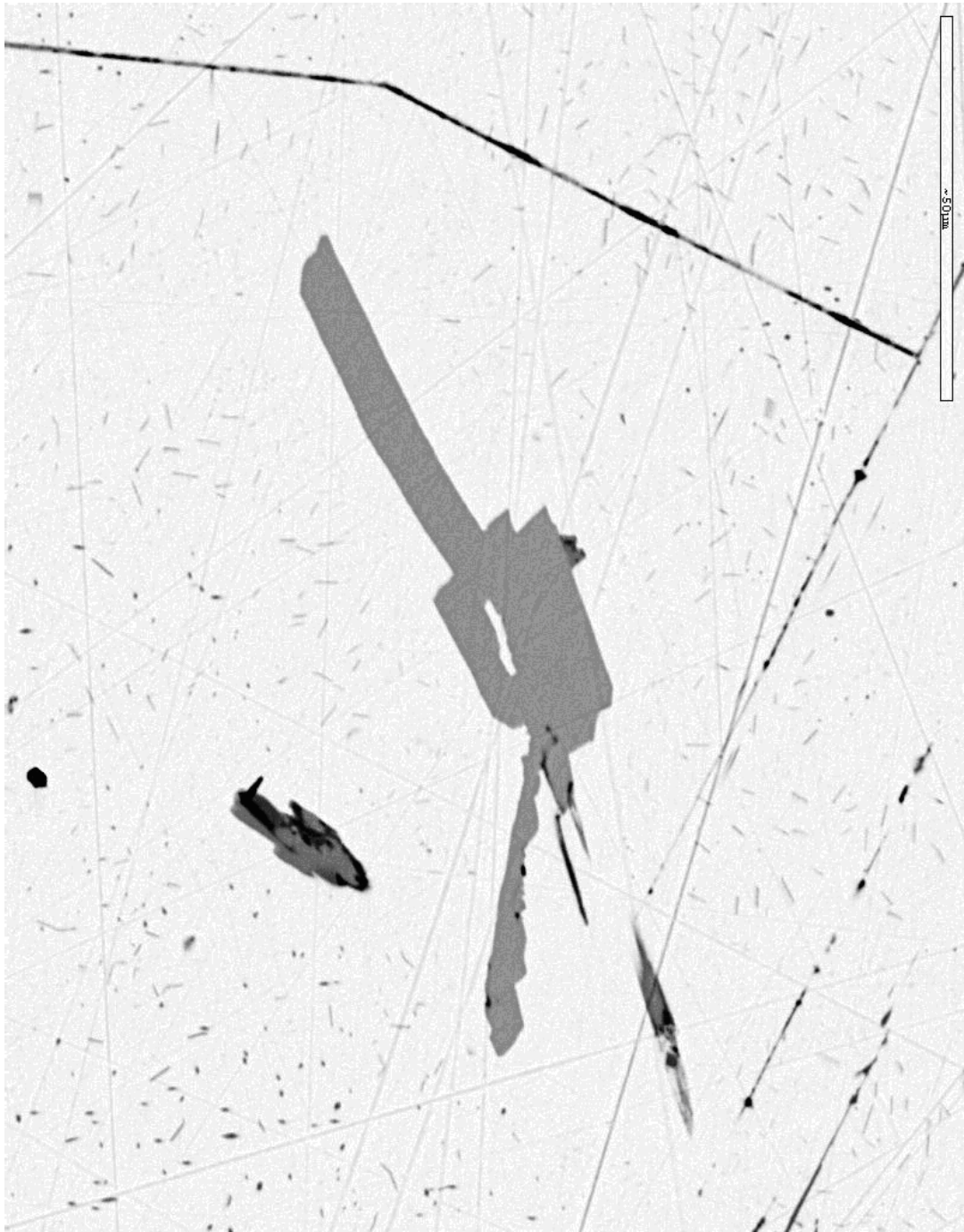
- Ag-Sb-Pb-Bi-S (Te) phases

Associated phases

- Sb-Pb-S, sphalerite

Implications

- (low T assemblage, hydrothermal processes)



Silver minerals

Size and distribution

Silver minerals

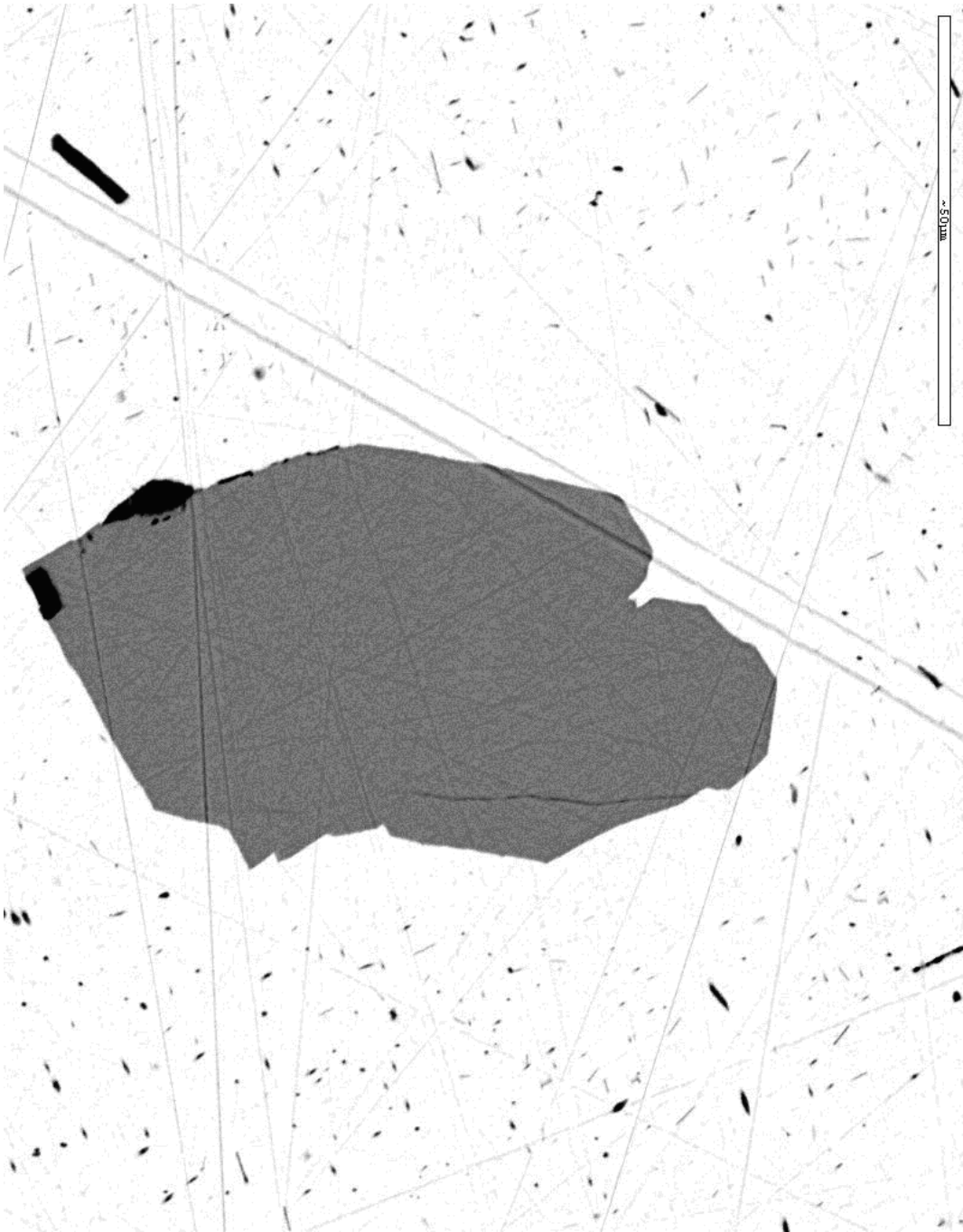
- **Ag-Sb-Pb-Bi-S (Te) phases**

Associated phases

- **Sb-Pb-S, sphalerite**

Implications

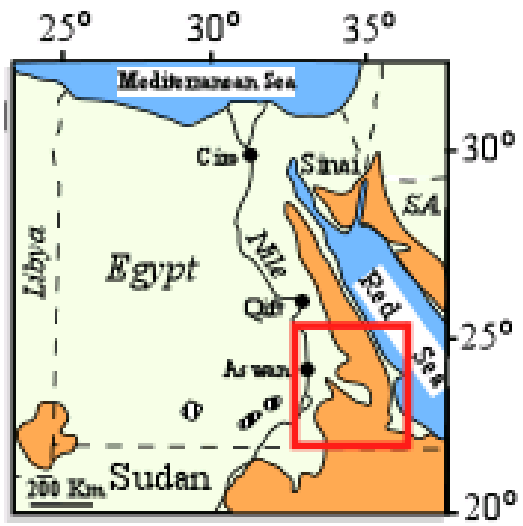
- **(low T assemblage, hydrothermal processes)**



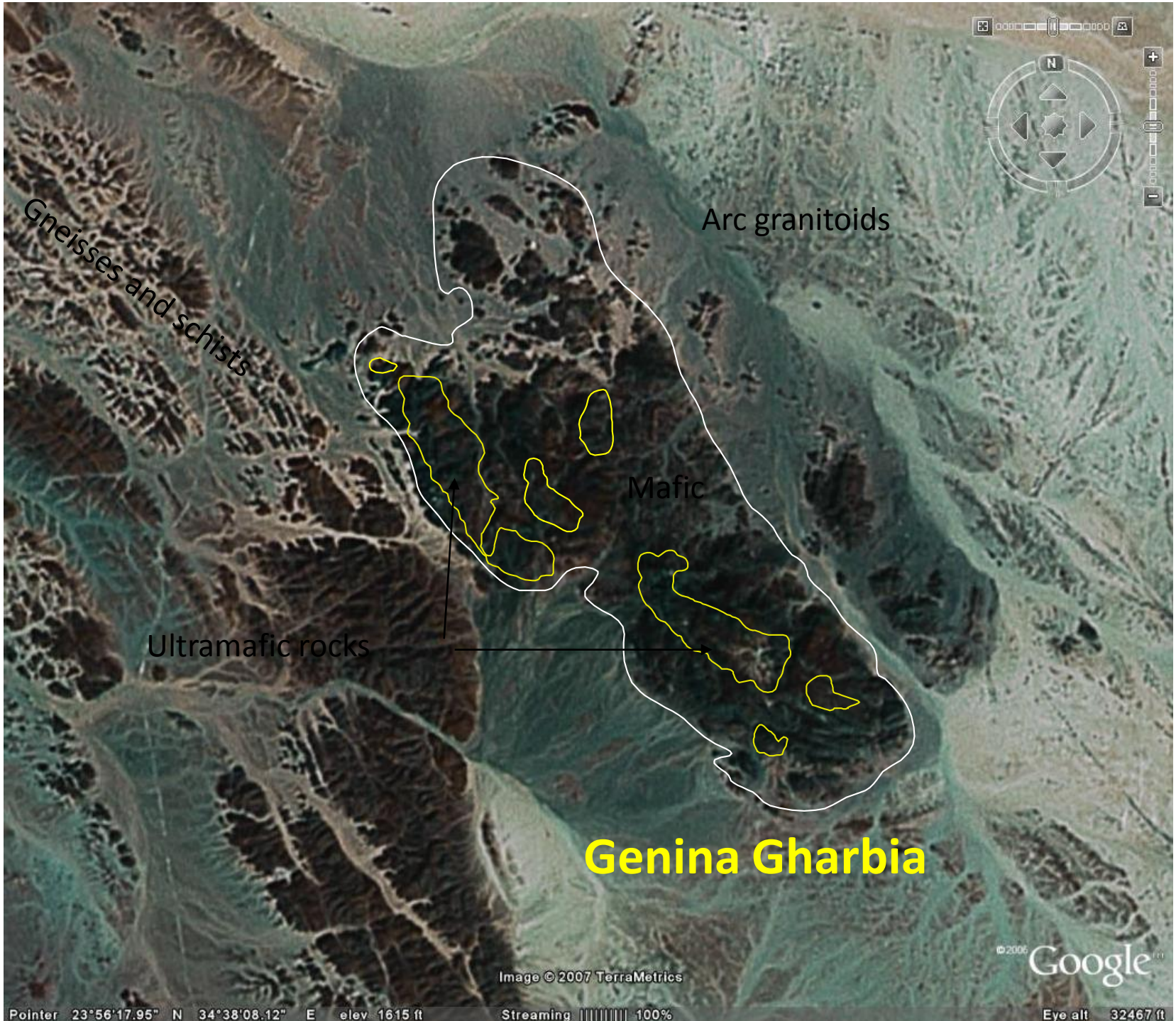
Recommendations

- Re-evaluation of the Zn-Cu-Pb-Ag deposits
- Oriented exploration in Shadli metavolcanis and Wadi Kid area

