Geology of Mineral Resources in Africa

First Term (2025/2026)

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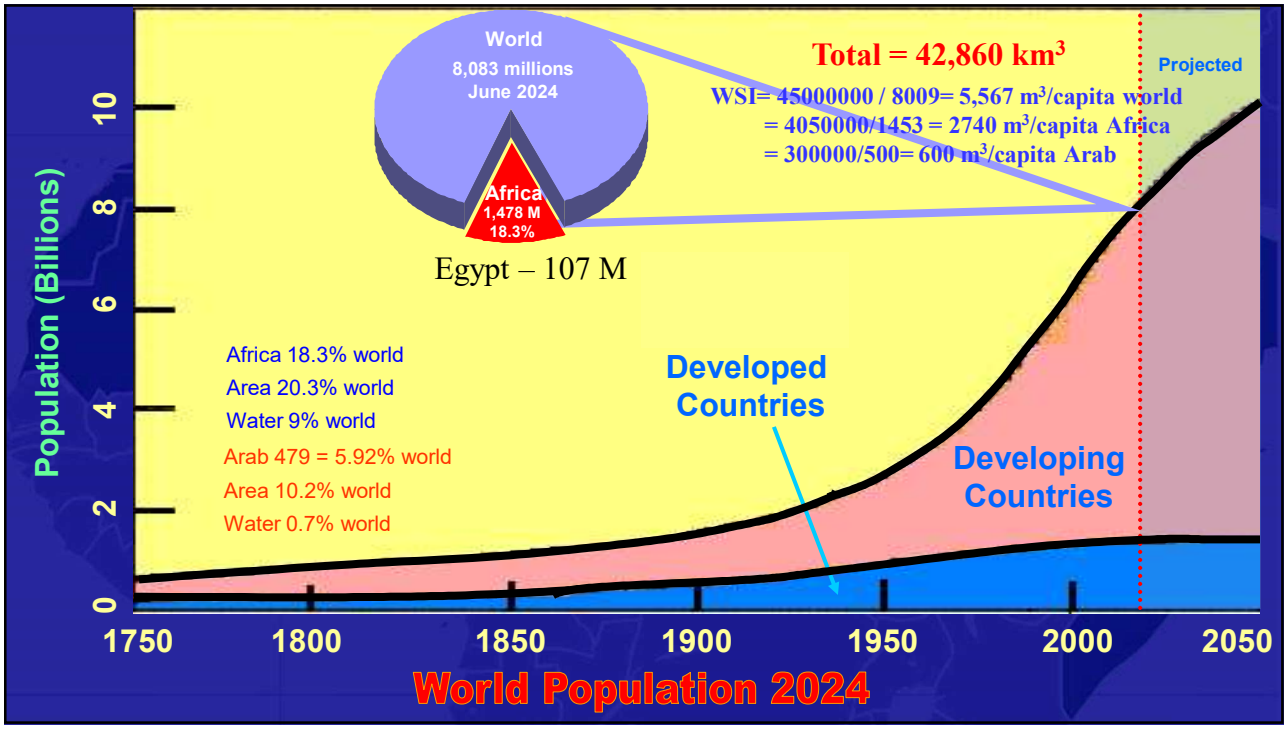
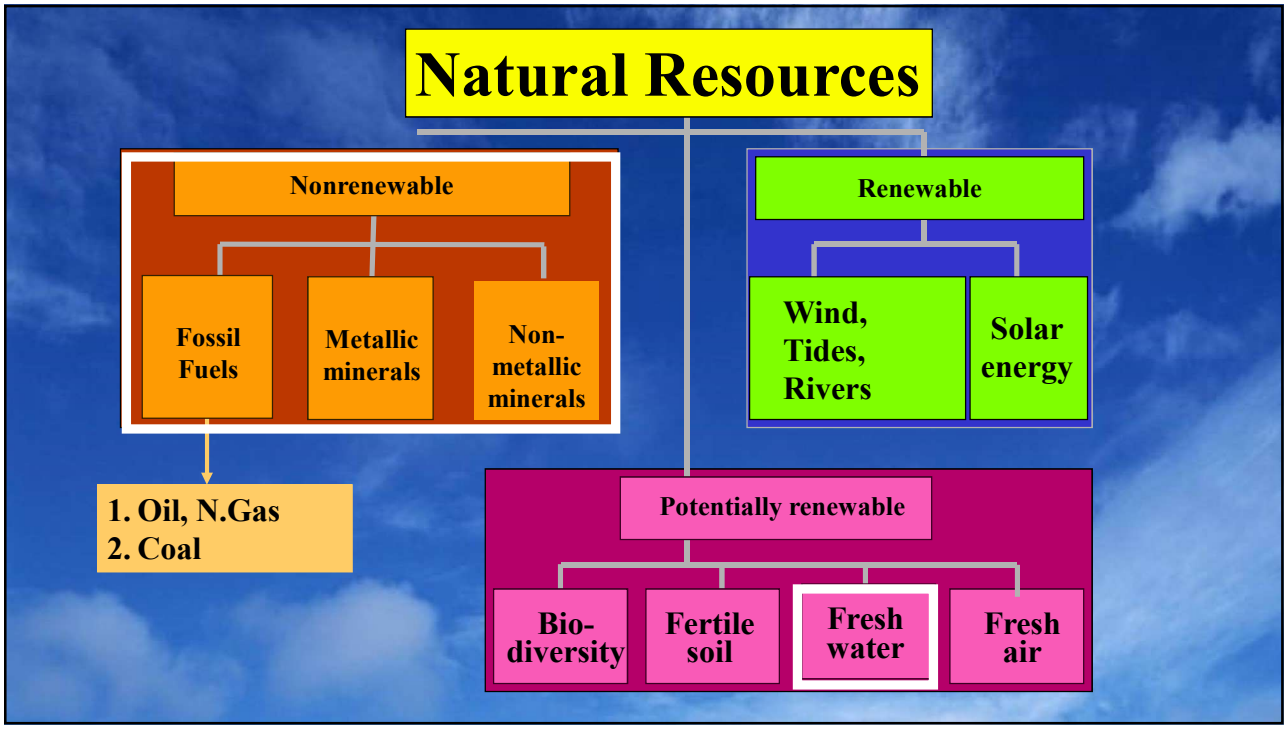
TENTATIVE LECTURE TOPICS

- Introduction, readings, meetings and schedule
- Mineral deposits: Classification of mineral deposits
- Magmatic deposits I: Mafic complexes, ophiolites and massive sulfides
- Magmatic deposits II: Kimberlites, carbonatites and pegmatites
- Hydrothermal deposits (porphyry deposits)
- Hydrothermal deposits (epithermal deposits)
- Mid Term Exam ……Nov. 18, 2023
- Metamorphic deposits
- Sedimentary mineral deposits, residual, supergene enrichment, placer I
- Sedimentary mineral deposits, residual, supergene enrichment, placer II
- Research paper presentations
- Research paper presentations
- Dec. 23, 2023 Oral Exam

Grading

Mid Term Exam	10%
Activities	10%
Oral Exam	10%
Final Exam	70%





MINERAL

Naturally

Solid

Inorganic

Crystal form

Chemical composition

Mineral Resources

1. What will this course examine?
   a. Types of mineral deposits.
   b. Formation of mineral deposits.
      i. Potential sources of metals.
      ii. Transport mechanisms of metals.
      iii. Depositional mechanisms.
      iv. Geologic setting of mineral deposits.

   c. Mineral deposits in Africa.
      i. I to iv
      ii. Distribution, Production and Reserves

Important Terms

- **Resources:**
- **The term resources covers everything we use, including air, soil, timber, water, fuel, coal, mineral, …**

- **Mineral Resources:**

  Mineral resources include non-food, non-fuel resources such as metals (e.g. aluminum, palladium) and industrial minerals (e.g. gypsum, phosphate).

- **Mineral Deposits:**

  Mineral resources become concentrated in Earth's crust as a result of specific geologic processes associated with the formation of rocks.

Important Terms

- **What is an ore?**

  An ore is a naturally occurring solid material containing a useful commodity that can be extracted at a profit.

- **Reserves**
- The total tonnage of ore in the deposit at a given grade.
- 1. Proven -sampled in three dimensions.
- 2. Probable - sampled in two dimensions.
- 3. Possible - inferred or thought to be present

- **Gangue**
- **Non-economic minerals (e.g. quartz, feldspar, and calcite) found in association with ore minerals and are considered waste.**

- **The concentration factor (CF)**
- **It is the increase in the concentration of a mineral required to generate an ore.**
- **economic concentration by the average concentration of the mineral in the crust**

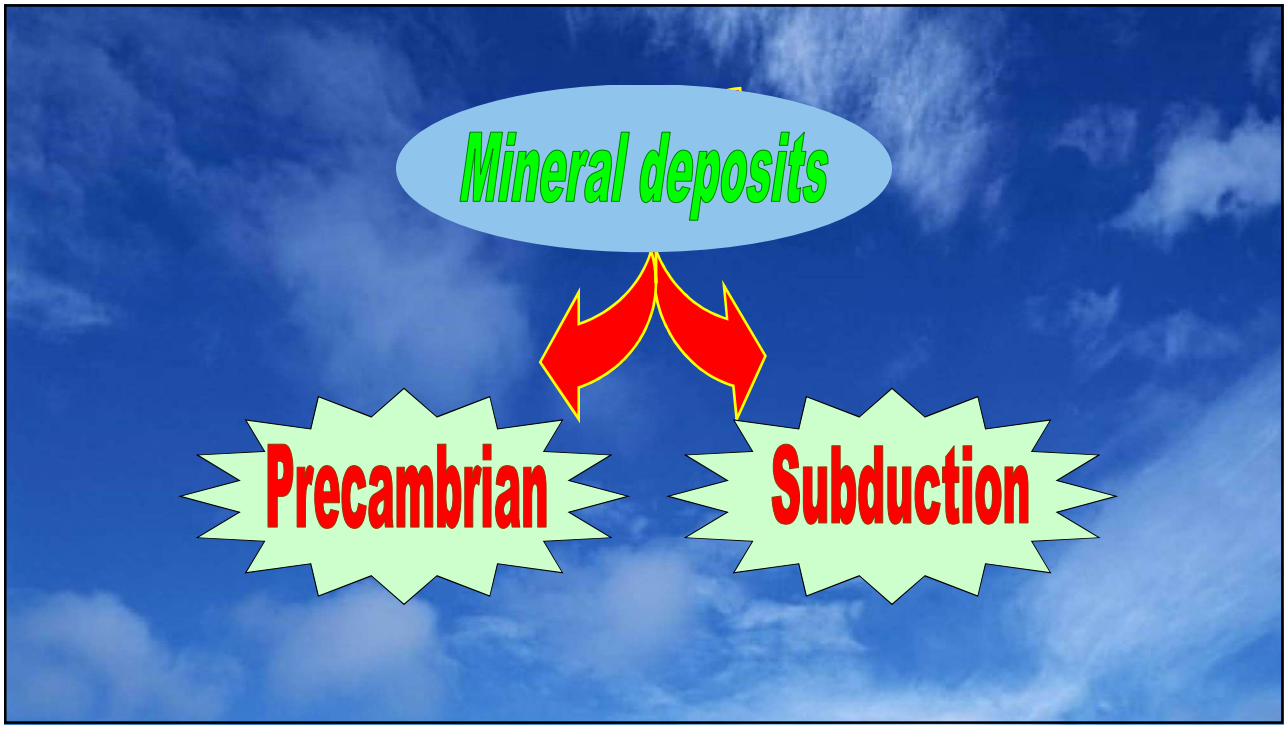
  CF = conc. mineral / conc. Average crust

