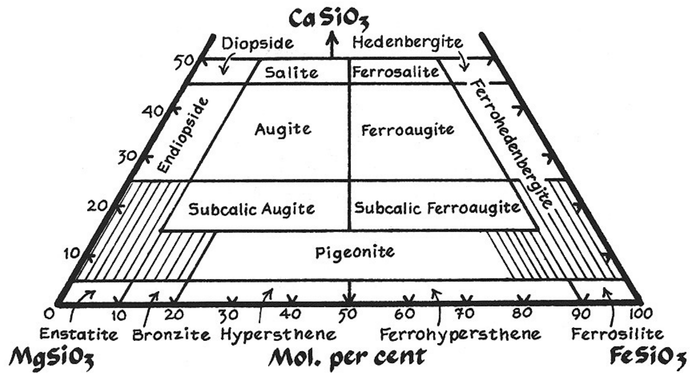
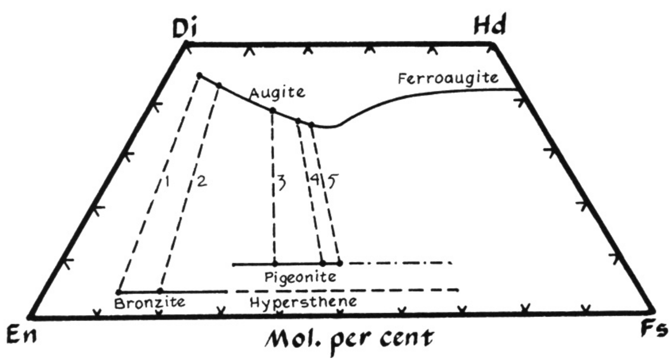
Ultramafic Rock Bodies

Best, Chapter 5

Pyroxene Classification



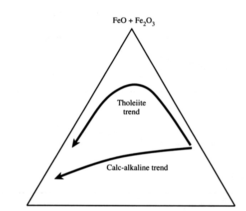


Topics

- **Petrography - gabbroic & ultramafic rocks**
- **Nature of plutons**
- **Oceanic subalkaline associations**
- **Ophiolites (treated with basalts in GLY206)**

AMF Diagrams

- Initial compositions
- Early iron enrichment
- Later alkali enrichment
- Tholeiitic vs. calc-alkali trends



Petrography

- **Fabric**

  Phaneritic grain-size

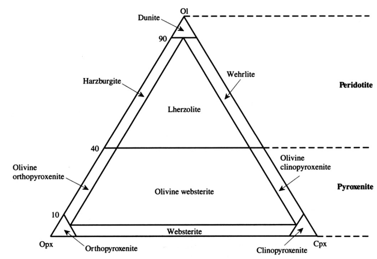
- **Slow sequential growth**
- **Hypidiomorphic granular**
- **Cumulate texture**

Mineralogy

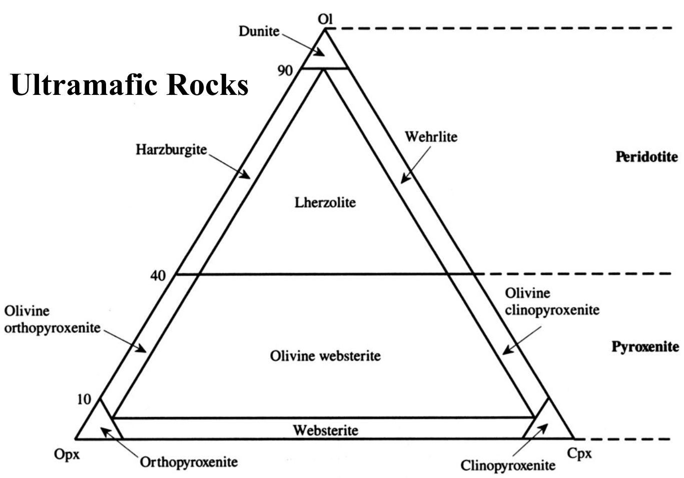
- Plagioclase
  - An_{85} to An_{50}
- Pyroxene
  - Ortho (Hypersthene)
  - Clino (Augite to Pigeonite)
- Olivine
  - Fo_{85} to Fo_{30}

Petrography

- Classification
- Pl-Ol-Px
- Olivine-Opx-Cpx



Ultramafic Rocks



Alteration

- Deuteric and hydrothermal alteration
- Serpentine
- Secondary iron oxide
- Brucite & talc

