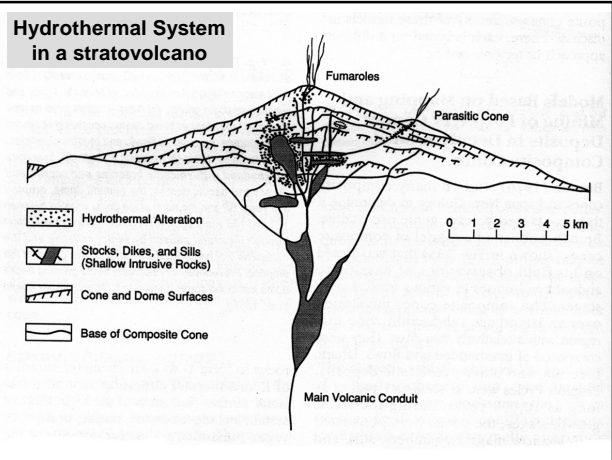


Hydrothermal Systems

References:

Encyclopedia of Volcanoes, pp. 817-834;
897-912

Wohletz and Heiken, 1992, *Volcanology and Geothermal Energy*, pp. 261-292

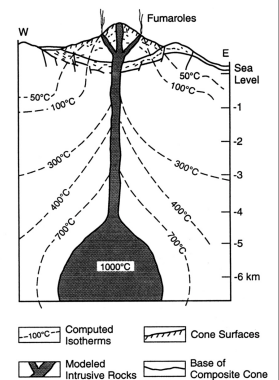


Topics

- Source of heat
- Source of water
- Circulation systems
- Geothermal energy
- Alteration of host rock
- Mineral deposits

Source of Heat

- Young volcanism is the major source of heat
- Radioactive decay of crustal rocks is a minor course



Flow of Heat

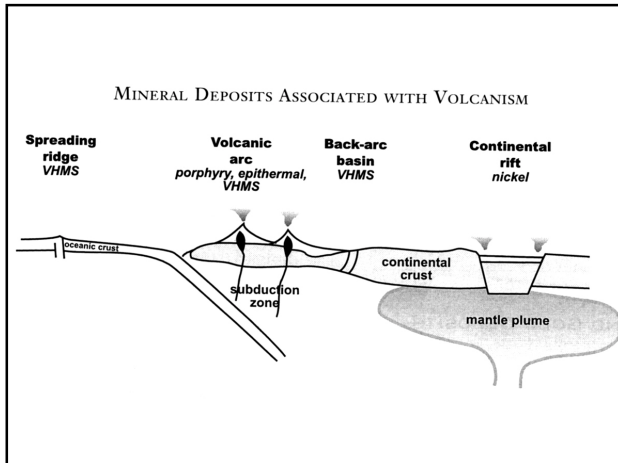
Heat flow equation

$$q = k (dT/dz)$$

- q is heat flow ($mW m^{-2}$)
- k is thermal conductivity ($W m^{-1}$)
- T is temperature ($^{\circ}K$)
- z is depth (m)

Source of Water

- Derived mainly from ancient precipitation
- Magmatic contribution < 15%
- Reservoir water generally older than 10,000 yr

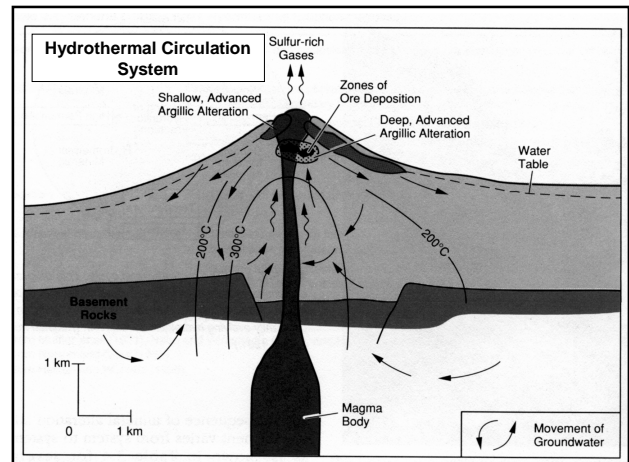
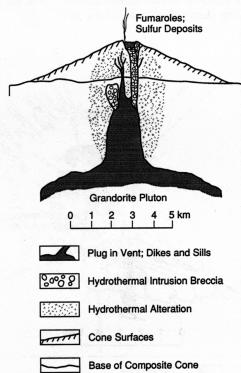


Host Rock Alteration

- **Common phases**
 - Quartz, calcite, illite, chlorite, adularia
- **Less common**
 - Epidote, anhydrite, wairakite
- **Common sulfides**
 - Pyrite, pyrrhotite, galena, sphalerite, chalcopyrite

Alteration Zones

Silicic	Silica
Potassic	Adularia
Sericitic	Mica
Argillic	Clays, no mica
Chloritic	Chlorite
Propylitic	Albite, epidote, Chlorite



Classification

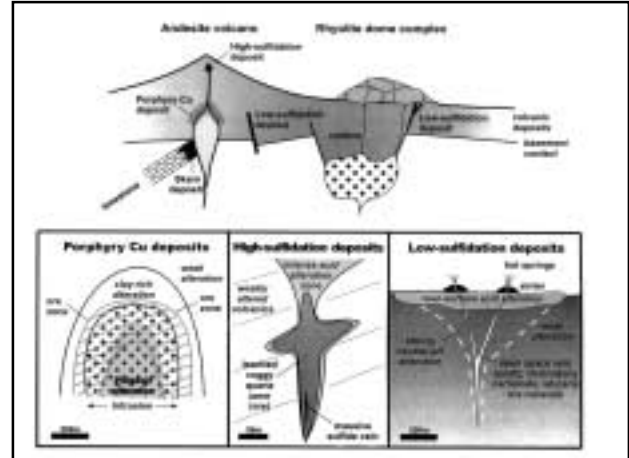
Porphyry Deposits
Epithermal deposits
Massive sulfides
Mafic association
Nickel sulfides
Diamonds

Porphyry Deposits

- **Copper, Molybdenum, and Gold**
- **Form at depths of 2-4 km below volcanoes**
- **Generally are large but low grade**
- **Shallow cooling releases hydrothermal ore fluids**
- **Associated with stocks (frozen chambers)**

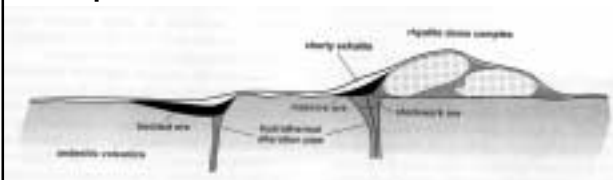
Epithermal Deposits

- Gold, Silver, Base metals
- Occur within subaerial volcanic rocks
- Low-sulfidation types
 - Open vein filling
 - Adularia and carbonates
- High-sulfidation types
 - Massive disseminated character
 - Enargite, alunite



Massive Sulfides

- Copper, Zinc, Lead, Silver, Gold
- Seafloor hydrothermal vent system
- Submarine exhalative processes
- Pyrite, pyrrhotite, chalcopyrite, sphalerite



Mafic Association

- Nickel sulfides, platinum
- Komatiites
- Massive and disseminated deposits
- Magmatic origin due to sulfur saturation

Diamonds

- Kimberlites
- Occur in pipes
- Diamonds are xenocrysts
- Rise directly from the mantle