Proterozoic Rocks

Chapter 15B

Proterozoic Terrain

- 2.5 to 0.57 Gy old
- Basaltic intrusions
- Anorthosite massifs
- Linear belt overprints

Basaltic Intrusions

- Dike swarms are common
- Suggest widespread horizontal extension
- In Canadian shield dikes migrated outward

Layered Mafic Intrusions

- Great Dyke, Zimbabwe
- Duluth Gabbro, MN (1.2 Gy)
- Muskox intrusion, NW Territory
- Sudbury, Ontario (1.7 Gy)
- Bushveld Complex, S. Africa (2.1 Gy)

Origin of Proterozoic Mafics

- The result of meteorite impacts?
- If so, why?
**Anorthosite Massifs**

- Largest volumes as Proterozoic massifs
- Surrounded by high-grade granulites
- Occur as sheets a few km thick

**Anorthosite Suite**

- Anorthosites
- Gabbro, norite, leucogranite also
- Ultra mafic rocks are missing
- Mafic phases are anhydrous

**Crystallization Conditions**

- Anhydrous mafic assemblage suggests low water pressure
  
  \[ \text{Hbld} + \text{Biot} + \text{Qtz} = \text{Hyper} + \text{K-spar} + \text{Plag} \]

- Plagioclase is generally andesine, not labradorite as in Archean mafic suites
- High T contact aureoles
  - Suggest P < 0.5 GPa

**Origin of Anorthosite**

- Crystallization temperatures 1000 - 1200°C
- Large Eu anomaly indicates magmatic
- Anorthosites are cumulates with plagioclase magacrysts
- Are the felsic charnockites co-magmatic?
  - Different Sr ratios from anorthosites
- Concentrated in space and time ~1.4 Gy

**Rapikivi Granites**

- Felsic member of the anorthosite suite
- Anhedral K-spar surrounded by rims of sodic plagioclase
- Ages of 1.1 to 1.7 Gy
- Some emplaced at a shallow crustal level
- Locally associated with volcanic equivalents
**Proterozoic Mobile Belts**

- Differ from orogenic belts
- Origin as ensialic reworking of materials
  - No new materials involved
- Form by suturing of small blocks
- Typical of Proterozoic terranes
- Examples:
  - South Africa
  - Grenville

**Grenville Province**

- Peripheral to Archean terrane
- Rests on sialic basement
- Basal submarine basalts overlain by calc alkaline volcanics
- Folds overturned toward Archean terrane
### Bancroft Terrane
- Middle to upper amphibolite grade marble
- Siliciclastic sediments
- Granodiorite/orthogneiss
- 1.1 Ga nepheline syenites
- Carbonatite
- Thrusting at base of southern zone
- High grade metamorphism of the central zone

### Elzivir Terrane
- Greenschist and amphibolite grade metavolcanics
- Marble and siliciclastic sediments
- Tholeiitic and calc-alkali volcanic rocks
- ~1.3 Ga tonalites and granites
- Peralkaline volcanics and plutons

### Frontenac Terrain
- Lacks metavolcanics and tonalites
- Contains marble and siliciclastic sediments
- Amphibolites to granulites
- SE dipping foliations
- ~1.2 gabbro-syenite-granite plutons

### Adirondack Terrane
- Mylonite zone at NW contact with Frontenac
- Large anorthosite-gabbro-charnockite complexes
- Siliciclastic, carbonate, and evaporite metasediments
- Felsic metavolcanics
- 1.3 – 1.1 Ga intrusions

### Grenville Controversies
- Anorthositic complexes?
- Nature of contact with Superior province
  - The Grenville Front
- Extensive granulate facies rocks
  - Suggest 60 km crust during formation

### Evidence for Grenville Origin
- Rifting at the start of the Grenville
  - Plateau basalts
  - NE trend of dike swarms
- Deformation and metamorphism ~1.1 Gy
- Probably represents the opening and closing of an ocean
- Rapikivi granites ~1.4 Gy represent rift related bimodal facies
Late Proterozoic Rifting

- Late Proterozoic rifting began ~0.8 Ga
- Continental breakup occurred ~ 0.6 Ga
- St. Lawrence represents a failed rift of this period
- Alkali intrusions associated with this rifting