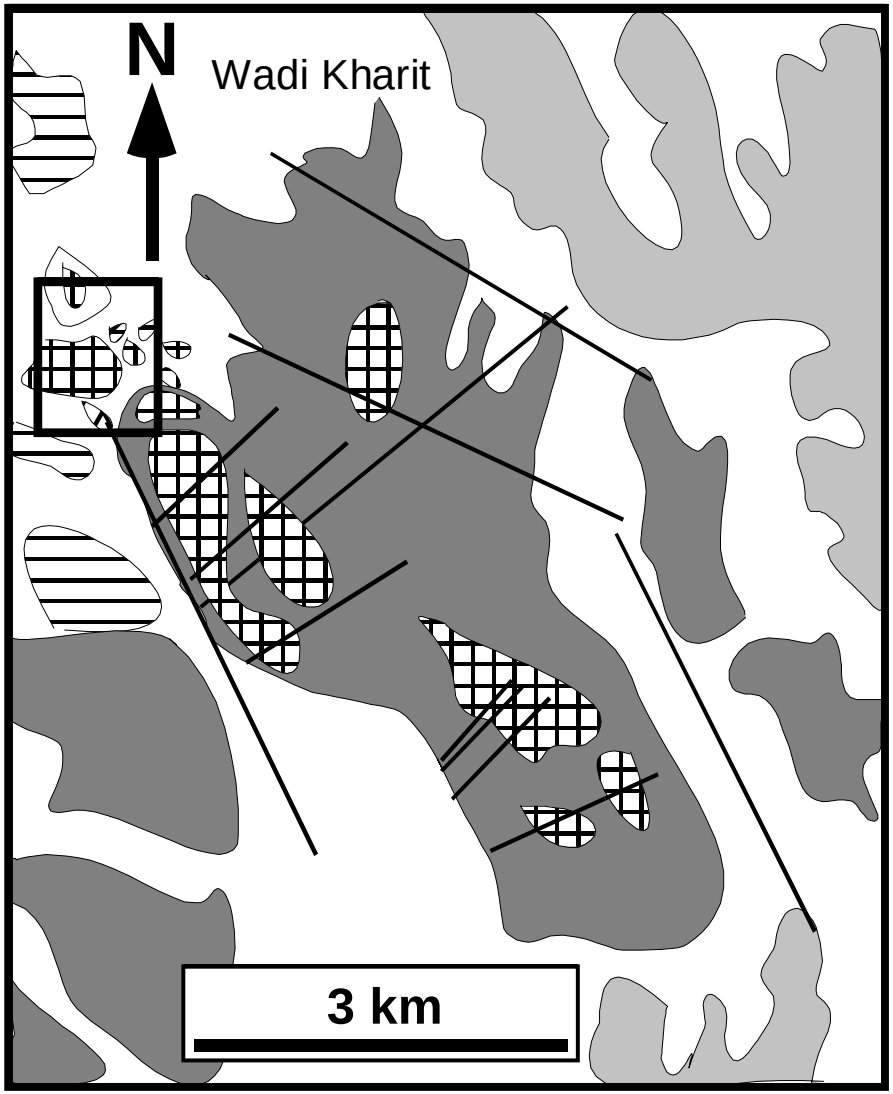
Copper-Nickel Platinum-group element Deposits

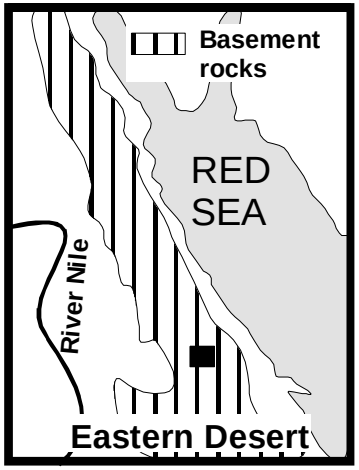


Gabbro Akarem
Genina Gharbia
Abu Swayel


Gneisses and schists
Arc granitoids
Mafic
Ultramafic rocks
Genina Gharbia
Image © 2007 TerraMetrics
©2006 Google
Pointer 23°56'17.95" N 34°38'08.12" E elev 1615 ft
Streaming 100%
Eye alt 32467 ft

Genina Gharbia Geological setting

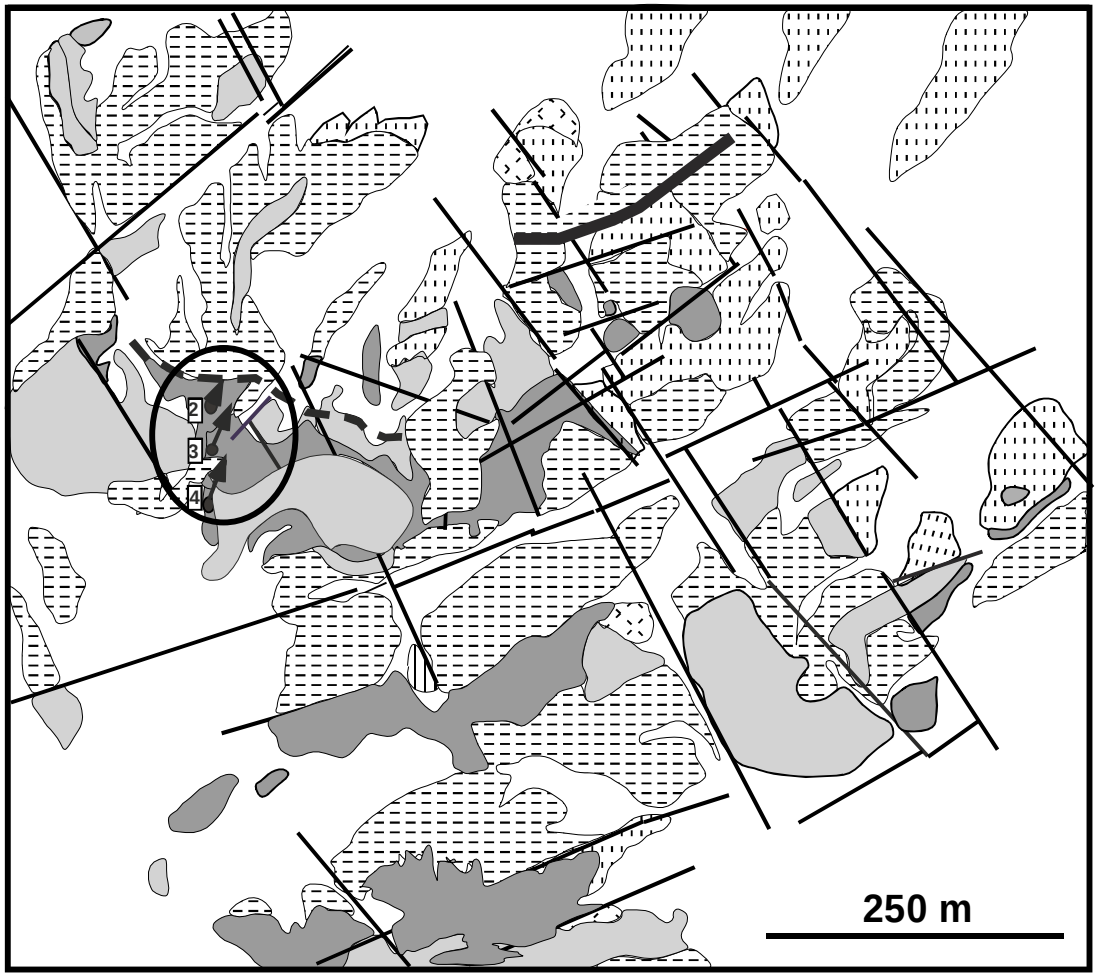


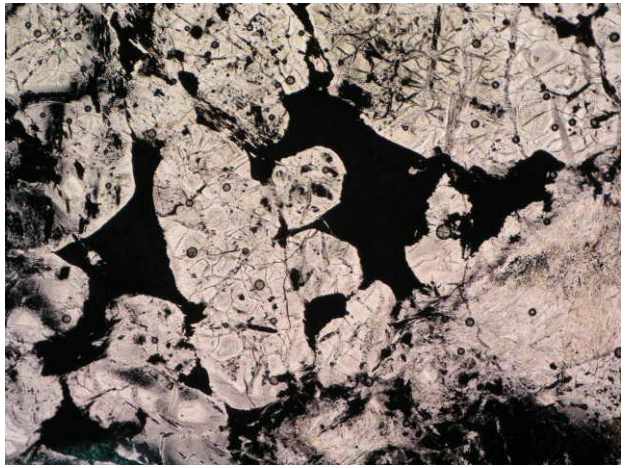
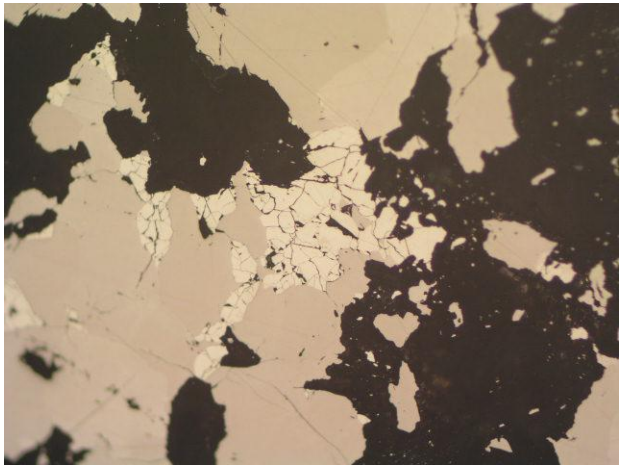
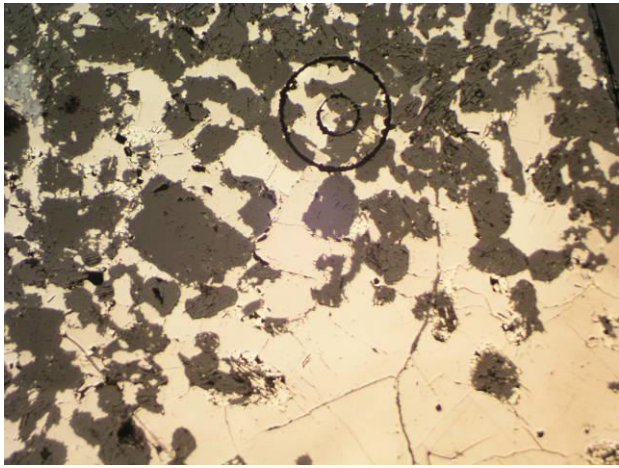
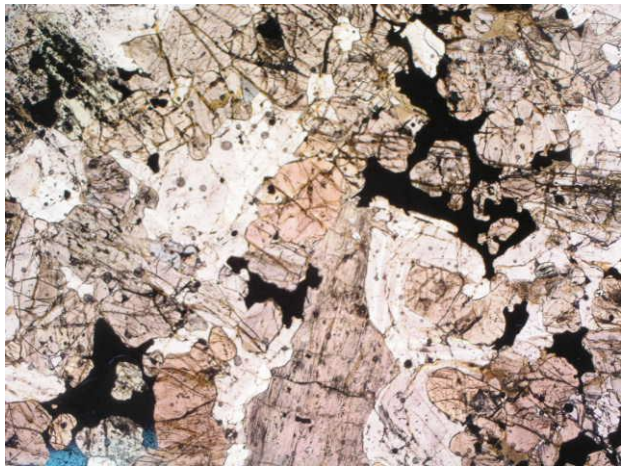
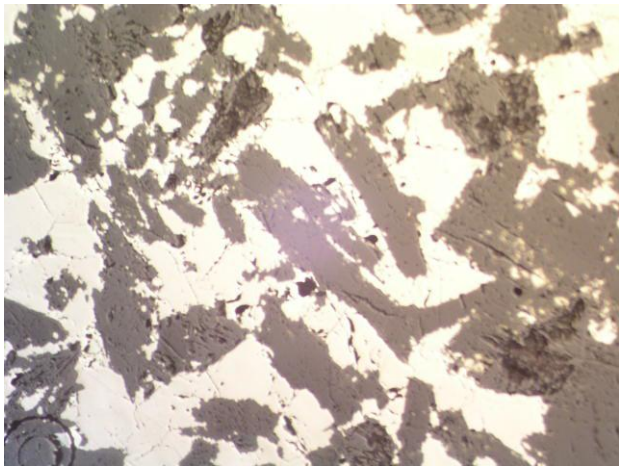