Nature of Plutons

- Dikes, sills, and plugs
- Layered intrusions
- Slow shallow cooling

Cooling & Crystallization

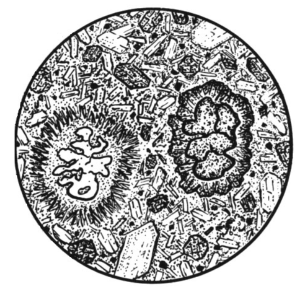
- Sills
- Progressive fractionation
- Settling at bottom
- Assimilation at top
- Crystallization from margins

Sequence of Crystallization

- **Olivine**
- **Clinopyroxene**
- **Plagioclase**
- **Fe-Ti oxides**
- **Apatite**

Reaction Textures

- Olivine surrounded by pyroxene
- Quartz surrounded by pyroxene
- Write the reactions

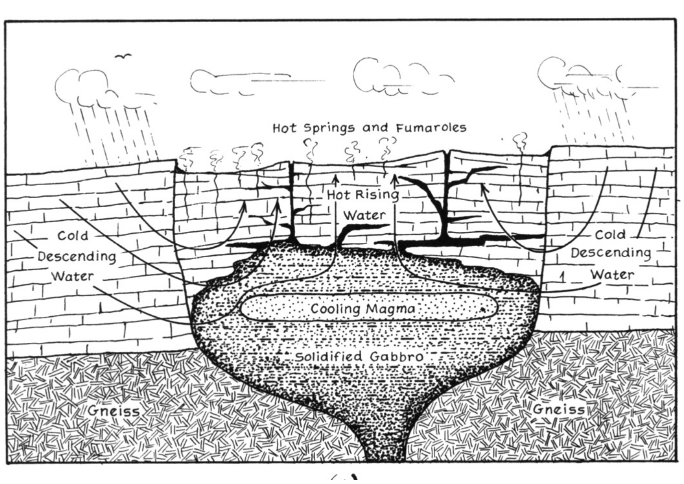


Form of Bodies

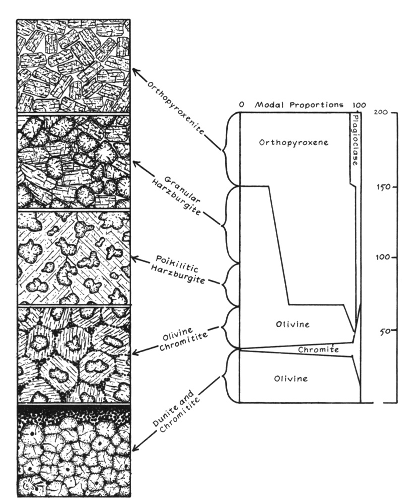
- Sills
- Example of Red Hill, Tasmania
- Form and zonation of body

Stillwater Intrusion, Montana

- Layering
- Zonation of minerals

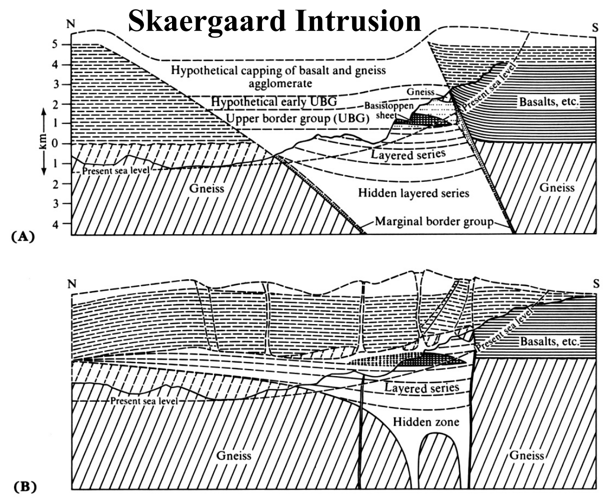


Stillwater Textures



Skaergaard Intrusion, Greenland

- General form of the body
- Layering of the intrusion
- Mineral zonation of layers
- Hydrothermal alteration

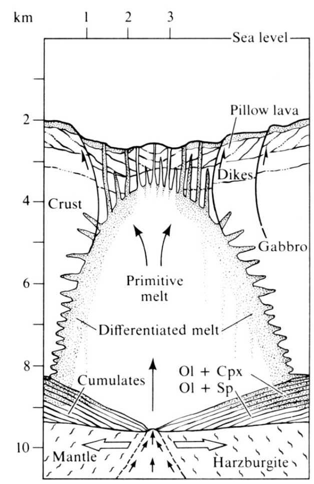


Oceanic Rifts

- Their lavas comprise 70% of the earth's surface
- Sea floor spreading is the mechanism of their origin

