

1. Phaneritic Igneous Rocks

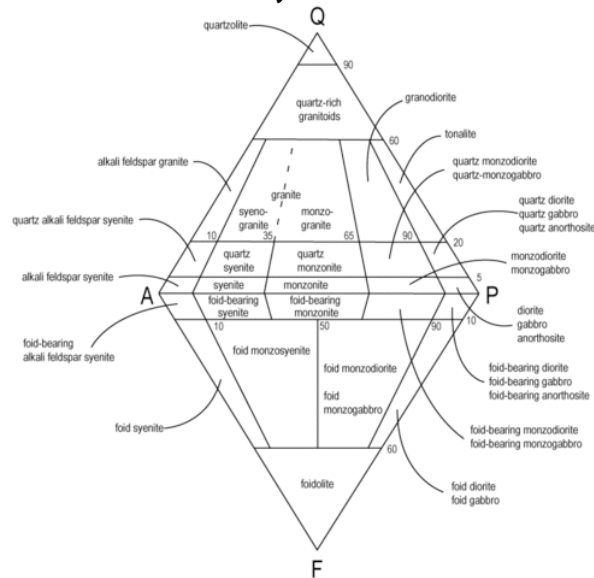
5. When appropriate, further **modify with** mineralogical or textural **adjectives** such as:

- **Leuco** (leucocratic = light-colored)
- **Mela** (melanocratic = dark-colored)
- **Mineral names** (list in order of *increasing* abundance, but do not repeat those implicit in the the rock name)
- **Porphyritic**

What's up with the "P" corner?

- **Gabbro:** >35% mafics (usually ol or px), plag is **An > 50**.
- **Diorite:** <35% mafics (usually ol or px), plag is **An < 50**.
- **Anorthosite:** <10% mafics

1. Phaneritic, $Q+A+P+F > 10\%$



1. Phaneritic Igneous Rocks

How to normalize: An example

A rock has Q = 10%, A = 30%, P = 20%, and Mafics = 40%.

Normalization gives recalculated values of Q, A, and P as:

$$Q = 100 \times 10/60 = 16.7\%$$

$$A = 100 \times 30/60 = 50.0\%$$

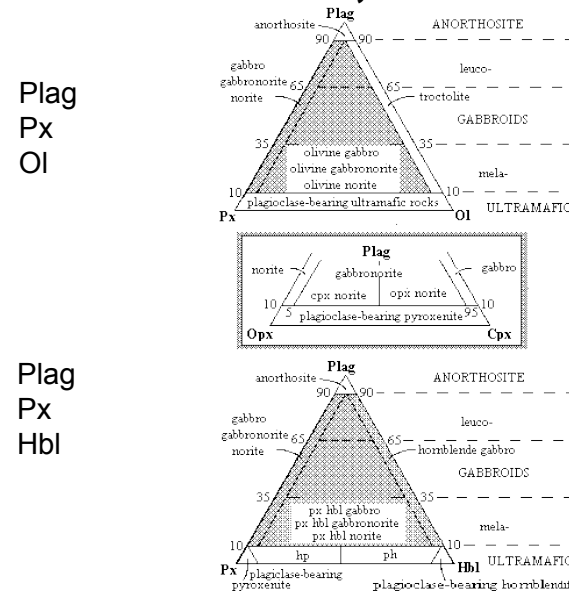
$$P = 100 \times 20/60 = 33.3\%$$

Let's practice:

- 10% qtz, 15% plag, 15% kspar, 40% hbl, 20% biot
- 13% qtz, 6% plag, 68% kspar, 5% cpx, 6% hbl, 2% other

