3e - Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
What do you notice about this volcanic eruption?
What about this one?
Magma

- All volcanoes are fueled by magma deep beneath Earth’s surface.

- **Magma** - mixture of molten rock, suspended mineral grains, and dissolved gases.

- Forms when temperatures are high enough to melt the rocks involved.
Depending on composition...most rocks begin to melt at temperatures between 800°C and 1200°C.

Such temperatures exist at the base of the lithosphere and in the asthenosphere.
Types of Magma

• The three major igneous rock types are basalt, andesite, and granite (forms the 3 types of magma).
a) **Granite** = Rhyolitic or Granitic magma
   - Middle of Continents

b) **Basalt** = Basaltic magma
   - Ocean Crust

c) **Andesite** = Andesitic magma
   - Coastlines
• The volcanoes that make up the Hawaiian Islands are made of basalt.

• Mount St. Helens in Washington is andesitic.

• The dormant volcanoes in Yellowstone are fueled by rhyolitic magma.
• The **type of magma** determines how **explosive** the volcano will be.

• Magma erupts either as a non-explosive lava flow, or as an explosive eruption of ash and pumice.
• Lava explosiveness determined by amount of silica

• **Rhyolite** = high silica.

• **Basalt** = less silica.

• Basaltic magma = thin and non-explosive

• Rhyolitic magma = thick and explosive
This is Silica... Remember? Continental Crust is mainly Silica!
• **Silica Content** also determines thickness of lava.

• **Viscosity** – resistance to flow

• High Viscosity = Higher the silica = thicker the lava.

• Low Viscosity = Lower the silica = the more fluid or thinner the lava.
- Viscosity also depends on temperature.
- The hotter the magma - the lower the viscosity.
- The cooler the magma – the thicker the viscosity.
<table>
<thead>
<tr>
<th>Volcanic rock name</th>
<th>Silica ($\text{SiO}_2$) content</th>
<th>Eruption temperature</th>
<th>Lava color scale in $^\circ\text{C}$:</th>
<th>Mobility of lava flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basalt</td>
<td>48-52 %</td>
<td>1160$^\circ\text{C}$</td>
<td>1160$^\circ\text{C}$ to 600$^\circ\text{C}$</td>
<td>Low resistance to flow (thin, runny lava)</td>
</tr>
<tr>
<td>Andesite</td>
<td>52-63 %</td>
<td></td>
<td></td>
<td>High resistance to flow (thick, sticky)</td>
</tr>
<tr>
<td>Dacite</td>
<td>63-68 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhyolite</td>
<td>68-77 %</td>
<td>900$^\circ\text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thick / Viscous magma</td>
<td>Thin / NonViscous magma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Honey or Molasses</td>
<td>- Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Does not flow very easily</td>
<td>- Flows very easily</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Why is Magma Viscous?**
- Low temperatures
- High Silica content

**Why is Magma Nonviscous?**
- High temperatures
- Low Silica content

More Viscous  ⇌  Less Viscous
<table>
<thead>
<tr>
<th>Composition</th>
<th>Basaltic Magma</th>
<th>Andesitic Magma</th>
<th>Rhyolitic Magma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Material</td>
<td>Upper Mantle</td>
<td>Oceanic Crust and Oceanic Sediments</td>
<td>Continental Crust</td>
</tr>
<tr>
<td>Viscosity</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Gas Content</td>
<td>1-2% Low</td>
<td>3-4% Medium</td>
<td>4-6% High</td>
</tr>
<tr>
<td>Silica Content</td>
<td>About 50% Low</td>
<td>About 60% Medium</td>
<td>About 70% High</td>
</tr>
<tr>
<td>Explosiveness</td>
<td>Least Low</td>
<td>Intermediate Medium</td>
<td>Greatest High</td>
</tr>
<tr>
<td>Location of Magma</td>
<td>Oceanic Crust</td>
<td>Continental margins at subduction zones</td>
<td>Continental Crust</td>
</tr>
</tbody>
</table>
Tavurvur Volcano in Rabaul Caldera, Papua New Guinea.
Arenal, Costa Rica

The Cascade Mountains
Mount Rainier
Washington

Mount Pinatuba
Indonesia
Mount Chaiten, Chile
Volcanic Shapes

• Shape of a volcano is determined by magma type

• *Basaltic magma* = large, flat, broad, gentle-sloped volcanoes  **Shield Volcano**

• *Andesitic magma* = tall, steep-sided volcanoes

• *Rhyolitic magma* = steep-sided volcanoes and calderas

**Composite Volcano or Stratovolcano**
Volcano type as a function of gas content and viscosity

- high gas content:
  - explosion crater (maar) - usually result of water in eruption
  - ash eruption
  - pyroclastic flow
  - dome with pyroclastic flows
- low gas content:
  - scoria (cinder) cone
  - stratovolcano
- Viscosity:
  - Shield volcano
  - simple cone
  - dome