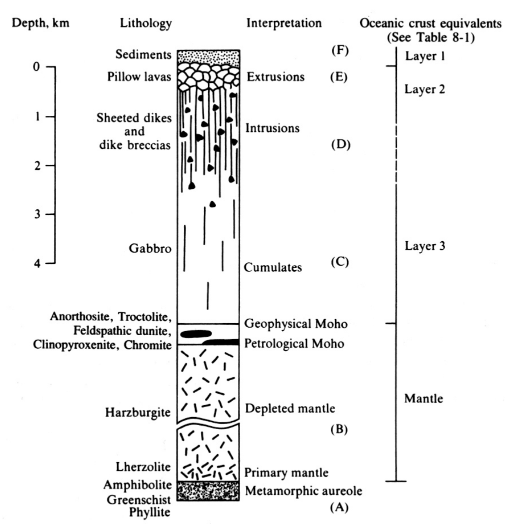
Ridge Structure

- **Pillow lavas**
- **Sheeted dikes**
- **Gabbro**
- **Cumulates**
- **Hartzburgites**



Oceanic Lithosphere

- **Layer 1**
  - **0 to 1 km thick, sediment**
- **Layer 2**
  - **1 to 3 km thick, basalt flows, pillows breccia, dikes**
- **Layer 3**
  - **4 to 8 km thick, fractured mafic intrusions**
- **Below layer 3 is is subcrustal peridotite**



Ocean Floor Basalts

- MORB
  - Reference composition to other basalt types
  - See book Table 5-5 for chemical characteristics
- Low K_2O content & large-ion lithophile elements
- Originate in the mantle
- Partial melts within the asthenosphere
- Olivine tholeiitic composition (Ol and Hy in norm)

Ocean Floor Lavas

- Evidence of disequilibrium
  - Corroded phenocrysts of Mg olivine and Ca plagioclase
  - Chemically evolved groundmass
  - Anomalous melt inclusions
- Uniform composition of lavas
  - Suggest recurrent mixing in shallow chambers under rifts

Depleted Magma Source

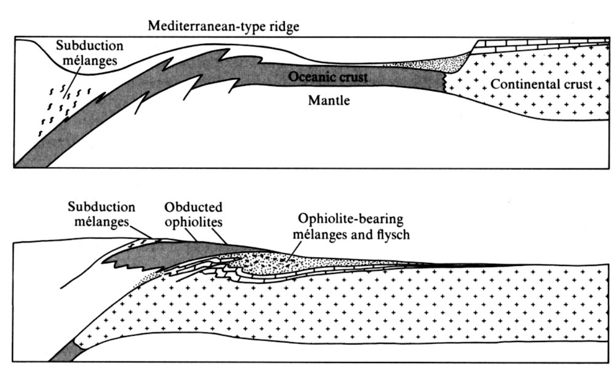
- Several lines of evidence
  - Extremely low concentrations of incompatible elements
  - Rb/Sr ratio too low to yield Sr isotopic ratio (~0.703)

Models for Ocean Floor Lavas

- Thin lid model
  - Primitive lavas fed from center of chamber
  - More fractionated materials from margins
- Evolving system
  - Several small chambers at different stages of fractionation
- Strong role of crystal fractionation
  - Supported by presence of mafic cumulate horizons

Ophiolites

- Alpine ultramafic bodies
- Hartzburgitic type
  - Mainly hartzburgite and dunite
  - Minor dikes & veins of other types
  - Can not be the source of basaltic magmas by melting
- Lherzolitic type
  - Mainly lherzolite , minor pyroxenite
  - May yield basaltic magmas by partial melting



Alpine Ultramafic Association

- Steinmann trinity
  - Ultramafic rocks
  - Pillow basalts (spilitic = metasomatized basalt)
  - Chert (with argillite and limestone)
- Origin by obduction
  - Ocean floor thrust onto continental crust during mountain building

Ophiolite Sequence

- Refractory residue of upper mantle hartzburgite
  - Deformed and drained of low-melting point materials
- Overlying fossil magma chambers
- Capping of fractionated basaltic lavas and dikes
  - Sheeted dike complexes