Location Map

- Wadi Alluvium
- Granites
- Hornblende gabbros
- Hornblende pyroxenite & peridotite
- Metavolcanics
- Metasediments
- Area of sulfide mineralization
- Faults and small shear zones

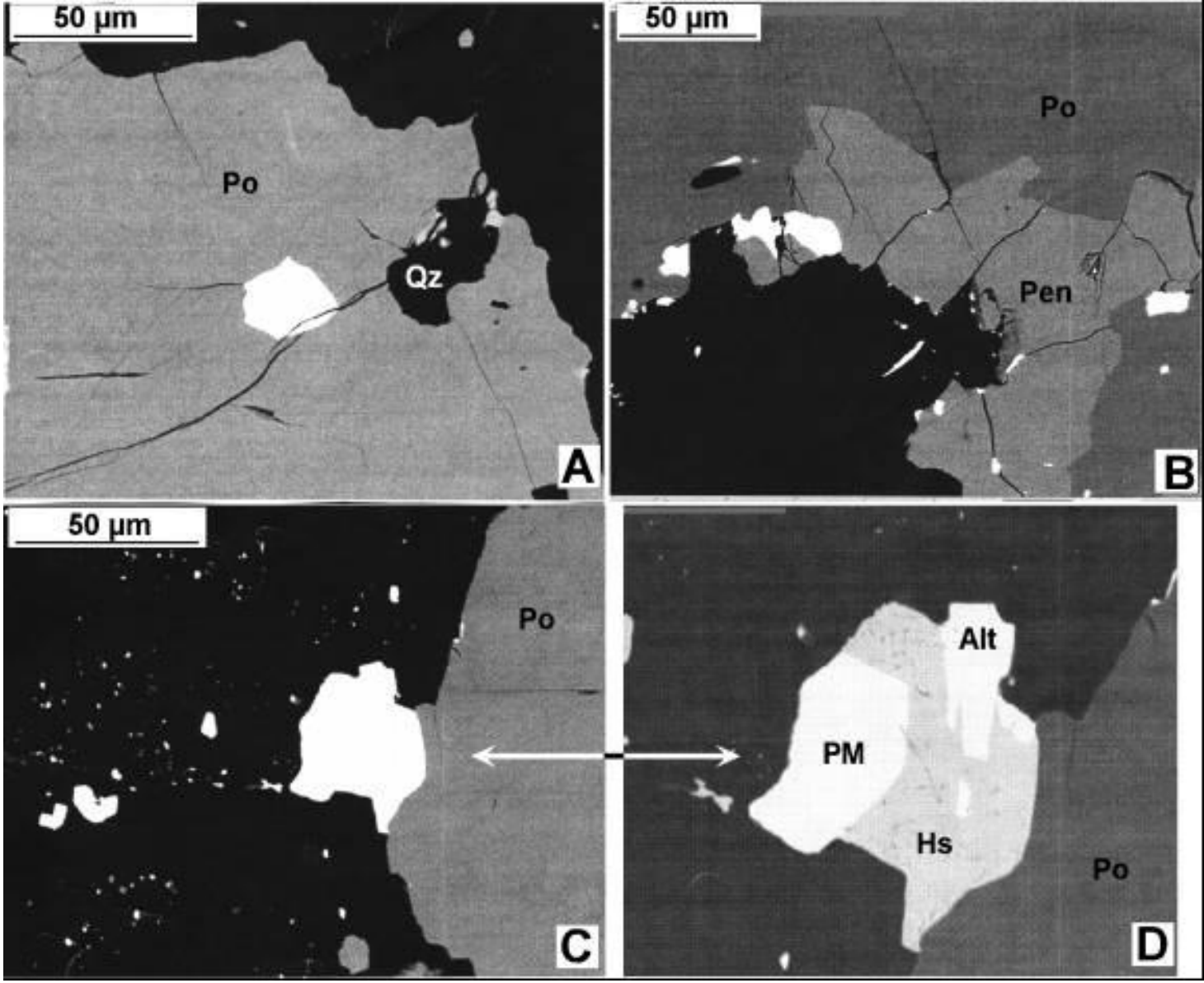
Detailed geology



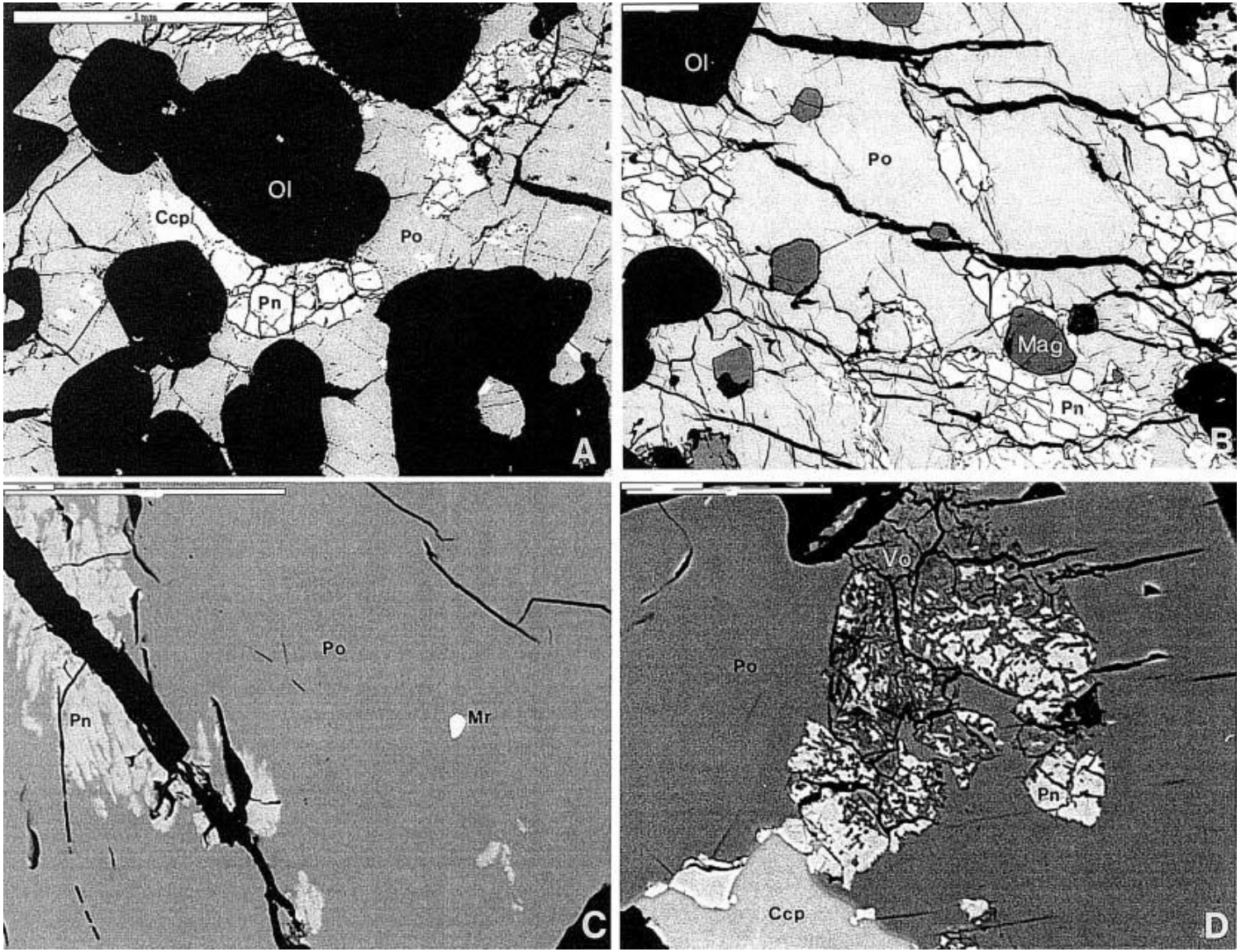
Cu-Ni-sulfide ores

- **PGM**
  - Pd Te2
  - PdTeBi
  - Pd-Bi melonite
- **Tellurides**
  - AgTe2
  - PbTe
  - BiTe
  - AuAgTe
  - Te

