Quiz Five (9:30-9:35 AM)
Last Time

1) Pyro-what? *(air fall volcanic rocks)*
2) Felsic and Intermediate Extrusive Rocks
3) Mafic Extrusive Rocks

Web notes 9
Pyroclastic Igneous Rocks

Pyroclastic: *Pyro* means “fire”. *Clastic* means particles; both are of Greek origin.

Pyroclastic rocks are usually erupted from composite volcanoes (e.g., they are produced via explosive eruptions from viscous, “cool” lavas)

The eruptions that produce pyroclastic rocks include phreatic, plinian and ultraplinian.

These rocks cool extremely rapidly. Textures are glassy to aphanitic.
Pyroclastic Igneous Rocks

Volcanic ash

Pumice
Pyroclastic Igneous Rocks

Volcanic ash

Obsidian
Pyroclastic Igneous Rocks

During pyroclastic eruptions, “volcanic gas” is produced in copious quantities (more so than ash and rock).

- water vapor (H₂O)
- carbon dioxide (CO₂)
- hydrogen chloride (HCl)
- sulfur dioxide (SO₂)
- nitrogen oxide (N₂O)
- hydrogen cyanide (HCN)
- argon (Ar)
- helium (He)
Other “pyroclastic” rocks

Volcanic Bombs

Rhyolite

Tuff

Chalk board
Felsic/Intermediate Extrusive Igneous Rocks

Felsic and intermediate rocks are classified by the amount of SiO$_2$ in their bulk chemistry (they have relatively high SiO$_2$ content). We can distinguish them on the basis of mineral composition and color.

Mt. St. Helens Lava dome

Rhyolite

Andesite
Mafic extrusive igneous rocks have relatively low \( \text{SiO}_2 \) contents in their bulk chemistry. Ultramafic extrusive igneous rocks are relatively rare today.
Mafic extrusive igneous rocks erupted under water produce a unique structure called “pillows”. Pillow basalt forms at divergent plate boundaries like the Mid-Atlantic Ridge.
Today’s Agenda

1) Intrusive igneous rocks and the bodies they form
2) Summary diagram of all igneous rock types
3) Igneous rocks that suck

Web notes 10
Intrusive Bodies

Sills: horizontal sheet intrusions
Dikes: non-horizontal sheet intrusions
Laccolith: Large flat-bottomed intrusions
Batholiths: really large intrusions
Intrusive Bodies

The larger the intrusion, the slower the cooling and the larger the crystals (e.g., phaneritic to pegmatitic textures).
Igneous Rock Texture

A: Glassy
B: Aphanitic
C: Phaneritic
D: Pegmatitic
E: Porphyritic

Hand Specimen (circle shows area enlarged)
## Igneous Rock Texture

<table>
<thead>
<tr>
<th>Bowen's Reaction Series</th>
<th>Composition</th>
<th>Major Minerals</th>
<th>Texture</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Ultramafic</td>
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<td>Glassy (no crystals)</td>
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<td>Mafic</td>
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<td>Felsic</td>
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- **Olivine**
  - Ultramafic: Dunite
  - Mafic: Komatiite

- **Olivine + Pyroxene**
  - Mafic: Peridotite

- **Pyroxene**
  - Mafic: Pyroxenite

- **Ca-Plagioclase, Olivine, Pyroxene**
  - Mafic: Scoria
  - Intermediate: Basalt
  - Felsic: Gabbro

- **Na-Plagioclase, Amphibole, Biotite**
  - Intermediate: Andesite
  - Felsic: Diorite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Obsidian
  - Felsic: Rhyolite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Tuff
  - Felsic: Rhyolite
  - Porphyry: Granite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Rhyolite
  - Felsic: Granite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Pumice
  - Felsic: Granite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Pegmatite
  - Felsic: Pegmatite

- **Orthoclase, Quartz, Biotite Muscovite**
  - Intermediate: Rhyolite Porphyry
  - Felsic: Rhyolite Porphyry
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<td></td>
<td>All Liquid</td>
<td>Dunite</td>
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<tr>
<td></td>
<td>Ultramafic</td>
<td>Scoria</td>
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<tr>
<td></td>
<td>Mafic</td>
<td>Volcanic Ash</td>
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<tr>
<td></td>
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<td>Na-Plagioclase, Amphibole, Biotite</td>
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<td>(Na-Plagioclase, Amphibole, Pyroxene)</td>
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Composition

Texture
Felsic and Intermediate Intrusive Igneous Rocks

Form at convergent plate boundaries.
Felsic and Intermediate Intrusive Igneous Rocks

Form at convergent plate boundaries.

Two types:
1) Ocean-ocean plate (Island Arcs)
2) Continent-Ocean Plate
Granite is a pink/pinkish-white rock composed of orthoclase, quartz and biotite.
Diorite is a black/white speckled rock composed of Na-Plagioclase, hornblende and biotite.
Mafic Intrusive Igneous Rocks

Form at divergent plate boundaries and oceanic hot spots.
Gabbro is a blue-grey to grey rock composed of Ca-Plagioclase, pyroxene and olivine.
Ultramafic Intrusive Igneous Rocks

Form deep in the Earth’s interior. Only exposed in mountain belts in convergent plate boundaries.
Ultramafic Intrusive Igneous Rocks

Dunite

Peridotite

Pyroxenite

Ultramafic Igneous Rocks
Summary Diagram
Igneous Rocks That Suck
Igneous Rocks That Suck

1) Too much $\text{SiO}_4^{4-}$ in the magma leads to early quartz precipitation during the intermediate stage

= Quartz Diorite
1) Too little $\text{SiO}_4^{4-}$ in the magma leads to no quartz precipitation during the felsic stage

= syenite
# Igneous Rocks That Suck

<table>
<thead>
<tr>
<th>Normal magma</th>
<th>Too much SiO$_4$$^{-}$</th>
<th>Too little SiO$_4$$^{-}$</th>
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<tbody>
<tr>
<td>Cooling</td>
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<tr>
<td></td>
<td>Amphibole</td>
<td>Amphibole</td>
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<td>Na Plagioclase</td>
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Today’s Homework

1. Study; Lecture test 1 next Tuesday

Next Tuesday

Lecture test 1

Next Thursday

Weathering, erosion and soils (sediment)