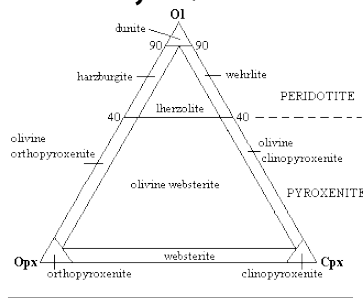
- 1) Biotite hornblende monzogranite (or biotite hornblende granite)
- 2) Clinopyroxene hornblende alkali feldspar quartz syenite (or clinopyroxene hornblende quartz alkali feldspar syenite)

1. Phaneritic, $Q+A+P+F < 10\%$

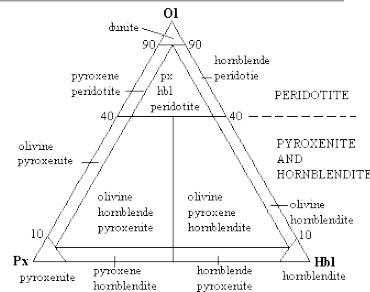


1. Phaneritic, Q+A+P+F < 10%

Olivine
Opx
Cpx

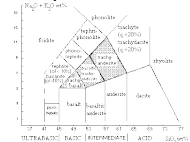


Olivine
Px
Hbl

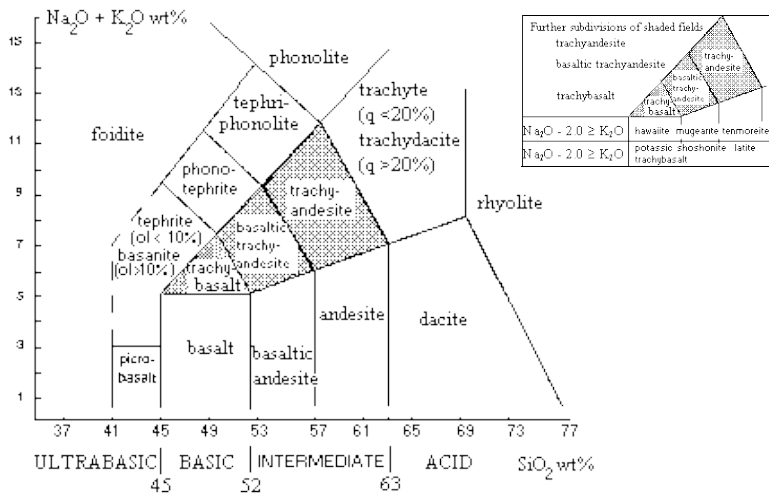


2. Aphanitic Igneous Rocks

- Similar triangular classification exists for aphanitic rocks, but modes are hard to estimate and biased toward early-formed phenocrysts; not satisfactory. *We will not use it.*
- **Chemical classification**
- Based on **major-element analyses** (Si, Al, etc present at weight-% levels), generally reported as oxides (*as in our homework earlier in the semester*)
 - 4 major divisions based on **SiO₂ content**:
Basalt (<52%), andesite (52-63%), dacite (63-69%), rhyolite (>69%)
- Widely used chemical classification system for volcanic rocks is **total alkalis vs silica plot**: *Textbook Figure 3-6*
 - Based on chemical analysis, normalized to 100% on dry basis

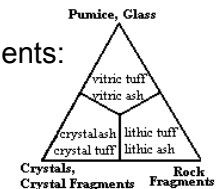


2. Aphanitic

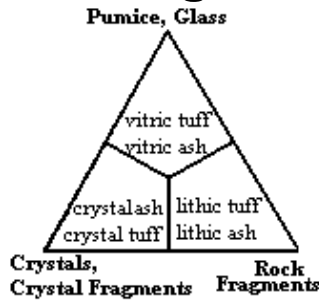


3. Fragmental Igneous Rocks

- Chemical classification is possible, but may be unreliable due to abundant xenoliths.
- **Textural classification**
- Based on relative proportions of 3 components:
 1. **Vitrics** (glass, pumice, ash)
 2. **Crystals** (phenocrysts)
 3. **Lithics** (xenoliths, rock fragments)
- Commonly use 2 most abundant components
- Arrange in order of increasing abundance
- Use degree of welding or compaction as a modifier



3. Fragmental Igneous Rocks



4. Other Igneous Rocks

- Pegmatites
- Carbonatites
- Obsidian
- Etc...