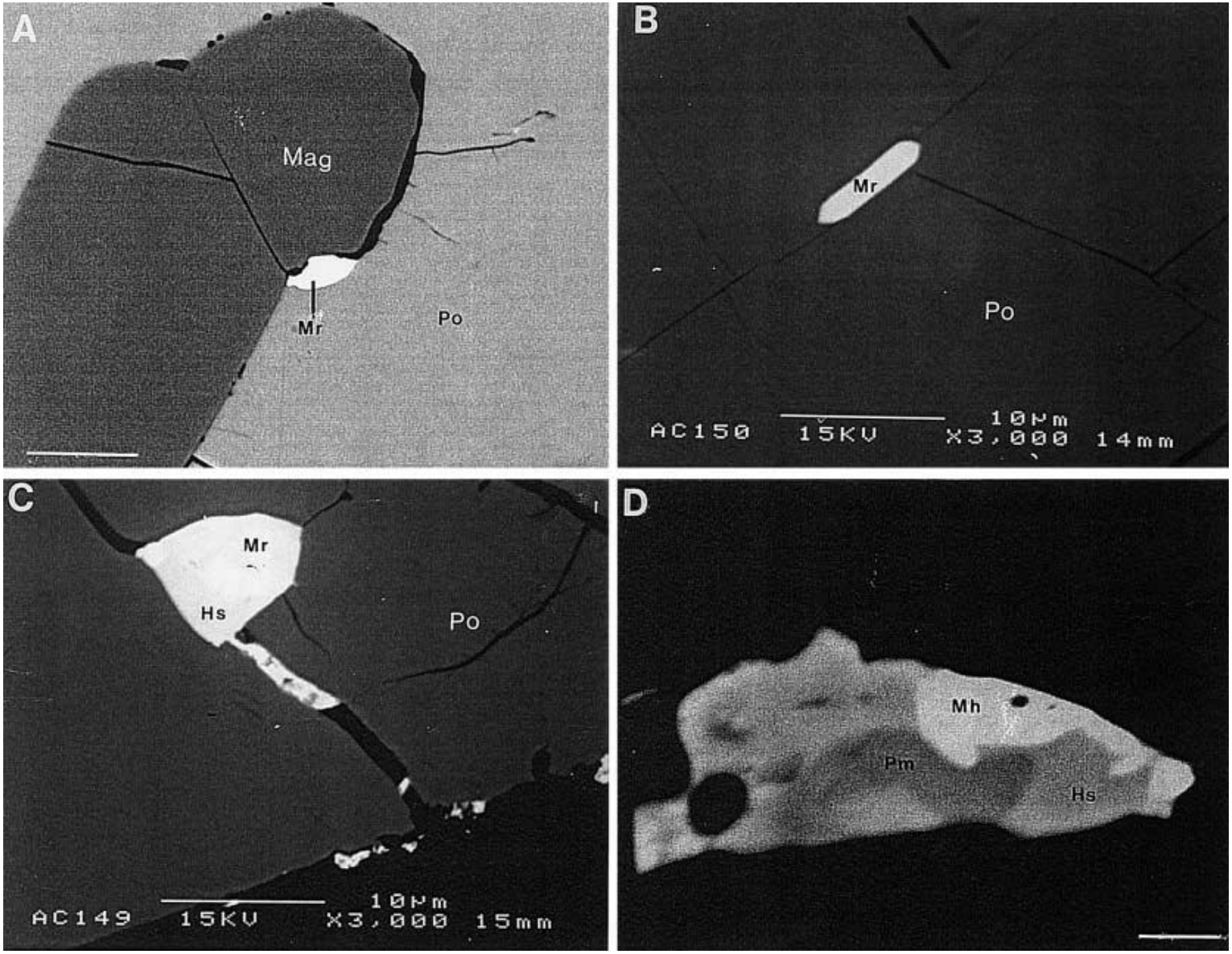


Platinum-group minerals


Precambrian gneisses and schists
Mafic rocks
Ultramafic rocks
Gabbro Akarem
Image © 2006 TerraMetrics
©2006 Google
Pointer 23°59'55.69" N 34°08'42.31" E elev 1176 ft Streaming 100%
Eye alt 27599 ft



Cu-Ni sulfide ores, Gabbro Akarem



Platinum group minerals, Gabbro Akarem

Recommendations

- Re-evaluation of the Cu-Ni-PGE ores
- Explore for new areas, especially along Wadi Alaqi (close to Abu Swayel)
- Placer deposits (SED)

Opportunities

- The new road Aswan-Ras Benas
  - This road goes very close to Cu-Ni-PGE deposits.

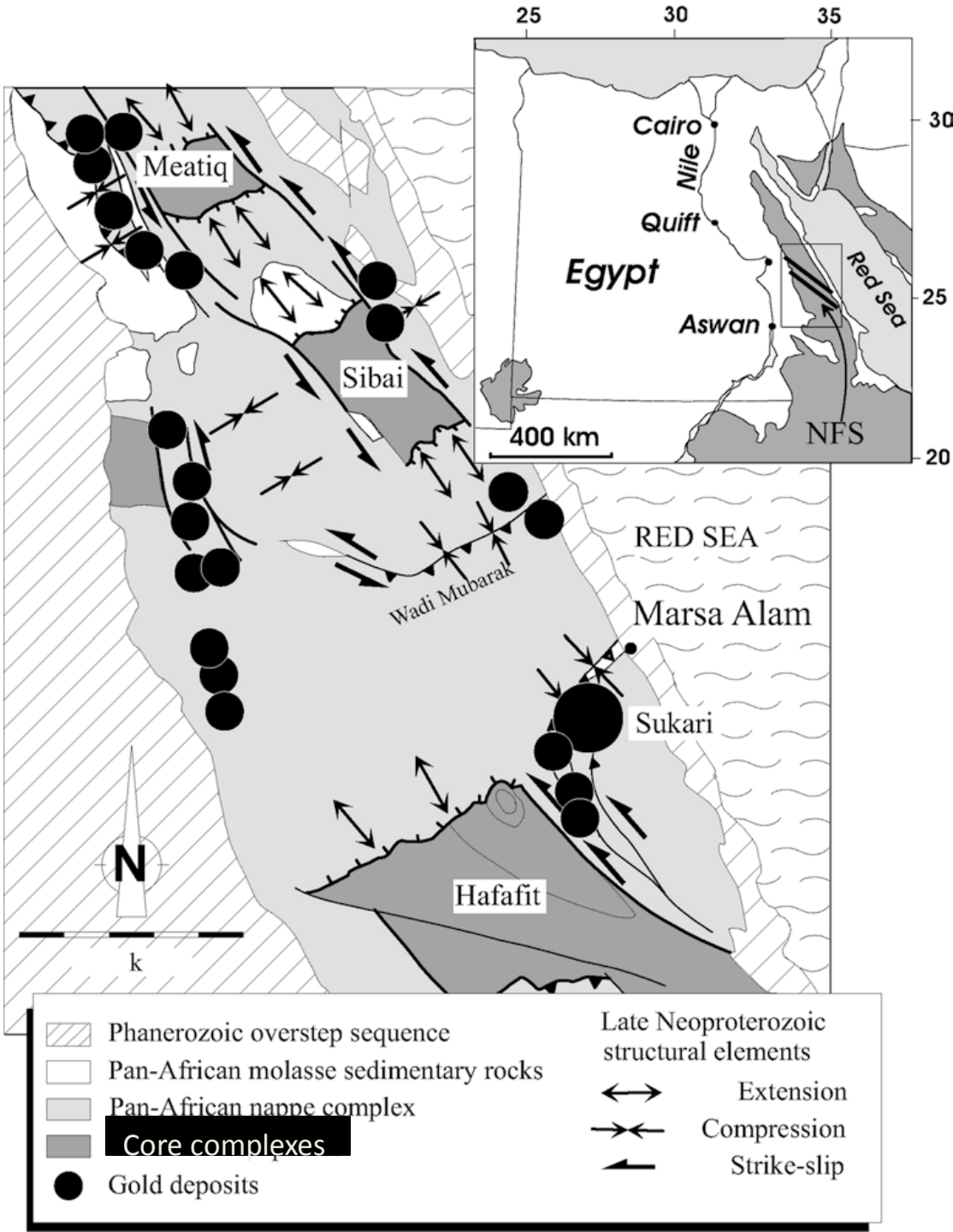
Gold deposits

Common Features

Vein-type deposits

Geologic setting

Regional Structural control?



Location at the gabbro-granite contact: Um Rus

Um Rus mine

Um Rus mine

Mass balance calculations

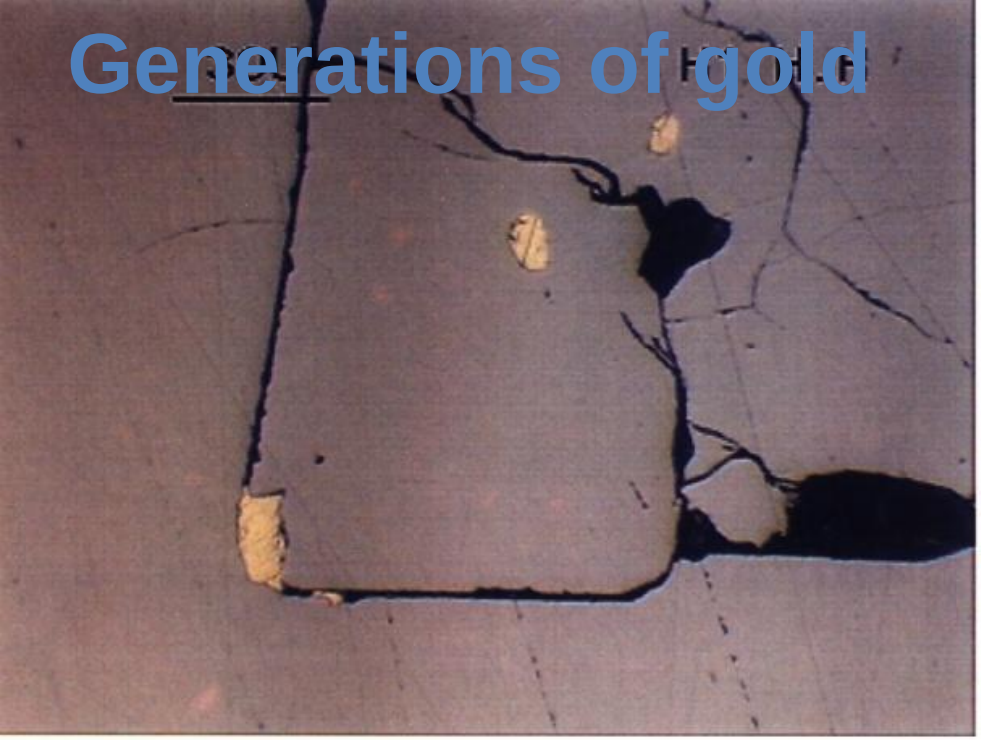
How much fluids and metals settle in the alteration zones?

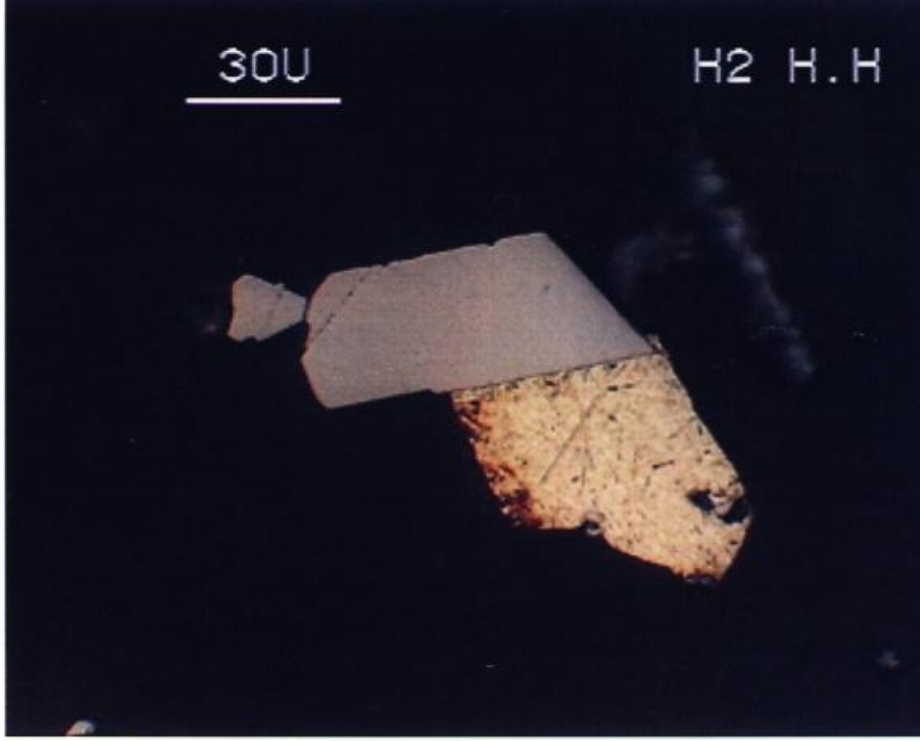
Chemical gradient in alt. zones is much higher!