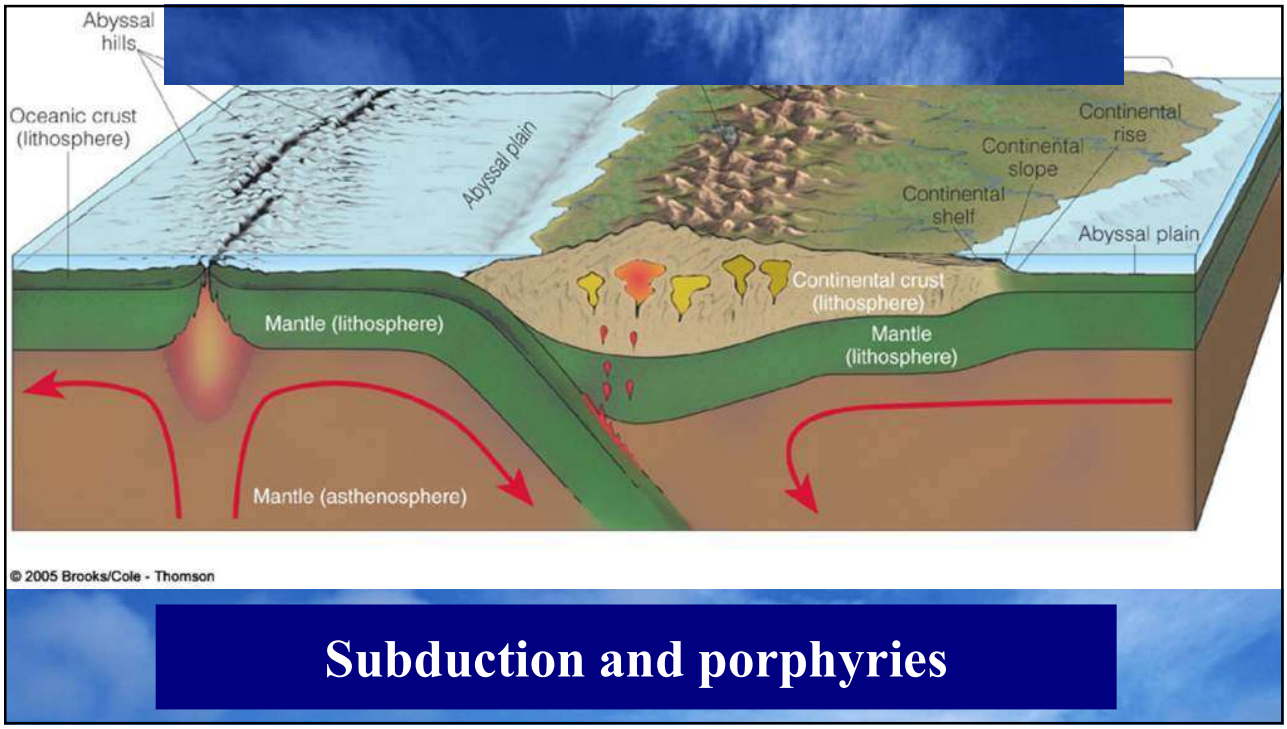
  Copper Bingham, Utah, 0.6%, Average in Crust = 55 ppm

  CF = 0.6*10000 / 55 = 109.09

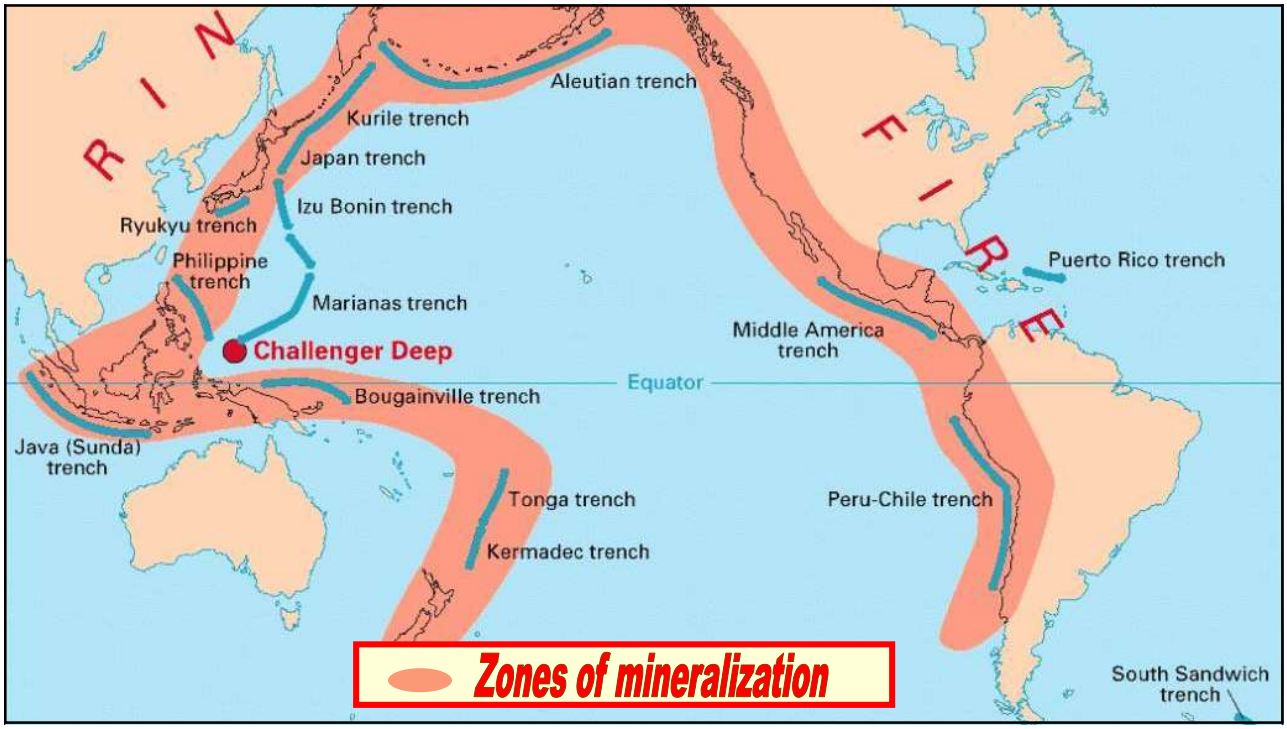
Factors influencing mining:

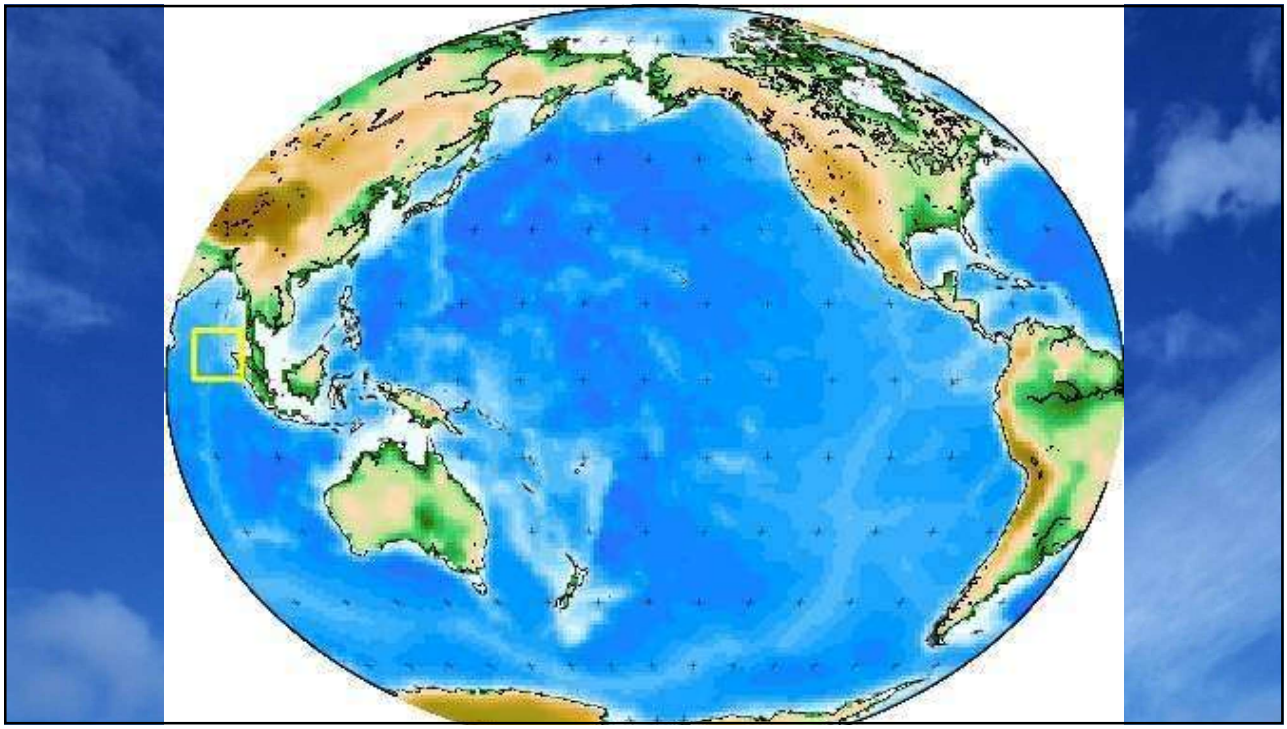
1. Tenor and tonnage.
2. Nature of the ore (type, grain size, texture, hardness ..
3. Location of the deposit.
4. The geological situation (surface, in depth, ...).
5. Technical factors.
6. Global and local economic and political situation.



