# Granites

**Best, Ch. 4**

- Petrography
- Field relations
- Origin
- Time-space patterns in plutons
- S-type and I-type compositions

## Petrography

- Fabric
- Classification
- Alteration

## Fabric

- Hypidiomorphic granular
- Equigranular
- Porphyritic
- Pegmatitic
- Graphic

## Anisotropy

- Foliatiation
- Lineation
- Segregation layers

## Compositional Classification

- Q-Ab-Or diagram
  - Chemical classification is useful
- Quartz, K-spar, Plagioclase diagram
  - Modal classification also is good
### Textural Classification

- **Porphyry**
  - Large crystals in a fine-grained matrix
- **Aplitne**
  - Leucocratic, fine sugary texture
- **Granophyre**
  - Micrographic texture

### Pegmatite

- Extremely coarse-grained with rare euhedral minerals
- Li, Be, Zr, Nb, Mo, Sn, Ta, W, Th, U concentrated
- Late-phase of granitic intrusions
- Lit-par-lit metamorphism

### Alteration

- Most granites show some degree of alteration
- High temperature minerals replaced by low temperature ones

### Field Relations

- General distribution
- External contacts
- Form of intrusions
- Internal features
- Time and depth of emplacement

### General Distribution of Granites

- Concentrated in orogenic belts
- Located at the margins of continents
- Also in deeply eroded Precambrian shields
- Alkaline granites occur in rift zones

### Mesozoic Batholiths, USA

- Sr isotopes lower in west than east
  - Boundary between shelf (ss, ls, sh) and back arc basin (greywacke, basalt, cherts)
  - 0.706 line represents old craton margin
- Two eastward migrating plutonic series
  - Concentric zoned plutons
External Contacts

- Sharp contacts
- Gradational border zones
- Contact breccia
- Migmatite

Form of the Intrusion

- Dike
  - Ring dikes
  - Cone Sheets
- Sill
- Laccolith
- Batholith

Interior of Bodies

- Zoned plutons
  - Mafic to felsic
- Mafic inclusions
  - Arrangement
  - Abundance
- Stoping

Origin

- Magmas vs. granitization
- Room problem
- Form of large batholiths
- Zoned plutons
- Origin of magmas

Gill, 1981
Origin of Plutons: Compositional Arguments

- Lowest temperature melts have subequal amounts of Q, Or and Ab
- Partial melting of crustal rocks produces a liquid in the thermal valley
- Crystal/liquid fractionation would produce a liquid which crystallizes Q, Or, AB in subequal amounts

Effect of Water Content

Hypersolvus granite vs. Subsolvus granite

Hypersolvus Granite

- Crystallize a homogeneous feldspar containing Na, K, and Ca components
- This subsequently exsolves to Perthite
- This indicates a relatively dry magma

Subsolvus Granite

- Both plagioclase and K-spar crystallize together
- Little exsolution
- Relatively wet melts

S-I-A-M Classification

- Chappell and White
- S-type granites
- I-type granites
- A-type granitoids
- M-type granitoids
### S-Type Granites
- Occur in regional metamorphic terranes
- Partial melting of metasediments
- High Al but contain no hornblende
- Biotite, muscovite, cordierite, & garnet
- High Rb in source rocks
- Initial Sr ratios > 0.710

### I-Type Granites
- Subduction zone continental margin
- High Ca and Na
  - Contain hornblende and sphene
- Hornblende-rich inclusions
- Melting of deep crustal igneous rocks
- Source region poor in Rb
- Initial Sr isotope ratios <0.708

### A-Type Granitoids
- Anorogenic origin
- High in SiO₂, up to 77%
- High alkalies, Fe/Mg, halogens
- Peralkaline?
- Stable craton environment

### M-Type Granitoids
- Originate as fractionated mantle melts
- Underplated mantle melts
  - May assimilate crustal materials
  - May mix with crustal melts
- Low Rb, Th, U
- Initial Sr ratios <0.705
- Form tonalites

### Time and Depth of Emplacement
- Post-tectonic
  - Cross cutting contacts
- Syntectonic
  - Concordant fabrics
- Pretectonic
  - Metamorphic imprint on fabric

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![Diagram of Orogenic and Transitional Processes](https://via.placeholder.com/150)
<table>
<thead>
<tr>
<th>TRANSITIONAL</th>
<th>ANOROGENIC</th>
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<td>Post-orogenic uplift/collapse</td>
<td>Continental rifting, hot spot</td>
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<tr>
<td>decompression melting</td>
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</tr>
<tr>
<td>hot spot plume</td>
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**Examples**
- Late Caledonian Plutons of Britain, Basin and Range, late Variscan, early Northern Proterozoic
- Nigerian ring complexes, Oslo rift, British Tertiary Igneous Province, Yellowstone hotspot
- Oman and Troodos ophiolites; Iceland, Ascension, and Reunion island intrusives

**Geochemistry**
- Calc-alkaline
- I-type S-type (A-type)
- Metalum. to Peralum
- Tholeitic
- M-type
- Metaluminous

**Rock types**
- Bimodal granodiorite + diorite-gabbro
- Granite, syenite + diorite-gabbro
- Plagiogranite