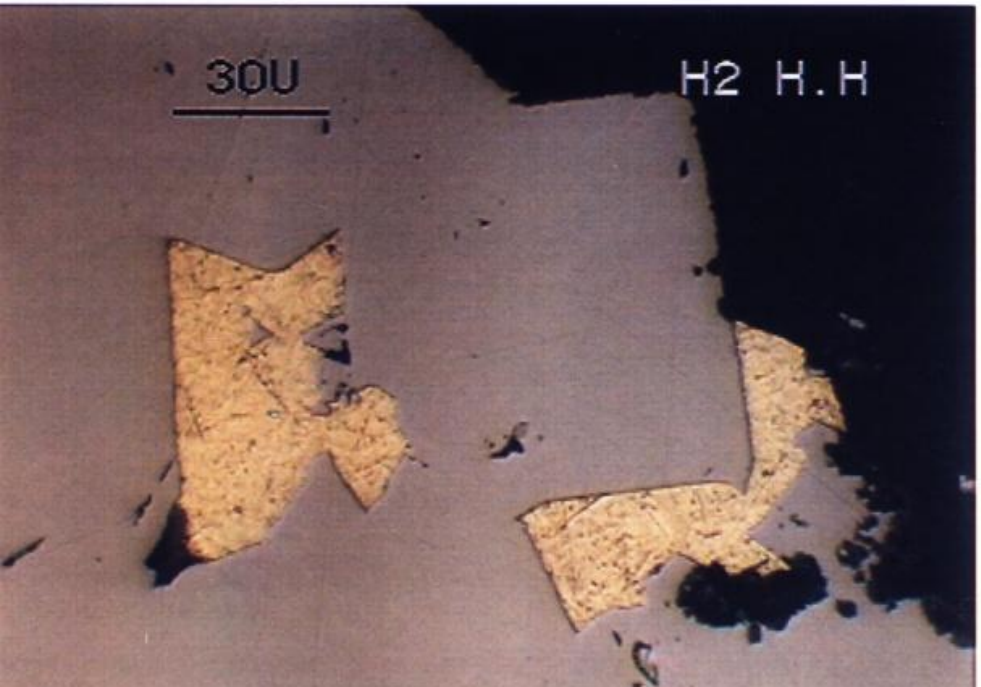
Location at the gabbro-diorite contact: Atud

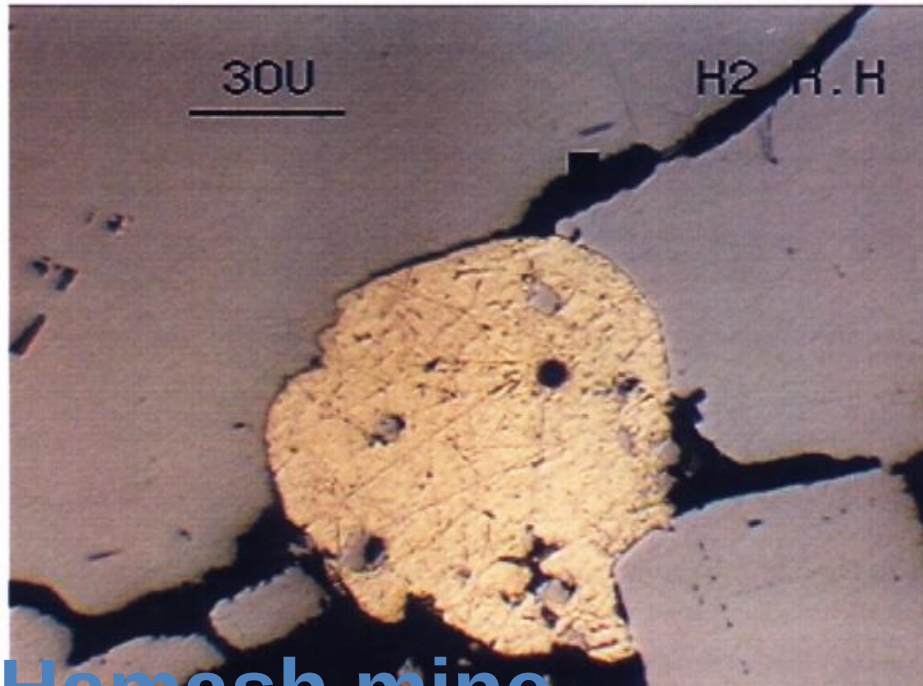
Location along shear zones : Barramiya

Generations of gold



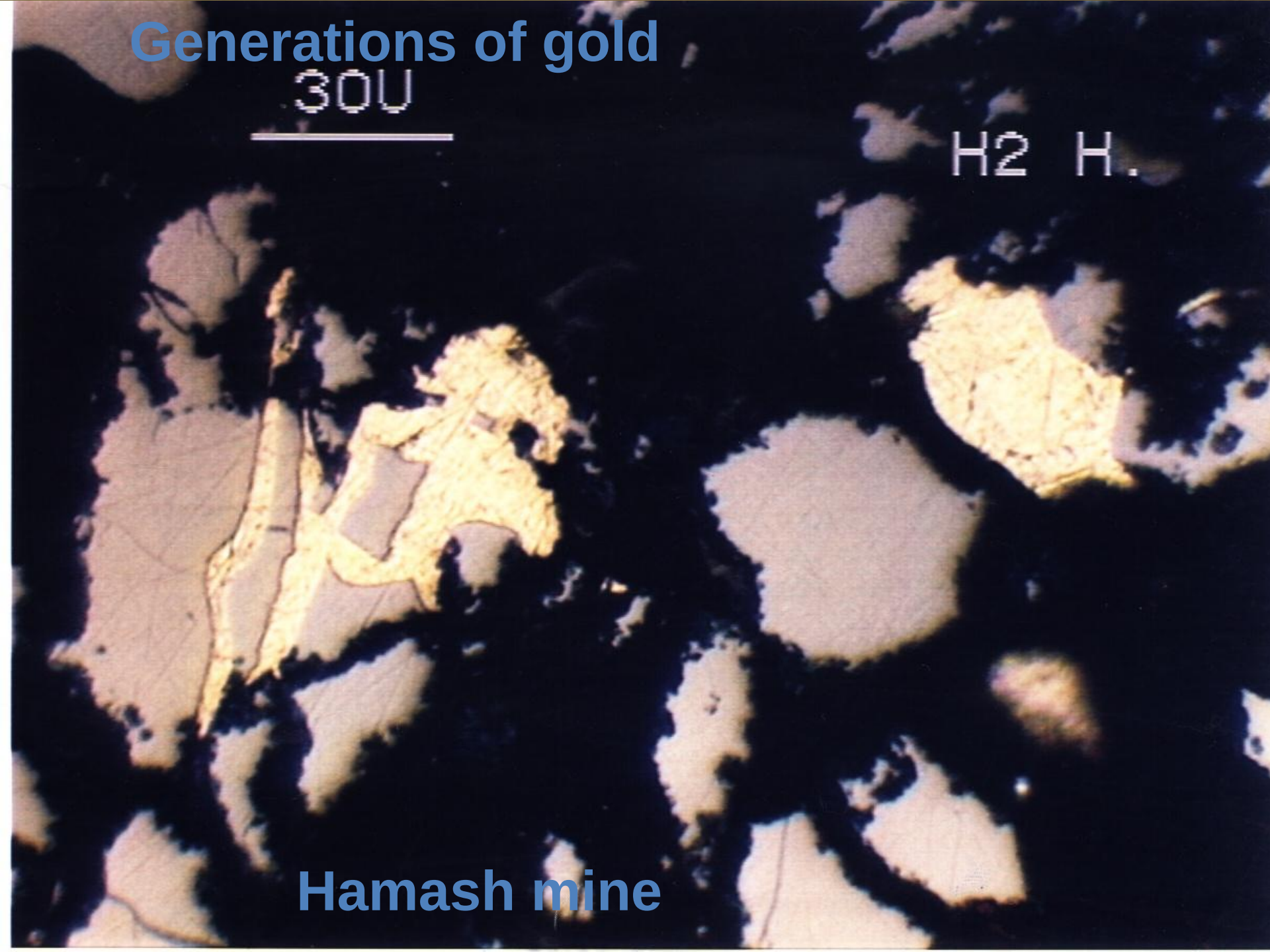






Hemesh mine

Generations of gold

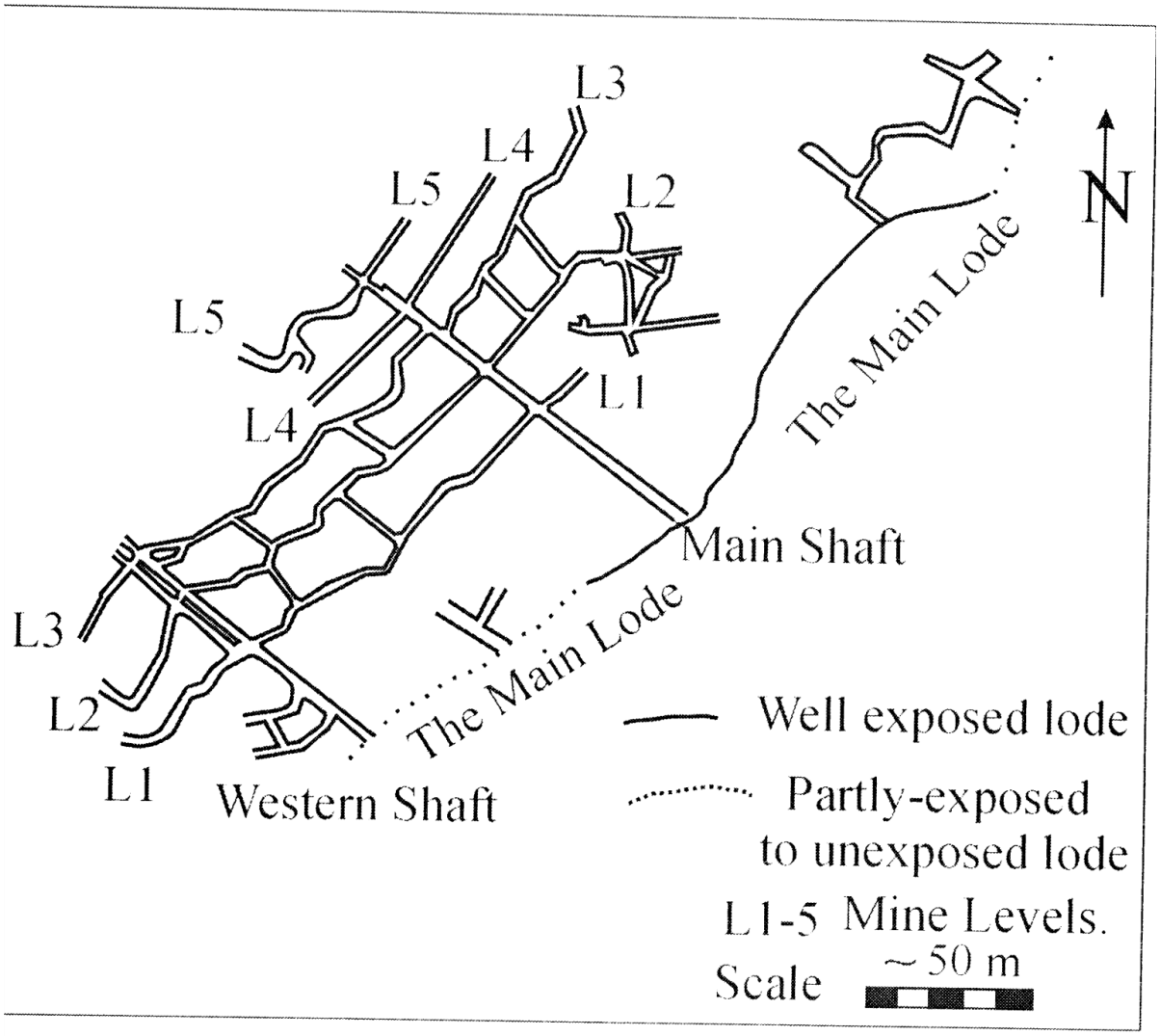


Hamash mine

The low production is due to previous mining concepts!