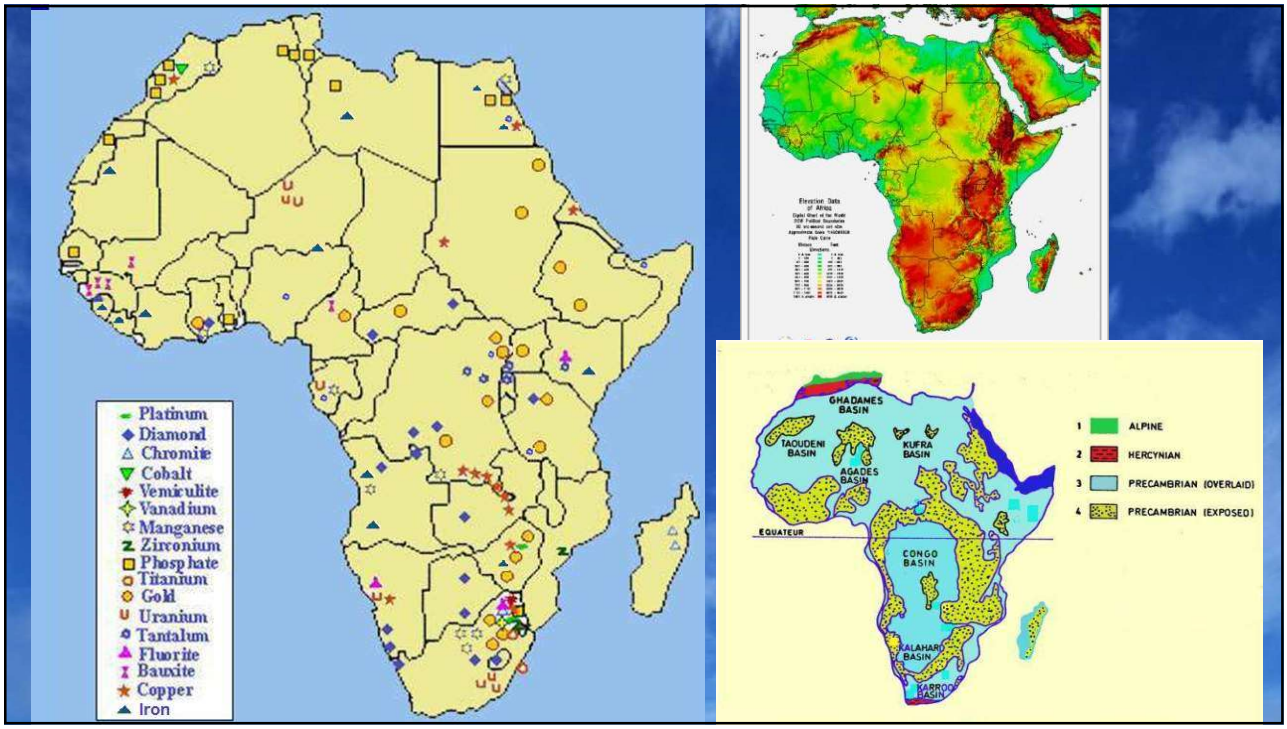


Subduction and porphyries



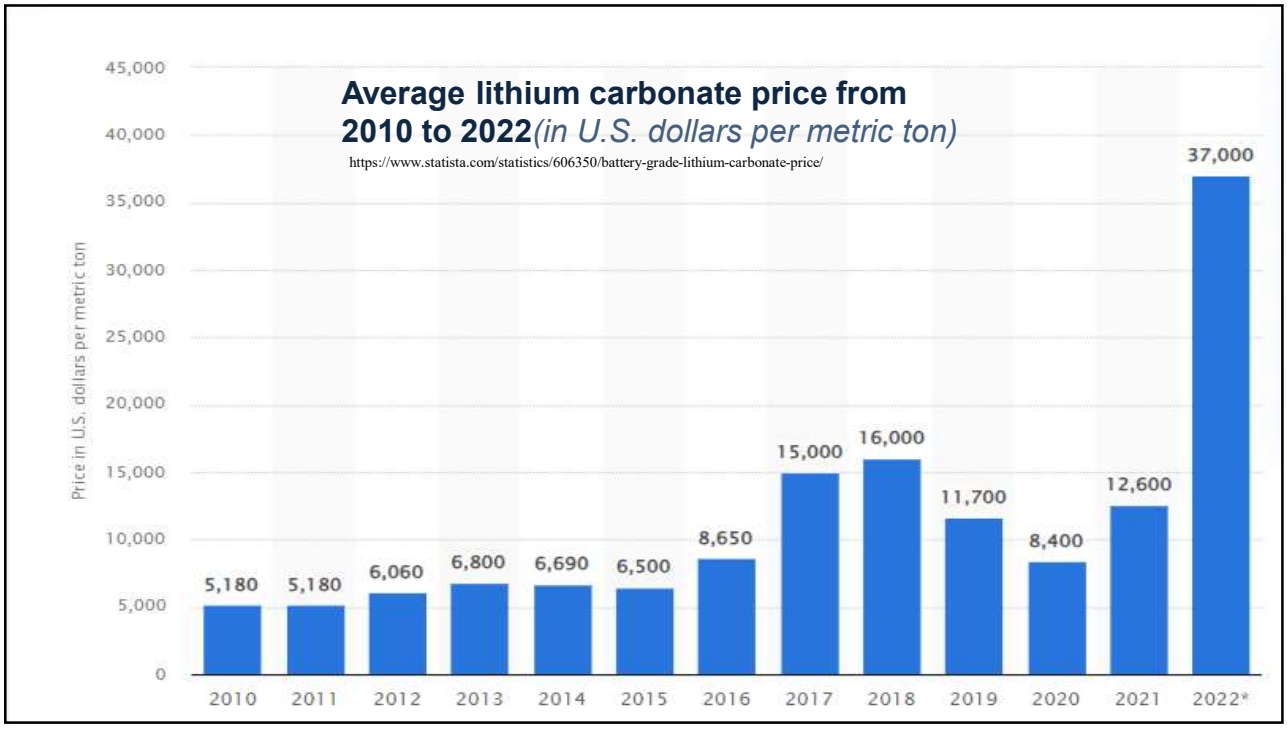


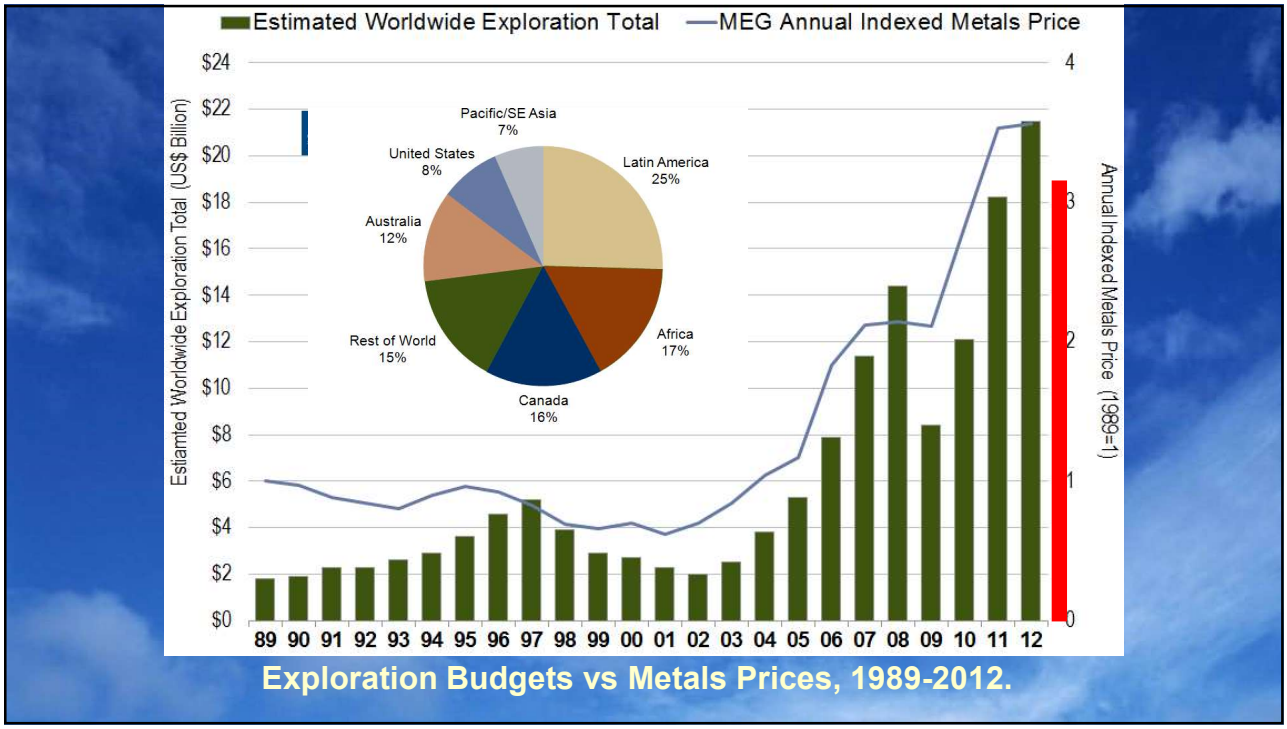

30 Year Gold Price in USD/oz
Last Close: 4290.14
High: 4290.14 Low: 252.57 ▲ 3906.49 1018.24%
30 Year Gold Price History
in US Dollars per Ounce
4500
4000
3500
3000
2500
2000
1500
1000
500
0.0
1995
1997
2000
2002
2004
2006
2008
2010
2012
2015
2017
2019
2021
2023
goldprice.org
https://goldprice.org/gold-price-charts/30-year-gold-price-history-in-us-dollars-per-ounce
Friday, October 17, 2025


Platinum
Diamond
Chromite
Cobalt
Vemiculite
Vanadium
Manganese
Zirconium
Phosphate
Titanium
Gold
Uranium
Tantalum
Fluorite
Bauxite
Copper
Iron
GHADAMES BASIN
TAOUDENI BASIN
KUFRA BASIN
AGADES BASIN
EQUATEUR
CONGO BASIN
KALAHARI BASIN
KARROO BASIN
1 ALPINE
2 HERCYNIAN
3 PRECAMBRIAN (OVERLAID)
4 PRECAMBRIAN (EXPOSED)