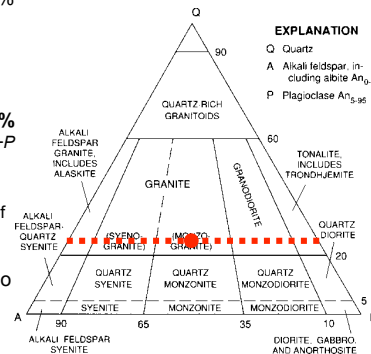
Igneous Minerals

- What minerals are *likely* to be present?
 - Bowen's reaction series
 - [Textbook Table 2-1](#)
- Major **light-colored** minerals:
 - Quartz, plag, alkali feldspars, muscovite; (leucite = never with quartz)
- Major **dark-colored** minerals:
 - Olivine, opx, cpx, hornblende, biotite; (tourmaline, beryl)
- **Accessory** minerals:
 - Apatite, magnetite, ilmenite, chromite, sphene (=titanite), pyrite
- **Alteration/secondary** minerals:
 - Chlorite, epidote, hematite

1. Phaneritic Igneous Rocks

Practice #1: 10% qtz, 15% plag, 15% ksp, 40% hbl, 20% biot

- $Q+P+A = 10+15+15 = 40$
- $Q=10/40=25\%$, $P=15/40=37.5\%$, $A=15/40=37.5\%$
- Find $Q=25\%$ on QAP ternary (a horizontal line, because 100% Q is the top and 0% Q is the bottom of this triangle)
- What's left over (on the ternary)? = A+P
- Notice there are equal amounts: $A = P = 37.5\%$ (so, if you subtract the $Q=25\%$ and re-normalize the A+P only, you get 50%A + 50%P)
- Thus, the rock will plot 1/2 way across the $Q=25\%$ line = monzogranite (on some versions of this ternary diagram, the "granite" field isn't subdivided into syeno- & monzo-)
- The rock also contains 20% biot + 40% hbl, so we have to add those words as modifiers (adjectives) in order of increasing abundance

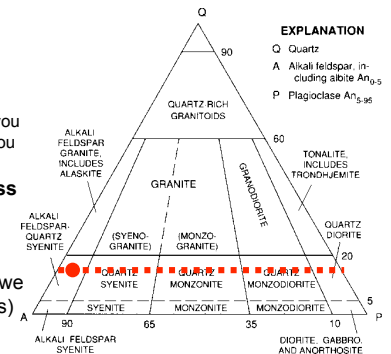


= Biotite hornblende monzogranite (or biotite hornblende granite)

1. Phaneritic Igneous Rocks

Practice #2: 13% qtz, 6% plag, 68% ksp, 5% cpx, 6% hbl, 2% other

- $Q+P+A = 13+6+68 = 87$
- $Q=13/87=15\%$, $P=6/87=7\%$, $A=68/87=78\%$
- Find $Q=15\%$ on QAP ternary (a horizontal line, because 100% Q is the top and 0% Q is the bottom of this triangle)
- What's left over (on the ternary)? = A+P
- Notice it's almost all A: $P=7\%$, $A=78\%$ (so, if you subtract the $Q=15\%$ and re-normalize the A+P only, you get 92%A + 8%P)
- Thus, the rock will plot 92% of the way across the $Q=15\%$ line toward A = alkali feldspar quartz syenite (on some versions of this ternary diagram, this field is quartz alkali feldspar syenite)
- The rock also contains 5% cpx + 6% hbl, so we should add those words as modifiers (adjectives) in order of increasing abundance



= Clinopyroxene hornblende alkali feldspar quartz syenite (or cpx hbl qtz alkali feldspar syenite on some ternaries)