Only quartz veins were mined

Major part of veins was left behind (70%)

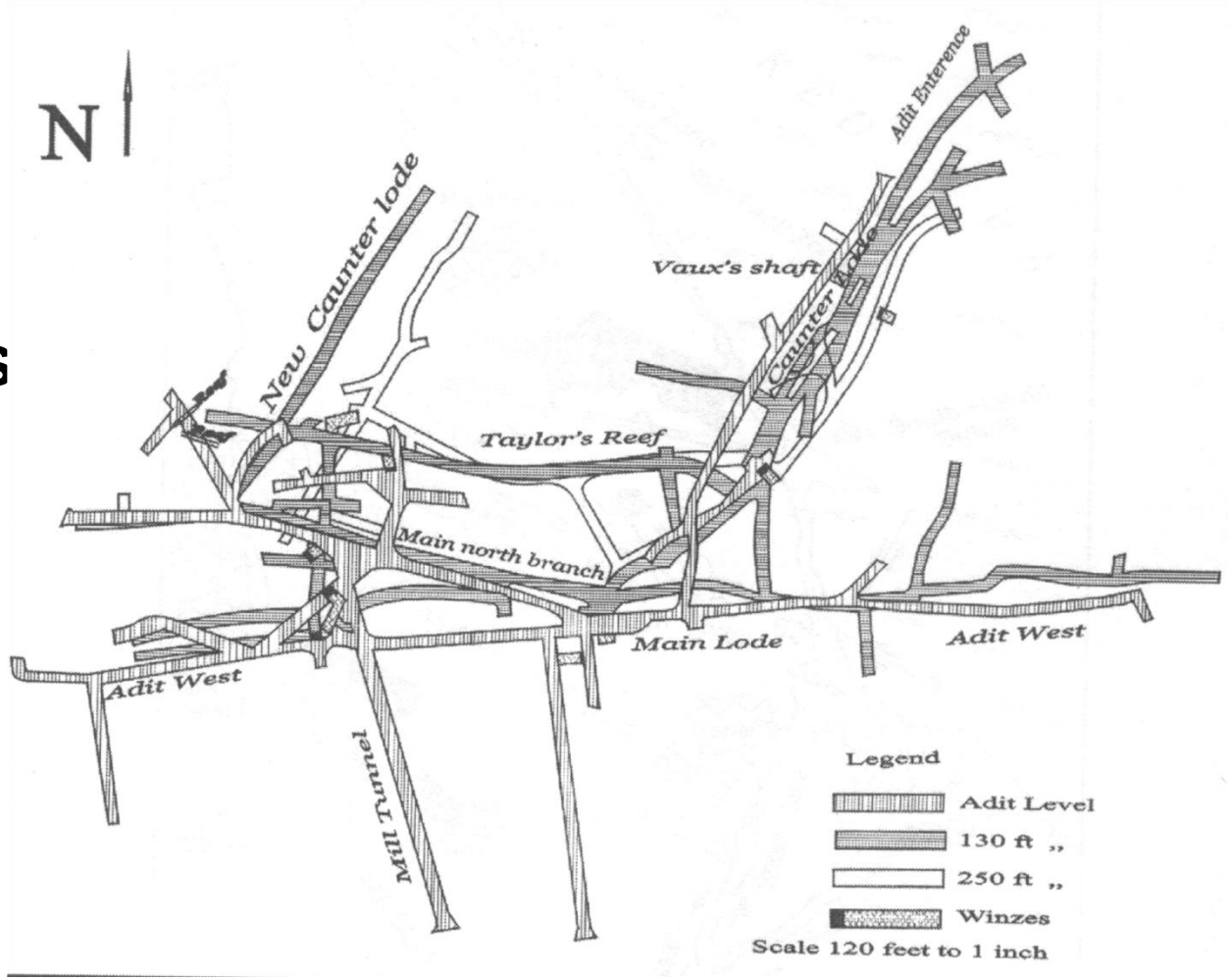


Um Rus gold mine

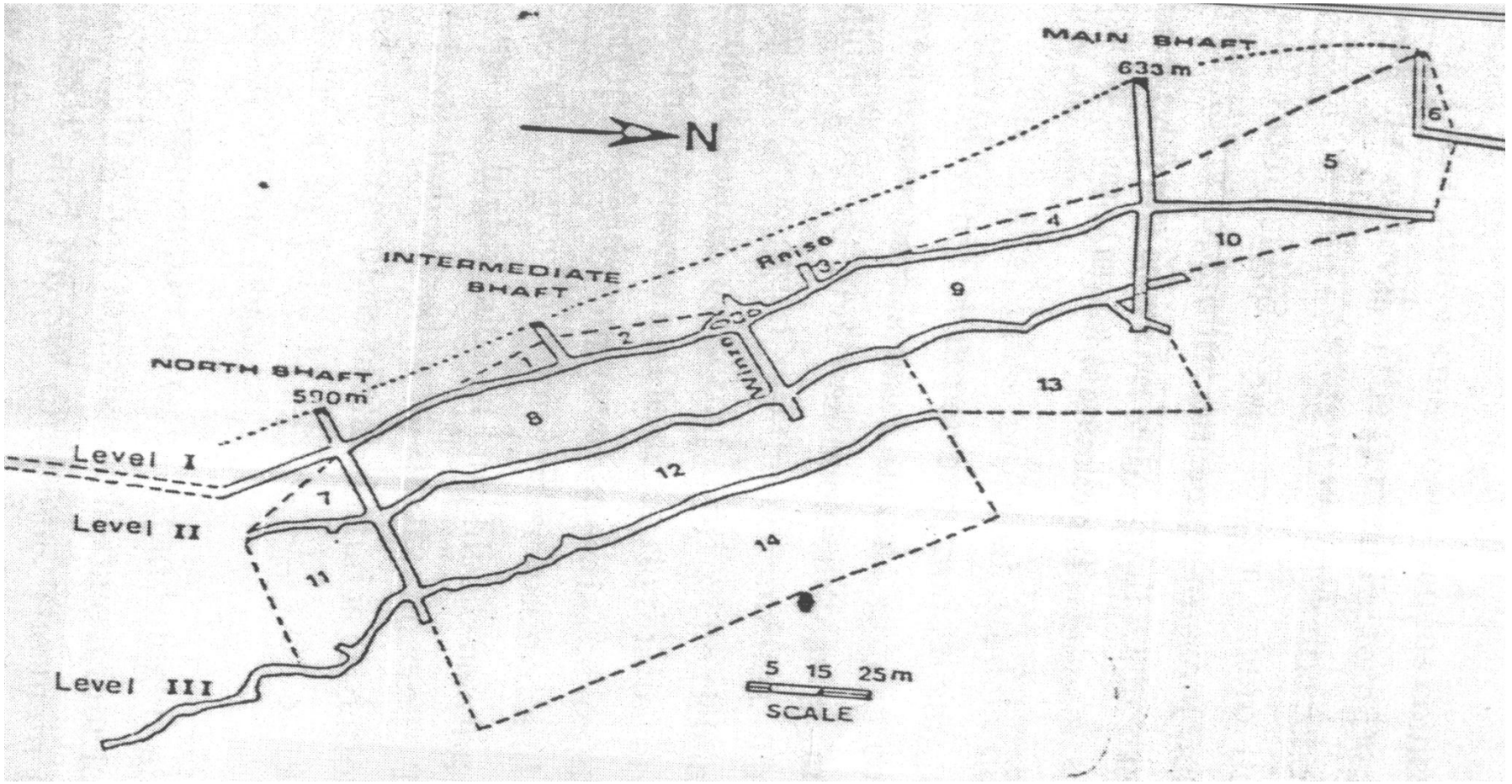
The low production is due to previous mining concepts!

Only quartz veins were mined

Major part of veins was left behind



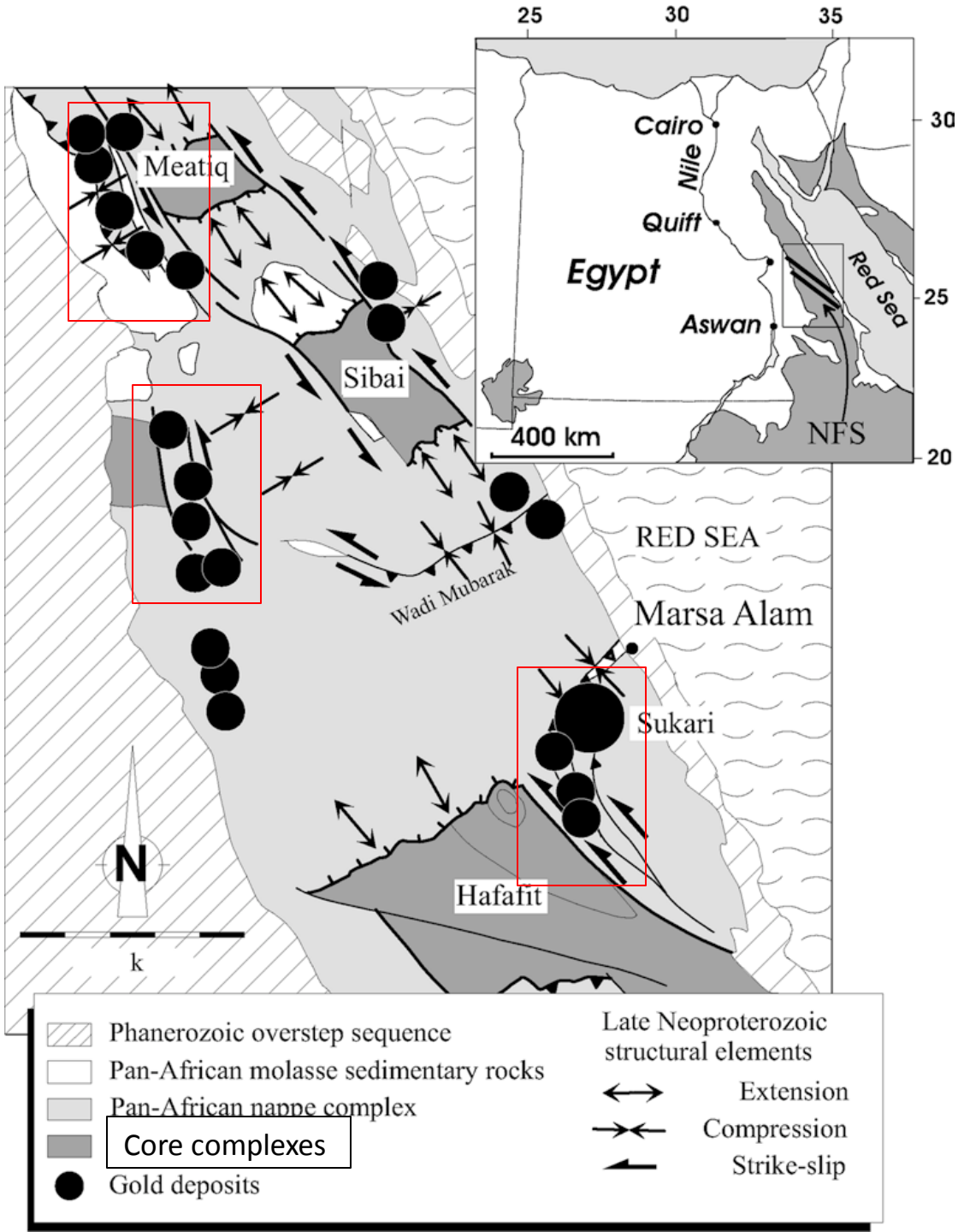
Barramiya gold mine


MAIN SHAFT
633 m
N
INTERMEDIATE SHAFT
Raise
NORTH SHAFT
590m
Winze
Level I
Level II
Level III
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5 15 25m
SCALE