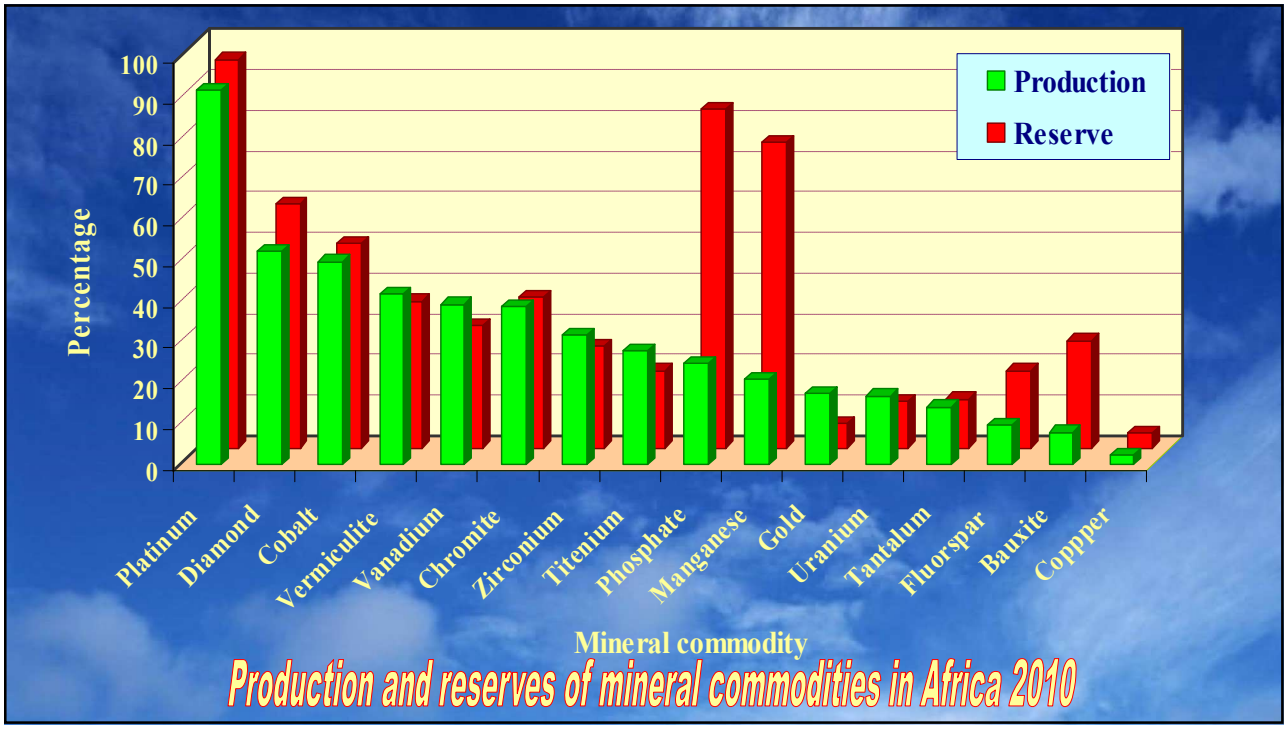

Mining in Africa FACTS
55%
of the world's diamonds led by Botswana and Congo
110
There are over 110 listed mining companies with operations in South Africa
22%
Africa produces about 483 tons of gold- 22% of the world's total production.
60%
of the mining in Africa is gold mining.
30%
Africa hosts 30% of the worlds mineral reserve


History of mineral production in Africa.
Lithium
DR Congo- Zimbabwe
Coltan
DR Congo
Iron
Liberia
Uranium
Niger + Namibia
Bauxite
Guinea
Copper
Zambia+DR Congo
Gold
S. Africa - Ghana
Diamond and Gold
Southern Africa
1900 1925 1950 1975 2000 2025


Average lithium carbonate price from 2010 to 2022 (in U.S. dollars per metric ton)
https://www.statista.com/statistics/606350/battery-grade-lithium-carbonate-price/
Price in U.S. dollars per metric ton
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
5,180
5,180
6,060
6,800
6,690
6,500
8,650
15,000
16,000
11,700
8,400
12,600
37,000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022*

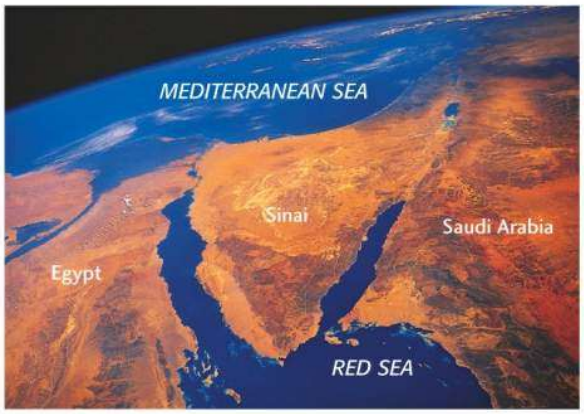


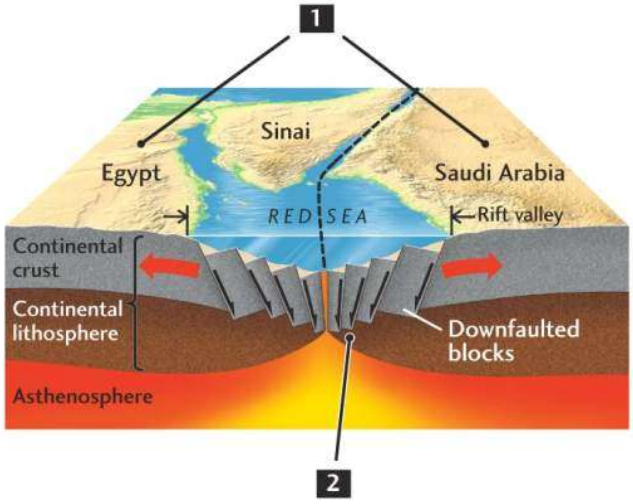
Exploration Budgets vs Metals Prices, 1989-2012.



Production and reserves of mineral commodities in Africa 2010

Tectonic Environment





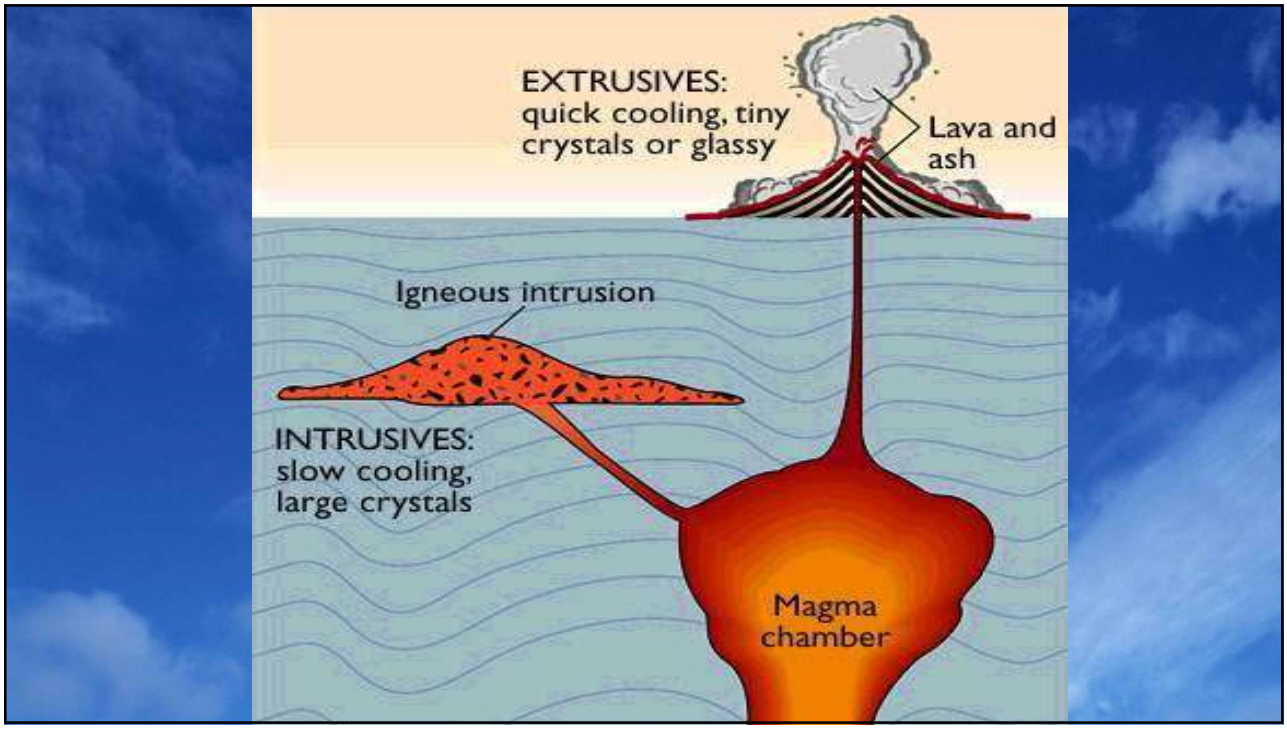
Mineral Deposits

- **METALLIC**
  1. Precious metals: Au, Ag and Platinum group metals (PGM)
  2. Ferrous metals: Fe, Mn, Cr, Ti and V
  3. Non-ferrous metals: Mo, Cu, Pb, Zn Sn, Ni and Al
     Base metals: Cu Pb Zn
  4. Radioactive elements: Uranium and thorium

- **NONMETALLIC (Industrial minerals)**
  Limestone, phosphate, clays, marble, fluorite and rock salt

