Classification of Igneous Rocks

Classification I: texture

Classification II: field relations

Classification III: chemical compositions

Classification IV: textural-mineralogical
Classification I: texture

- **Phaneritic**: rocks with mineral grains that are large enough to be identified by eye. Slowly cooled intrusive rocks.
- **Aphanitic**: rocks with grain *too small* to be identified by eye. Rapidly solidified extruded magma and marginal facies of shallow intrusions.
- **Porphyritic**: bimodal grain size distribution
- **Glassy**: no crystals formed
Granite

Photo by C. C. Plummer
Photomicrograph - Phaneritic Texture

Interlocking grains

Photo credit: C.C. Plummer
Rhyolite Hand Specimen

**Ryolite**

*Photo by C. C. Plummer*
Classification II: Field Relations

- **Extrusive or volcanic rocks:** typically aphanitic or glassy. Many varieties are porphyritic and some have fragmental (volcaniclastic) fabric. High-T disordered fsp is common (e.g. sanadine). Also see leucite, tridymite, and cristobalite.

- **Intrusive or plutonic rocks:** typically phaneritic. Monomineralic rocks of plagioclase, olivine, or pyroxene are well known but rare. Amphiboles and biotites are commonly altered to chlorite. Muscovite found in some granites, but rarely in volcanic rocks. Perthitic fsp, reflecting slow cooling and exsolution is widespread.
Classification III: Chemical compositions

- **Silica percentage (% SiO₂)**
  - >66%, felsic, granite/rhyolite
  - 52-66%, intermediate, diorite/andesite
  - 45-52%, mafic, gabboro/basalt
  - <45%, ultramafic, peridotite/dunite/komatiite

- **Silica vs. alkaline elements (SiO₂ Vs. Na₂O+K₂O)**
  - Calcic
  - Calc-alkaline
  - Alkalic-calcic
  - Alkalic

- **Aluminum saturation (Al₂O₃ Vs. Na₂O+K₂O+CaO)**
  - Peraluminous
  - Metaaluminous
  - Peralkaline
Table 2.1 Whole-Rock Chemical Composition of Basalt from the Columbia River Plateau, Sample BCR-1a

<table>
<thead>
<tr>
<th>Element</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>54.06%</td>
</tr>
<tr>
<td>TiO₂</td>
<td>2.24%</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>13.64%</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.59%</td>
</tr>
<tr>
<td>FeO</td>
<td>8.88%</td>
</tr>
<tr>
<td>MnO</td>
<td>0.18%</td>
</tr>
<tr>
<td>MgO</td>
<td>3.48%</td>
</tr>
<tr>
<td>CaO</td>
<td>6.95%</td>
</tr>
<tr>
<td>Na₂O</td>
<td>3.27%</td>
</tr>
<tr>
<td>K₂O</td>
<td>1.69%</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.36%</td>
</tr>
<tr>
<td>H₂O⁺</td>
<td>0.75%</td>
</tr>
<tr>
<td>H₂O⁻</td>
<td>0.81%</td>
</tr>
<tr>
<td>CO₂</td>
<td>0.03%</td>
</tr>
<tr>
<td>LOI</td>
<td>1.67%</td>
</tr>
<tr>
<td>Total</td>
<td>99.93%</td>
</tr>
</tbody>
</table>

aMajor element oxides in wt.%. Less certain values in parentheses. *, Trace element concentration in parts per billion (ppb); all other trace elements in parts per million (ppm).

Data from Govindaraju (1989).

What controls chemical composition of a rock?
Classification IV: textual + mineralogical

- **Textual**: phaneritic vs. Aphanitic
- **Mineralogical**:
  - Essential
  - Characterizing accessory mineral (>5%)
  - Minor accessory mineral (<5%)

**Classification IV**:

- **Felsic**: >10% quartz, feldspar or feldspathoid
- **Gabbroic**: plag+opx+cpx+ol+hbd > 95%
- **Ultramafic systems**: ol+opx+cpx+hdb > 95%
Classification of Igneous Rocks

Figure 2.1a. Method #1 for plotting a point with the components: 70% X, 20% Y, and 10% Z on triangular diagrams. An Introduction to Igneous and Metamorphic Petrology, John Winter, Prentice Hall.
Classification of Igneous Rocks

Figure 2.2a. A classification of the phaneritic igneous rocks: Phaneritic rocks with more than 10% (quartz + feldspar + feldspathoids). After IUGS.

Classification of Igneous Rocks

Figure 2.2b. A classification of the phaneritic igneous rocks: Gabbroic rocks. After IUGS.

Classification of Igneous Rocks

Figure 2.2c. A classification of the phaneritic igneous rocks: Ultramafic rocks. After IUGS.

Classification of Igneous Rocks

Figure 2.3. A classification and nomenclature of volcanic rocks. After IUGS.

The Petrology of the Silicate Earth

Oceanic crust: basalt+gabbororo

Continental crust: granite

Mantle: peridotite

Arc lavas: diorite/andesite
Summary

- Four classification schemes
- Difference between these rocks
  - Continental crustal rocks
  - Oceanic crustal rocks
  - Mantle rocks
  - Arc lavas
- Able to read/report chemical composition of a rock