Atud mine

Recommendations: Concessions

- **Government**
  - **Concession area delineation**
    - **Concession area delineation is not LINE Drawings**
    - **Concession areas should be small within certain geologic regimes and structural framework**
    - **Single mines concessions! Why not?**


25
30
35
30
25
20
Cairo
Nile
Quift
Egypt
Aswan
Red Sea
400 km
NFS
Meatiq
Sibai
RED SEA
Wadi Mubarak
Marsa Alam
Sukari
Hafafit
N
k
Phanerozoic overstep sequence
Pan-African molasse sedimentary rocks
Pan-African nappe complex
Core complexes
Gold deposits
Late Neoproterozoic structural elements
Extension
Compression
Strike-slip

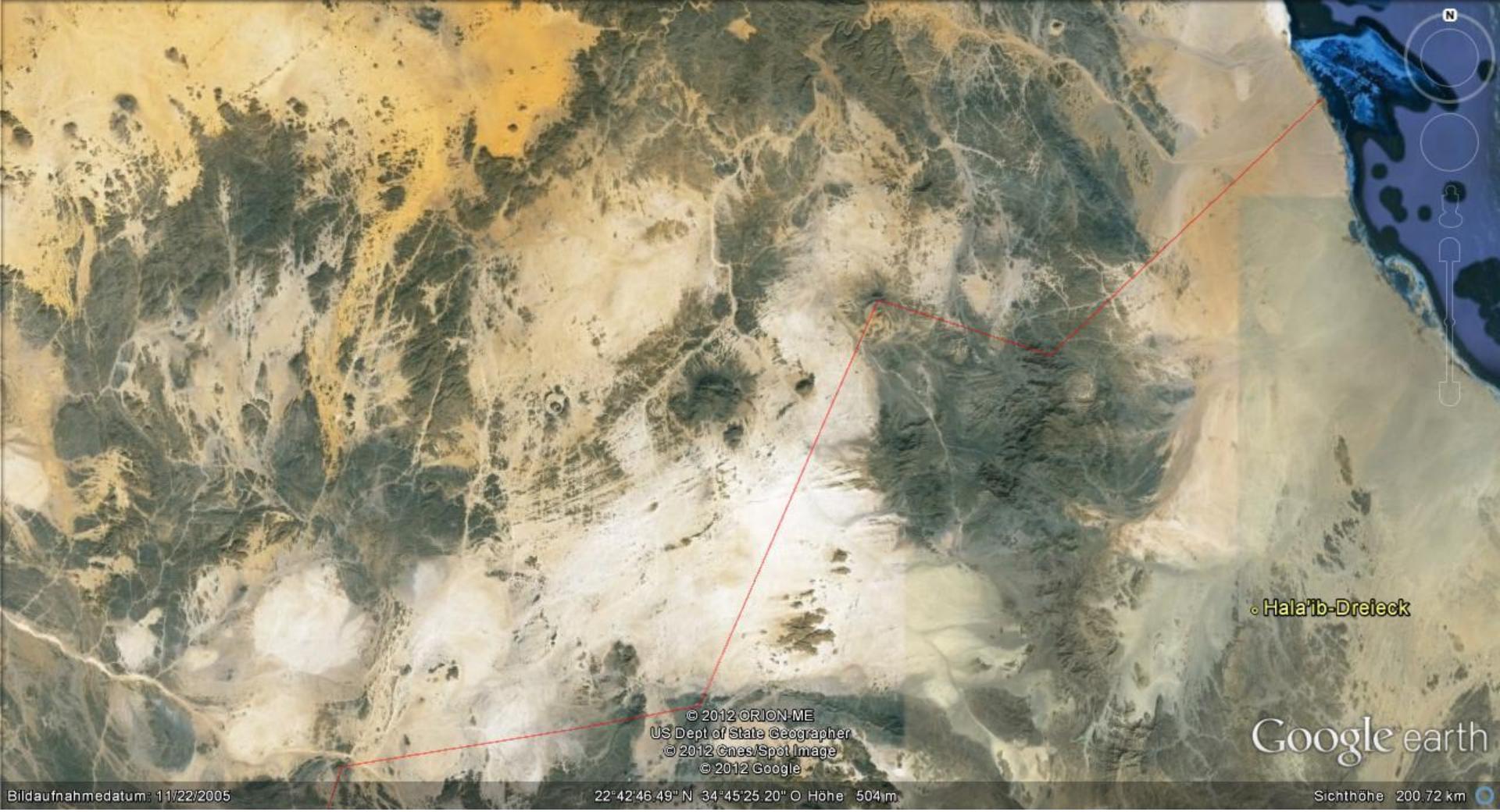
Recommendations: Exploration

Mining Companies:

- **Be selective!**
- **Avoid concessions containing gneiss domes**

If you have the concession area:

- **Exploration is not a routine work!**
- **Targets within a concession area are not of equal importance.**
- **Hit the spot, go to known mines.**
- **Go deep; follow alteration zones.**
- **Placer deposits**