Classification of mineral deposits

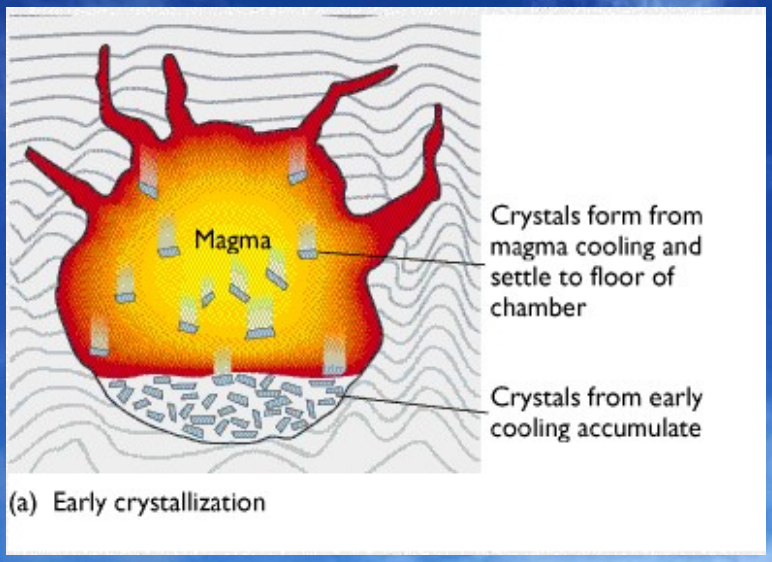
- Magmatic ore deposits



Classification of mineral deposits

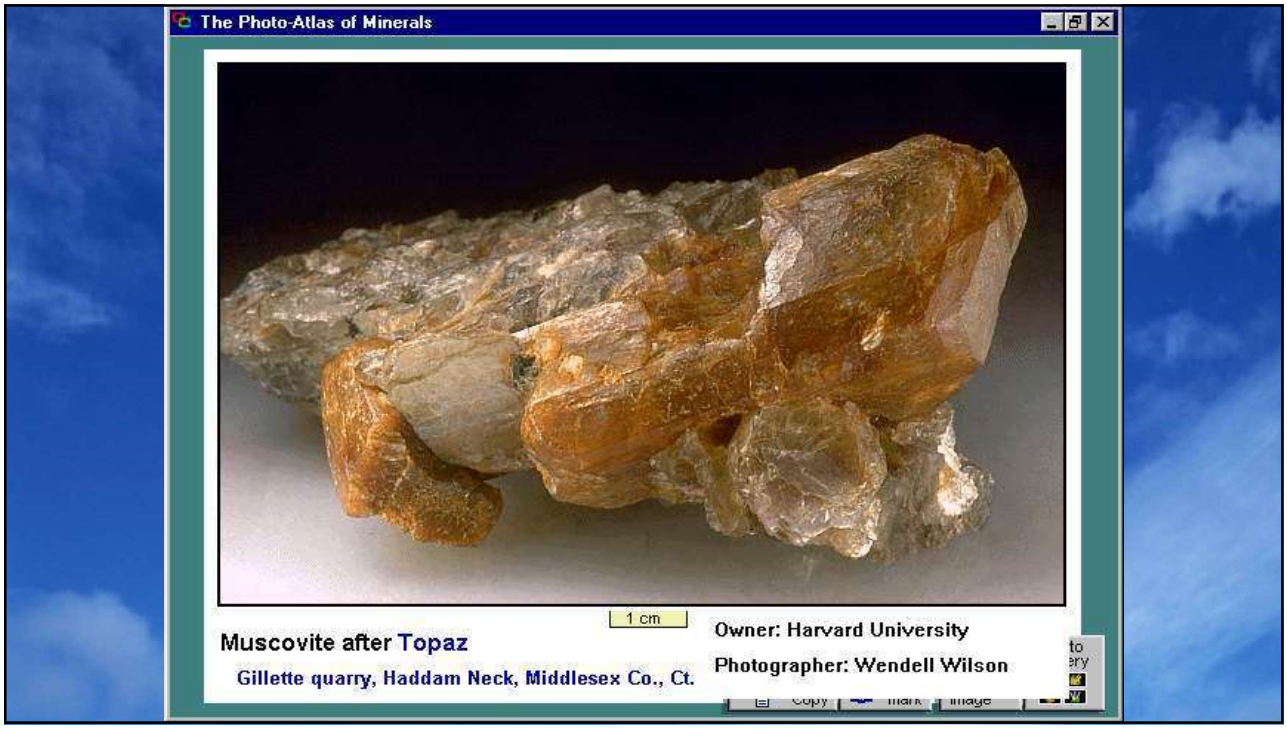
- Magmatic ore deposits
  - Segregation (BIC, Cr, Ni, Pt,…)

Segregation by Gravitational Settling



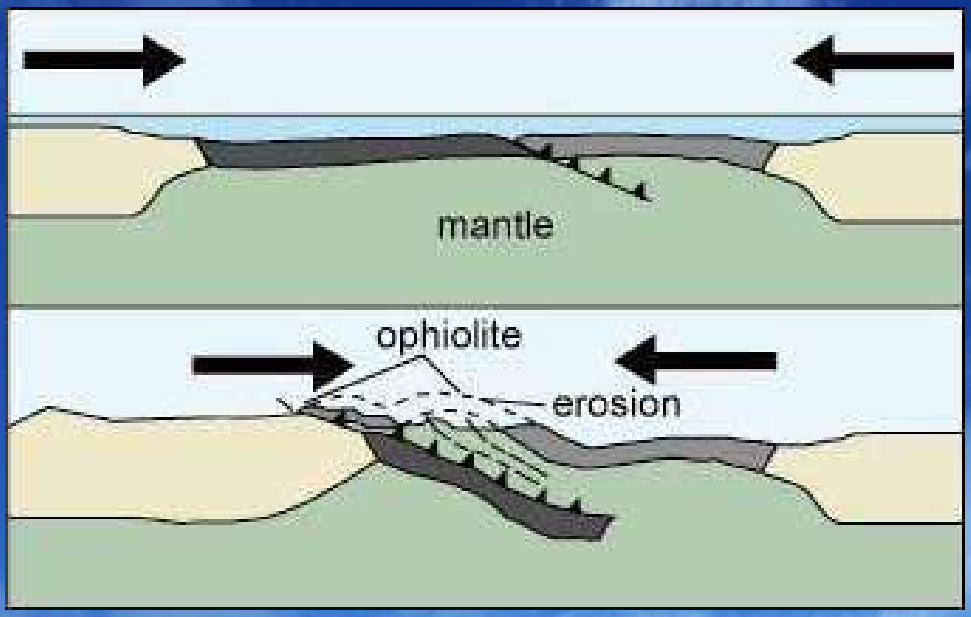
Classification of mineral deposits

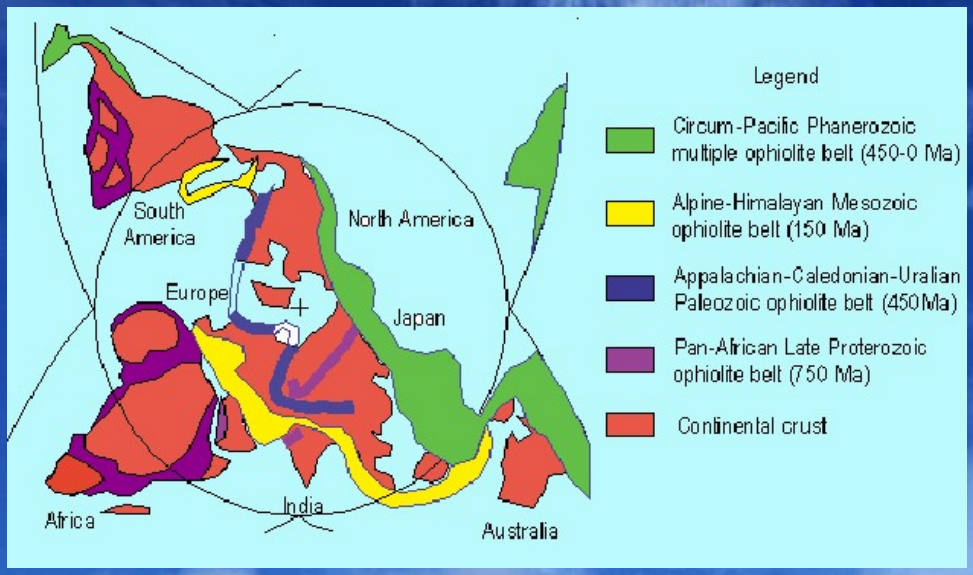
- Magmatic ore deposits
  - Segregation
  - Pegmatites (Beryl, tourmaline,…)



Classification of mineral deposits

- Magmatic ore deposits
  - Segregation
  - Pegmatite
  - Ophiolites (Cr)

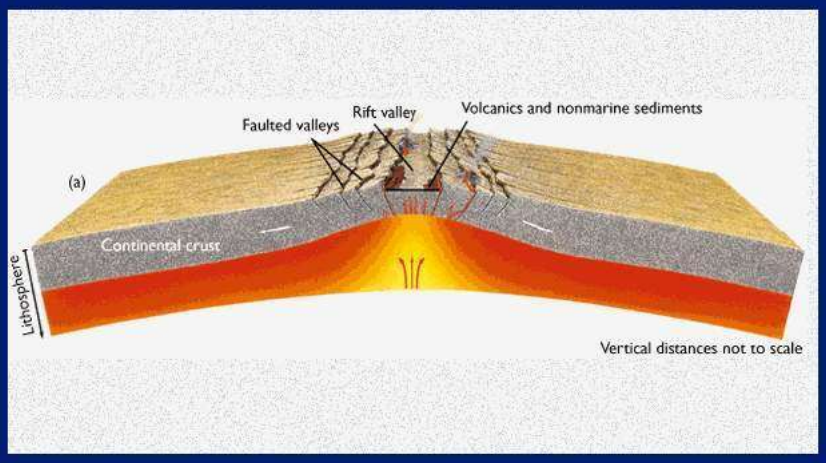




Ophiolite belts in the world

Classification of mineral deposits

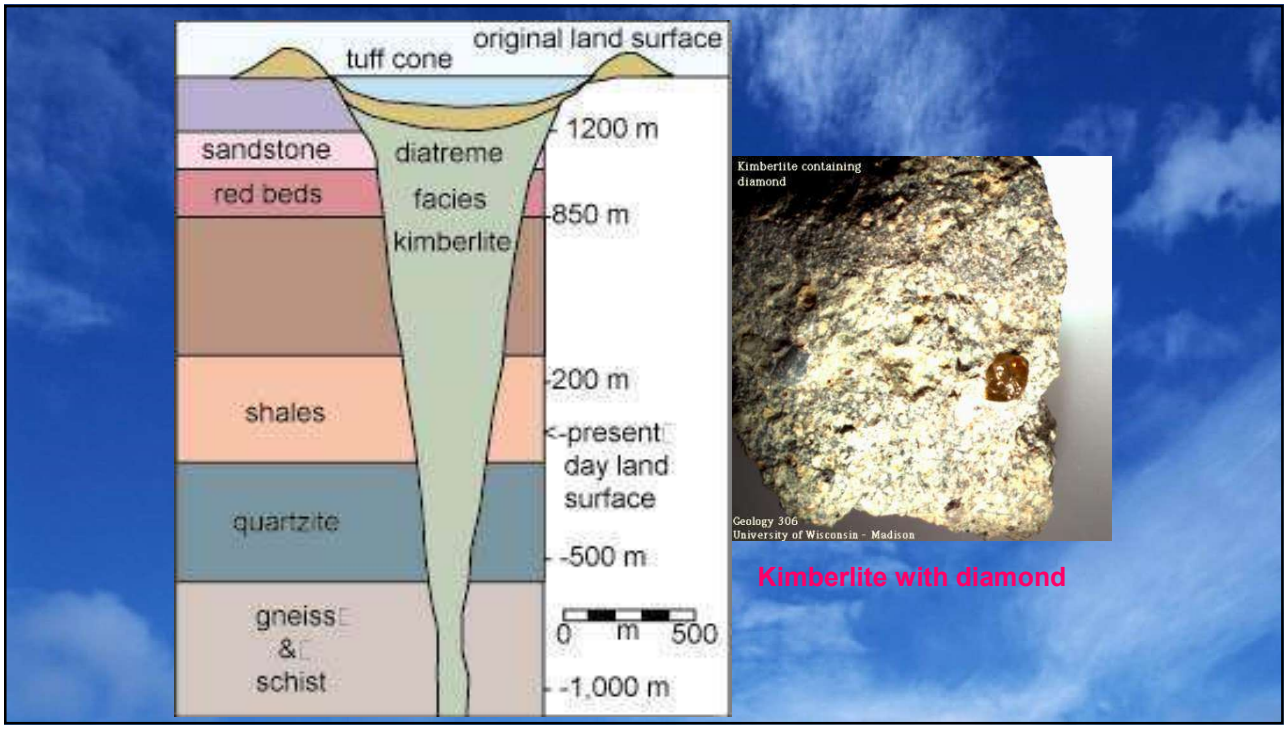
- Magmatic ore deposits
  - Segregation
  - Pegmatite
  - Ophiolites
  - Massive sulfides (Fe, Cu, Mn)