Target of lacer deposits: South Eastern Deposits

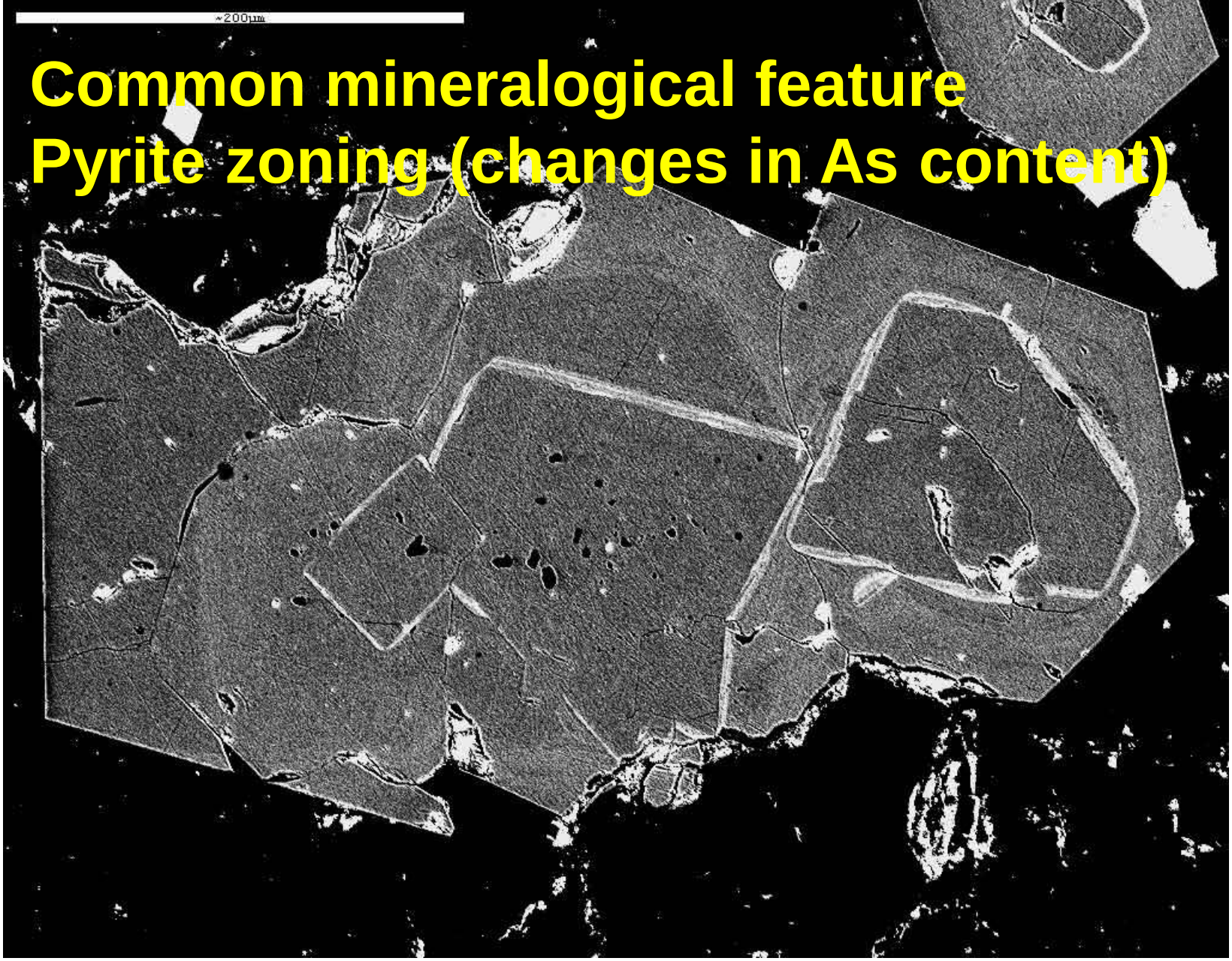
Central Eastern Deposits

Recommendations: Exploitation

- **Alteration zones; main target**
- **Open pit mining**

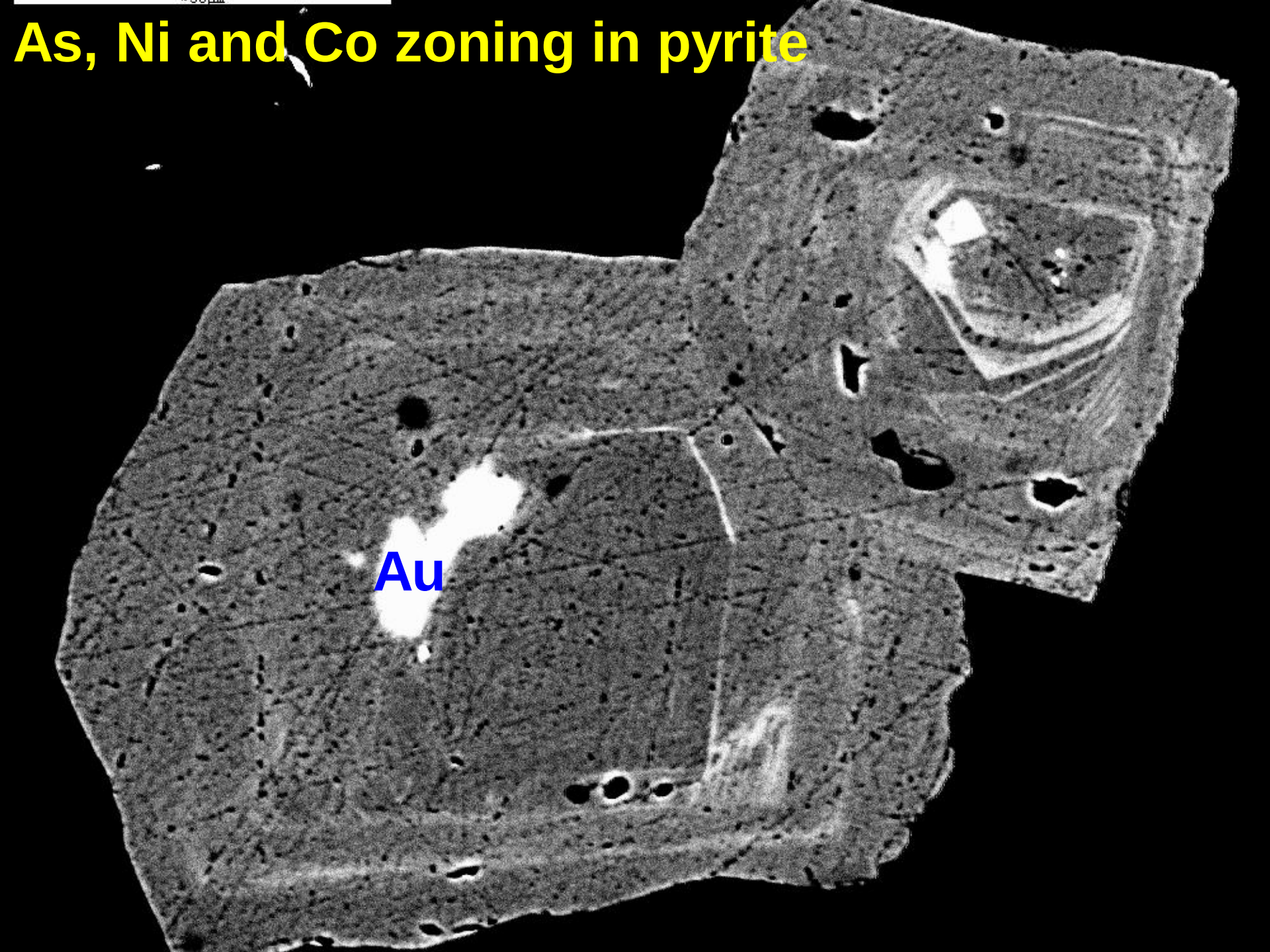
Recommendations: Research

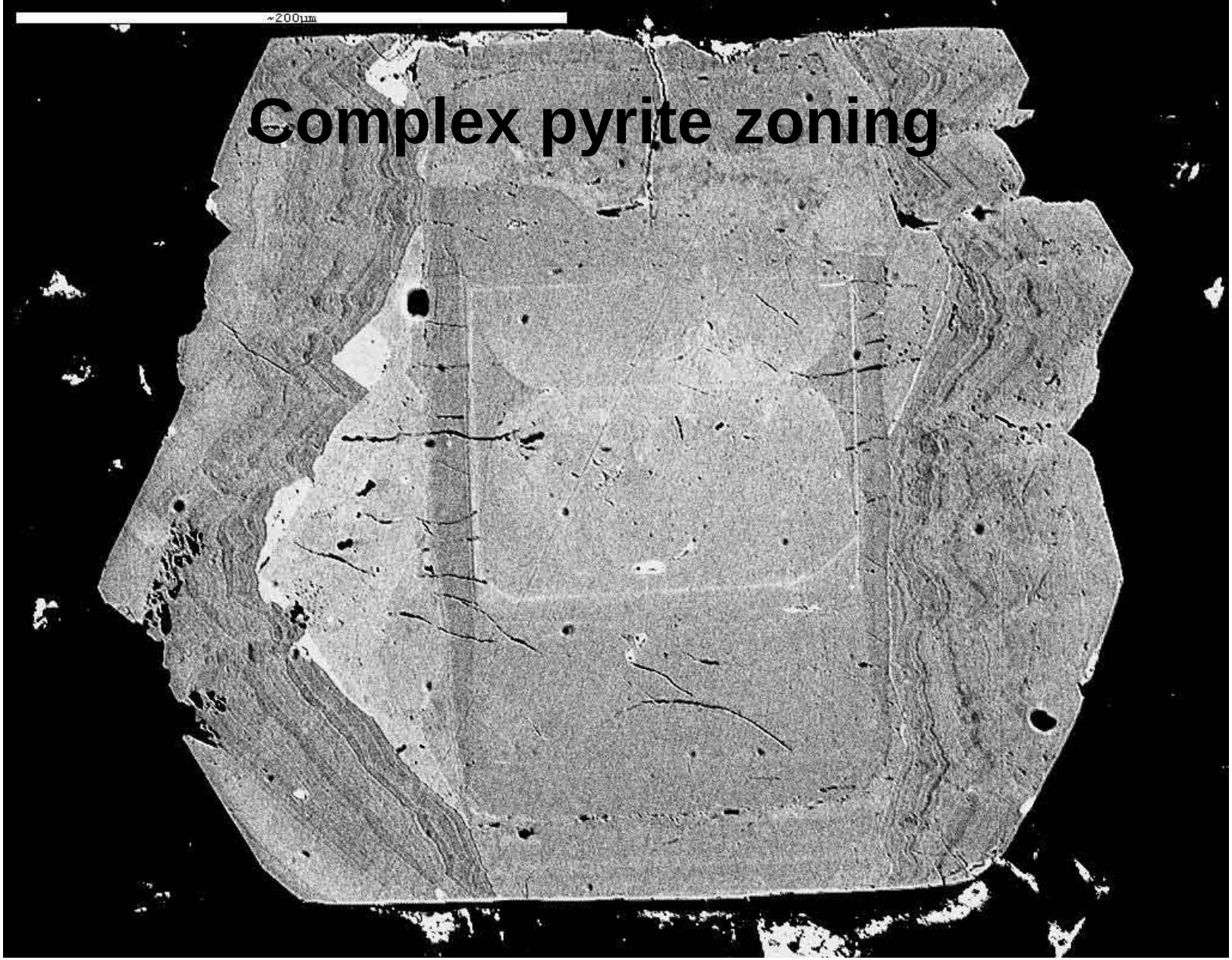
- **Avoid descriptive research**
- **No need for many un-practical classifications.**
- **From small-scale to large-scale, there is always a link!**
- **New areas of research to help beneficiation processes. Isotope studies to know the age and source of mineralizing fluids**


~200µm
Common mineralogical feature
Pyrite zoning (changes in As content)

Atud mine

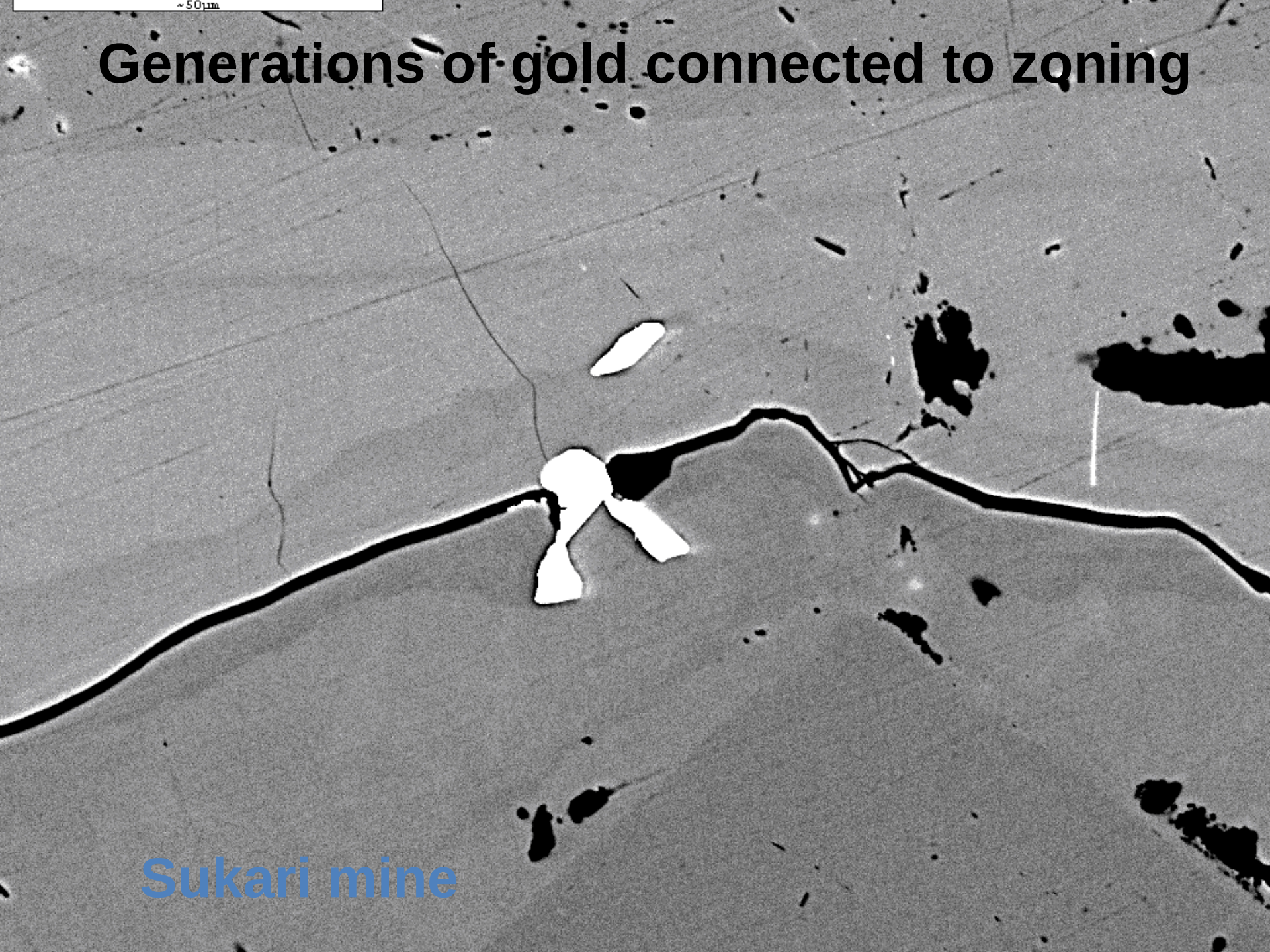
As, Ni and Co zoning in pyrite





Um Rus mine

Generations of gold connected to zoning



Sukari mine

Research proposal: Gold siting in sulfides from major arsenopyrite-bearing deposits ?

Questions to be answered!!

1) How invisible gold is hosted in sulfides?

As free nanoparticles?

As chemically pound?

2) What is the relation between Au and As?

Analytical techniques:

Laser ablation (Bonn University)

Focused Ion Beam (FIB) (GFZ, Potsdam, Germany)

Transmission Electron Microscopy (TEM)

Implications: Gold recovery from sulfides!

Research proposal: Gold siting in sulfides from major arsenopyrite-bearing deposits ?

Implications

Gold recovery from sulfides!

Fund!!

Gold mining companies?

Alexander von Humboldt Foundation