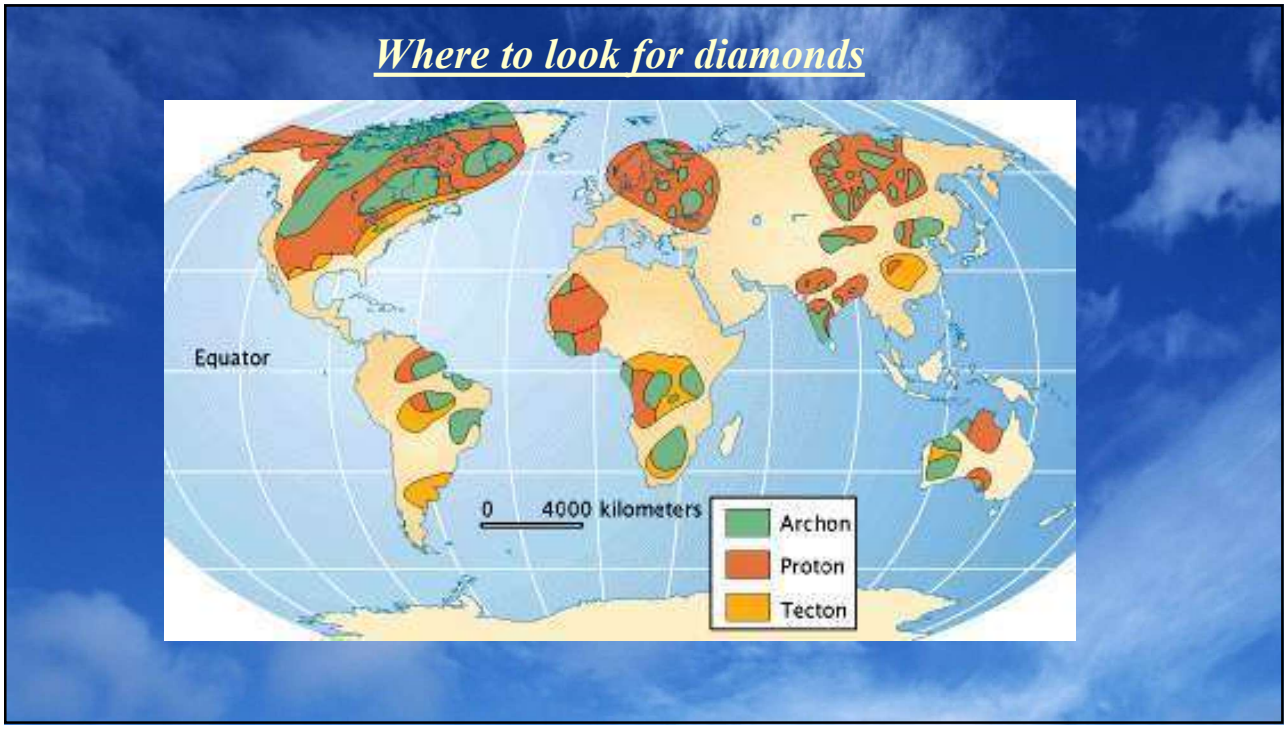


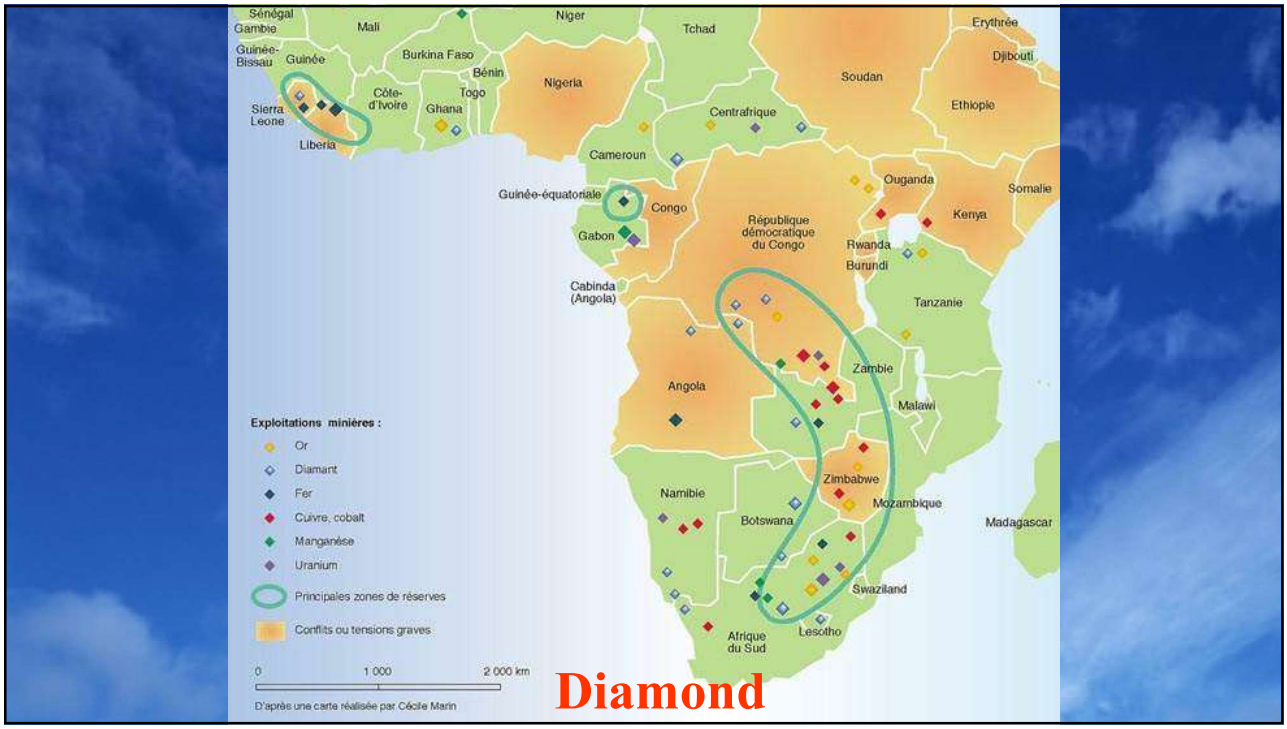
Tension

Classification of mineral deposits

- **Magmatic ore deposits**
  - **Segregation**
  - **Pegmatite**
  - **Ophiolites**
  - **Massive sulfides (Fe, Cu, Mn)**
  - **Kimberlites (diamond)**


original land surface
tuff cone
sandstone
red beds
diatreme
facies
kimberlite
1200 m
850 m
200 m
shales
present
day land
surface
quartzite
500 m
gneiss
&
schist
0
m
500
1,000 m
Kimberlite containing
diamond
Geology 306
University of Wisconsin - Madison
Kimberlite with diamond


Where to look for diamonds
Equator
0
4000 kilometers
Archon
Proton
Tecton

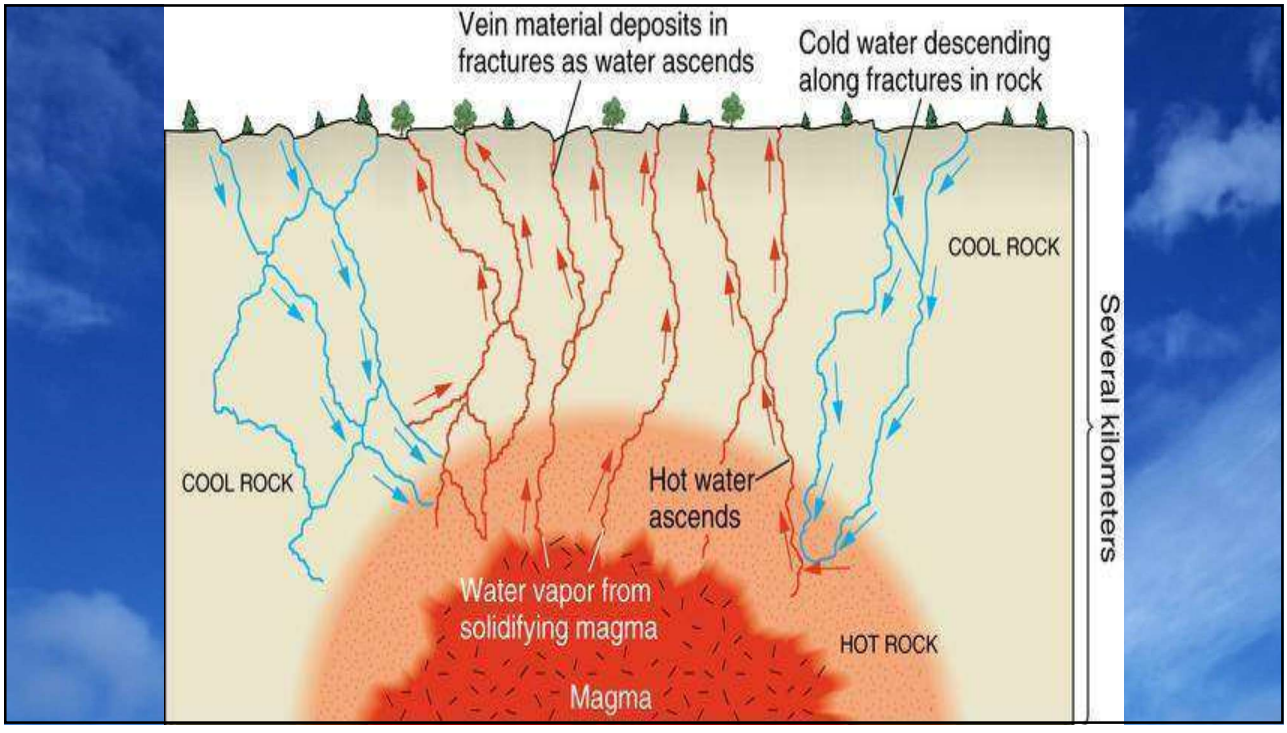


Classification of mineral deposits

- **Magmatic ore deposits**
  - **Segregation**
  - **Pegmatite**
  - **Massive sulfides (Fe, Cu, Mn)**
  - **Kimberlites (diamond)**
  - **Carbonatites (Nb, REE, Cu)**

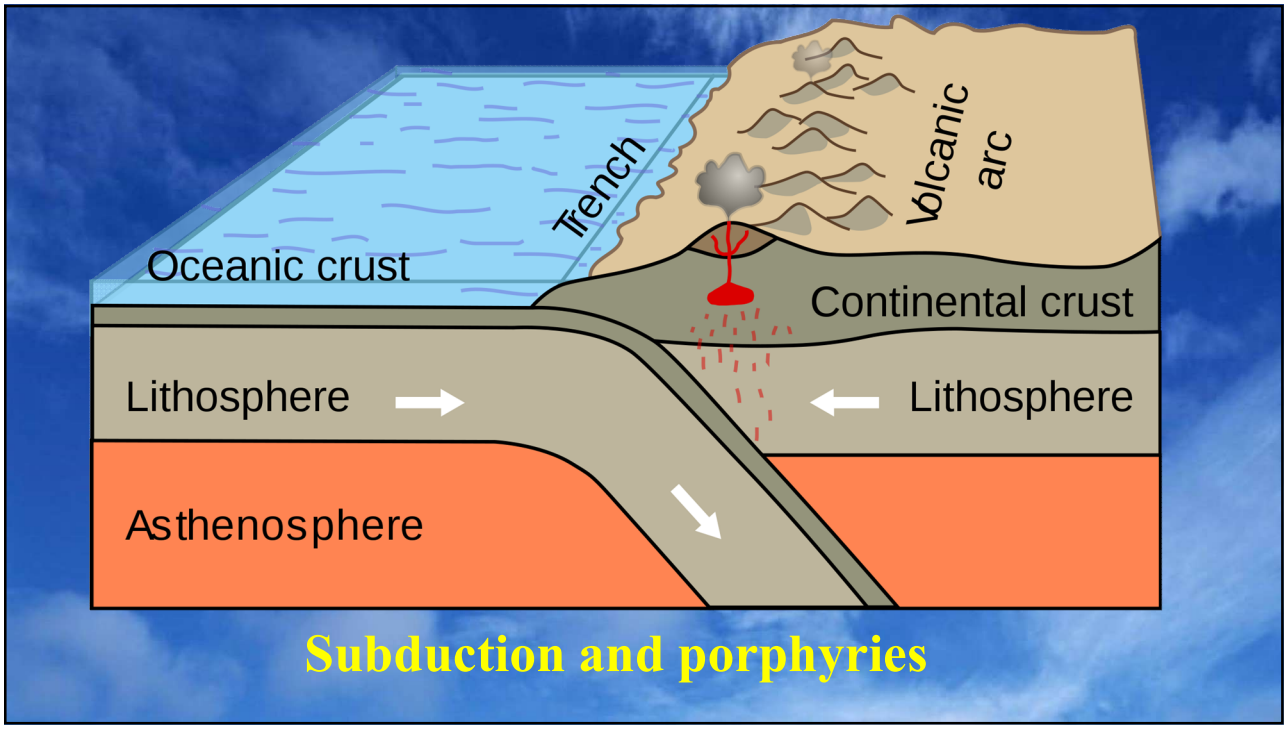
Classification of mineral deposits

- Magmatic ore deposits
- Hydrothermal ore deposits

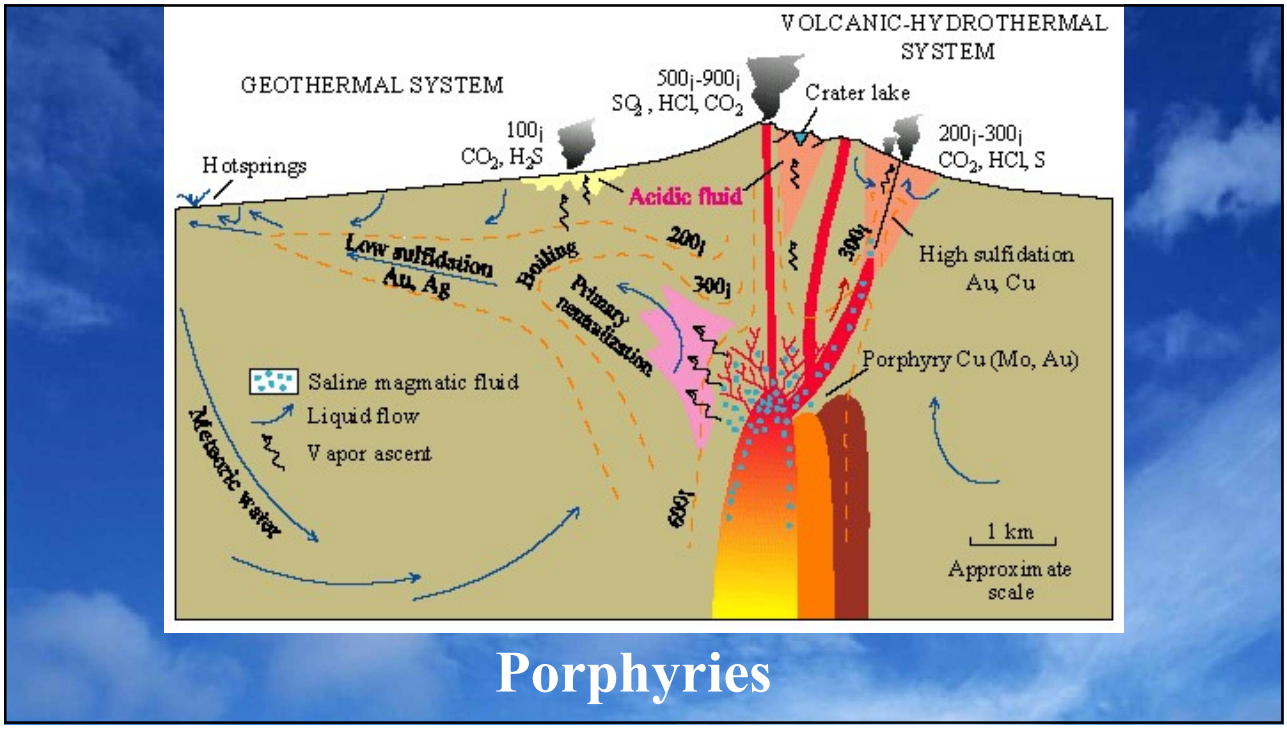


Classification of mineral deposits

- Magmatic ore deposits
- Hydrothermal ore deposits
  - Porphyry (Cu, Mo, Au)



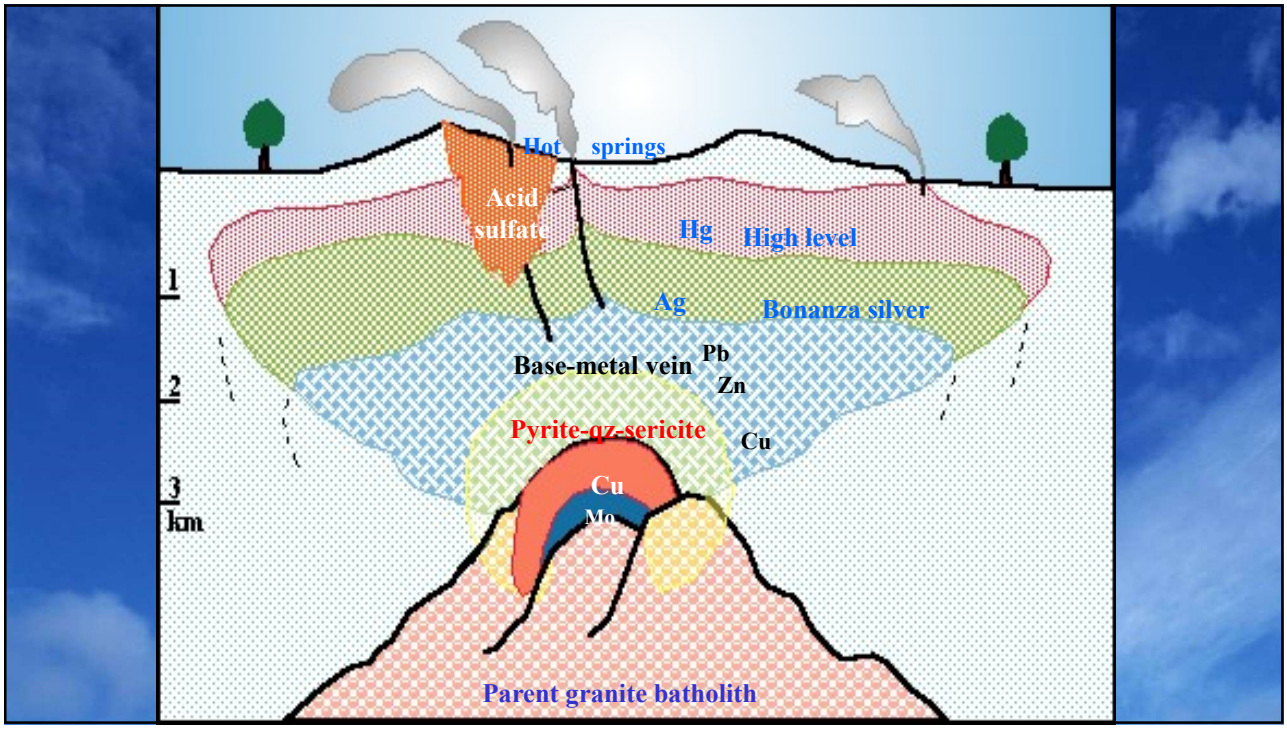
Subduction and porphyries



Porphyries

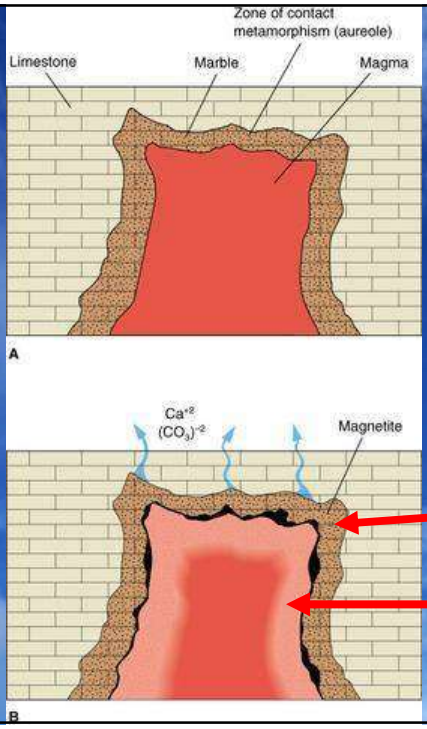
Classification of mineral deposits

- Magmatic ore deposits
- Hydrothermal ore deposits
  - Porphyry (Cu, Mo, Au)
  - Epithermal



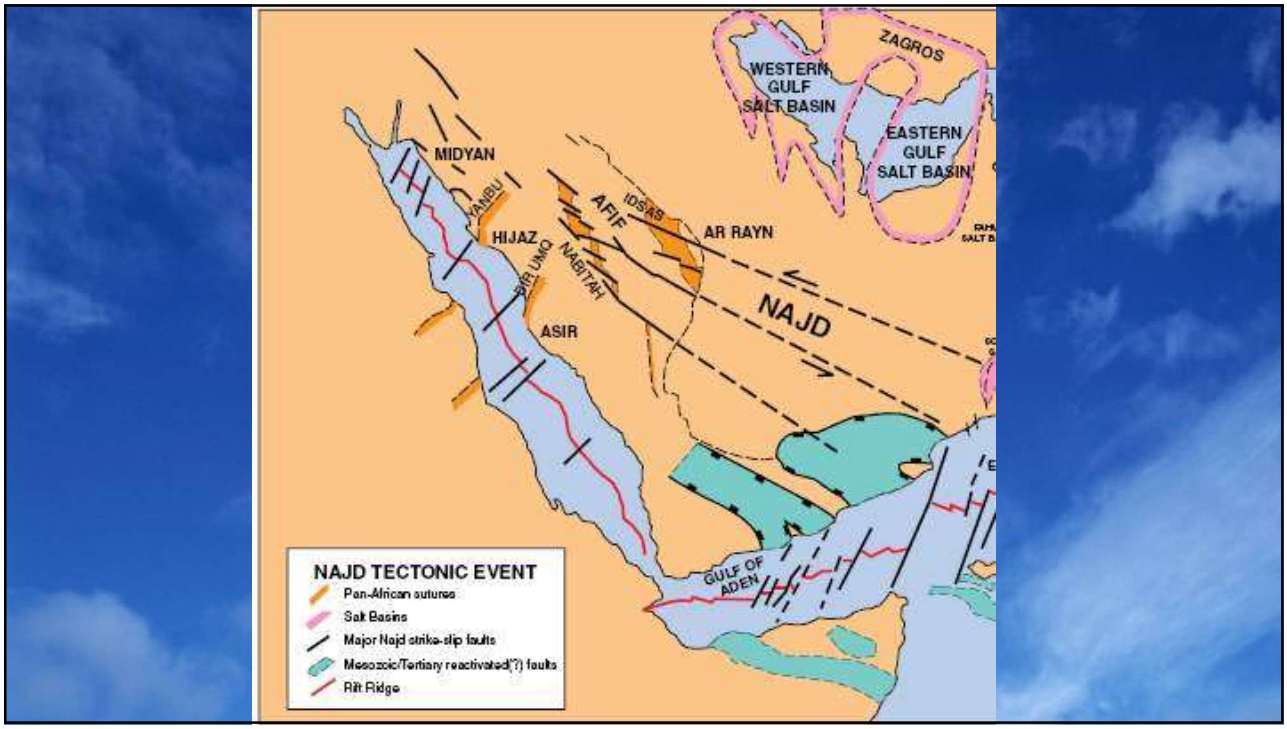
Classification of mineral deposits

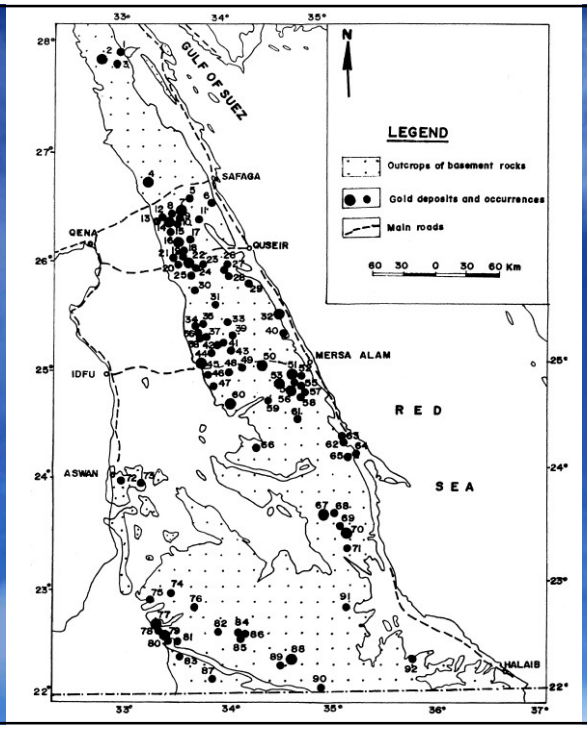
- Magmatic ore deposits
- Hydrothermal ore deposits
- Metamorphic ore deposits
  - Skarn



Exoskarn

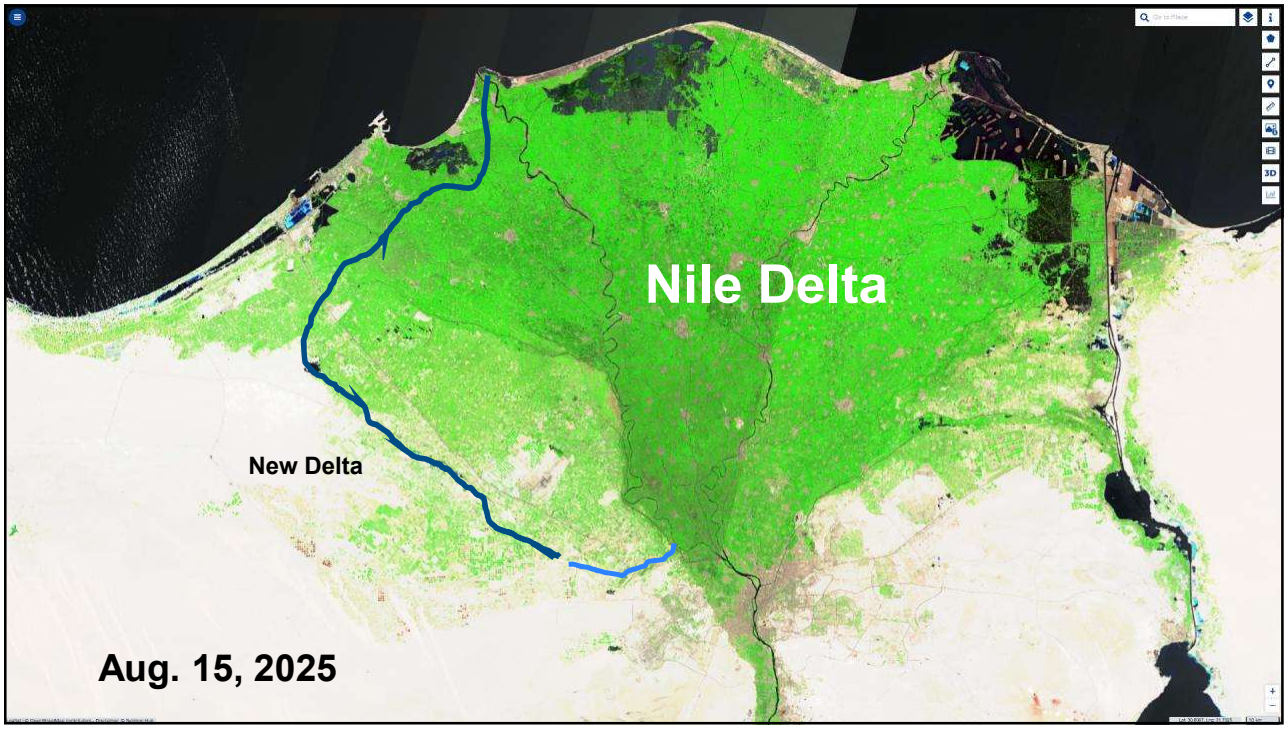
Indoskarn

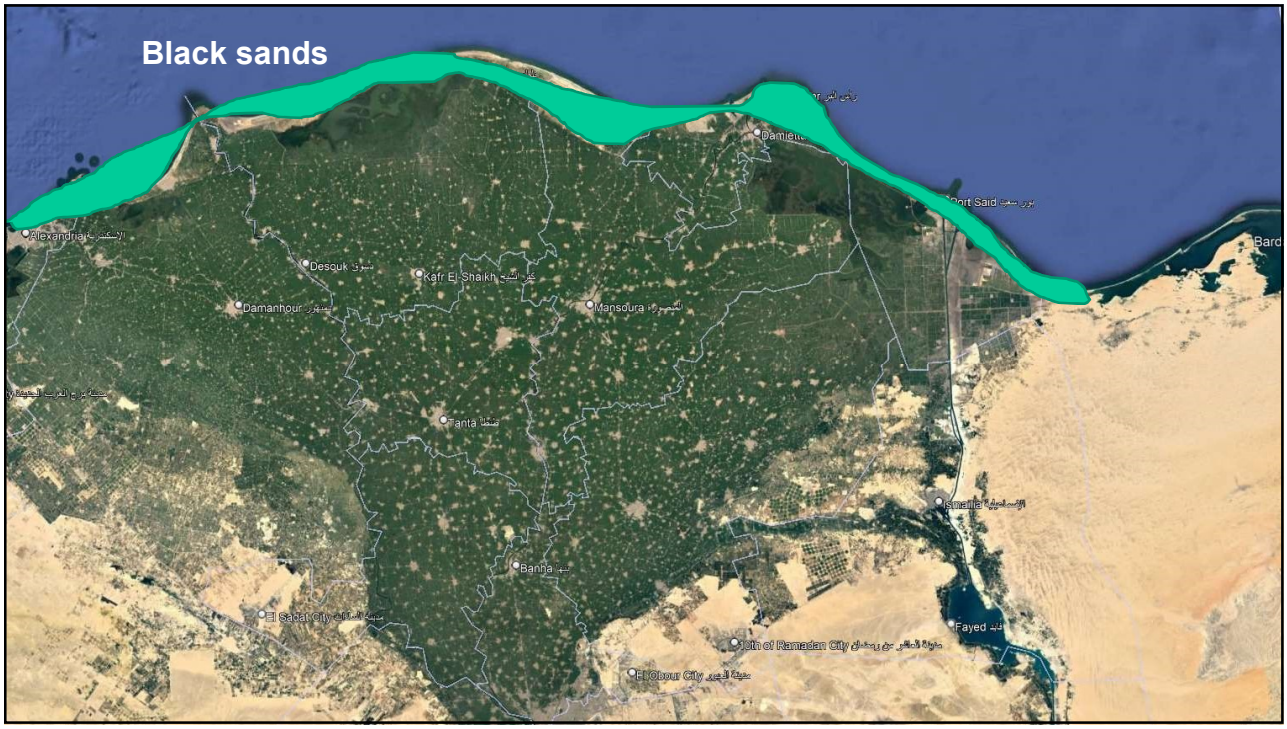

ZAGROS
WESTERN GULF SALT BASIN
EASTERN GULF SALT BASIN
MIDYAN
YANBU
AFIF
IDSAS
AR RAYN
HIJAZ
SHIB UMQ
NABITAH
NAJD
ASIR
GULF OF ADEN
NAJD TECTONIC EVENT
Pan-African sutures
Salt Basins
Major Najd strike-slip faults
Mesozoic/Tertiary reactivated(?) faults
Rift Ridge



Classification of mineral deposits

- Magmatic ore deposits
- Hydrothermal ore deposits
- Metamorphic ore deposits
- Sedimentary ore deposits
  - BIF, Cu, Pb, Zn, Placer Au


Nile Delta
New Delta
Aug. 15, 2025


Black sands
Alexandria
Desouk
Kafr El Shaikh
Damanhour
Mansoura
Tanta
Banha
El Sadat City
Damietta
Port Said
Ismailia
Fayed
10th of Ramadan City
El Obour City