# Igneous Rocks

ERSC 2P17 - Earth Science Methods
Greg Finn
Brock University



Kilauea lava flowing into Pacific Ocean




# Igneous Rocks

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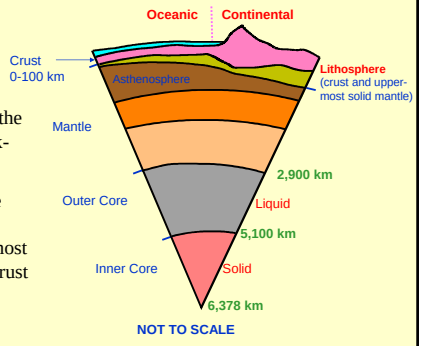
## Structure of the Earth




•Igneous rocks are the most abundant rock-type on Earth

•comprise all of the mantle, all of the oceanic crust and most of the continental crust

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## Igneous Rocks

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## Igneous Rocks

- Melt that exists below the surface is

- Melt that is erupted on the surface is

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## Formation of Magma

- Magma forms
- Melting takes place under the following conditions:
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## Melting by Decreasing Pressure

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- With depth temperature increases:
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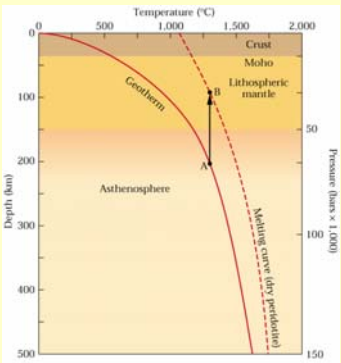
## Decompression Melting

A rock lies on the geotherm at **Point A** and rises to **Point B**. This change results in the rock staying at the same temperature but at a lower pressure (Decompression) causing the rock to begin to melt.

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## Melting by the Addition of Volatiles

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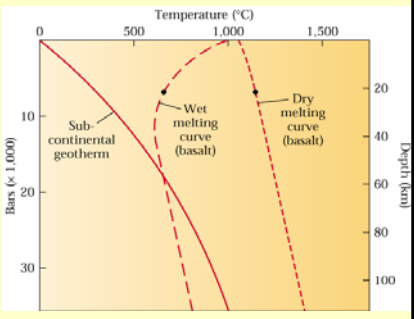
## Wet vs. Dry Melting

The addition of volatiles causes melting temperature to be lowered. At 20 km depth, a 'wet' basalt melts at a lower temperature (500°C less) than a 'dry' basalt.

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## Melting by Heat Transfer

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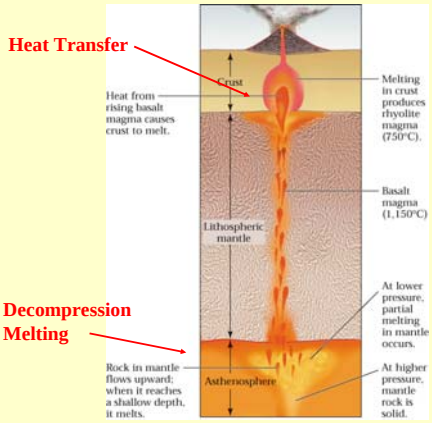


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## What is Magma Made Of?

- Composed of
- Other elements
-
- Magmas may be:
  -
  -

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## Types of Magma

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  – Acidic-
    – T
  – Intermediate
  – Basic -
  – Ultrabasic -
    – T

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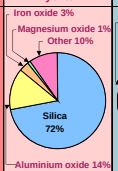
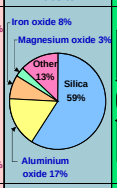
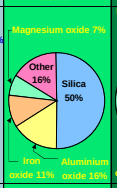
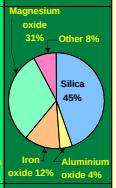
| Descriptive Terms | Acidic > 66 wt% $SiO_2$ | Intermediate 52-66 wt% $SiO_2$ | Basic 45-52 wt% $SiO_2$ | Ultrabasic < 45 wt% $SiO_2$ |
|---|---|---|---|---|
| Intrusive / Extrusive | Granite / Rhyolite | Diorite / Andesite | Gabbro / Basalt | Peridotite / Komatiite |
| Composition |   |   |   |   |
| Major Minerals | Quartz<br>Potassium Feldspar<br>Sodium Feldspar (plagioclase) | Amphibole<br>Intermediate plagioclase feldspar | Calcium Feldspar (plagioclase)<br>Pyroxene | Olivine<br>Pyroxene |
| Minor Minerals | Muscovite<br>Biotite<br>Amphibole | Pyroxene | Olivine<br>Amphibole | Calcium Feldspar (plagioclase) |
| Most Common Colour | Light coloured | Medium gray or medium green | Dark grey to black | Very dark green to black |

**Chemical Composition**

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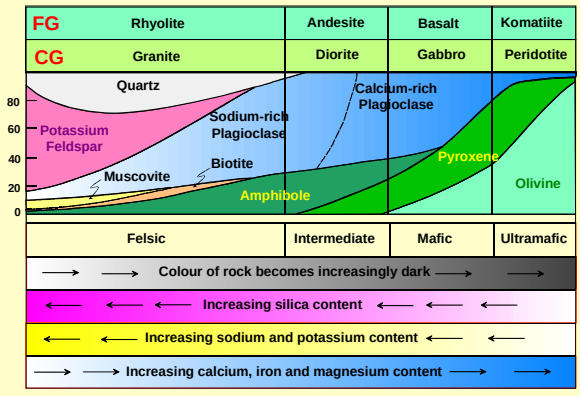


**Mineralogical Composition**

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## Why Different Types of Magma?

- The different types of magma reflect the following conditions
  - –
  - –
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## Source Rock Composition

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## Partial Melting

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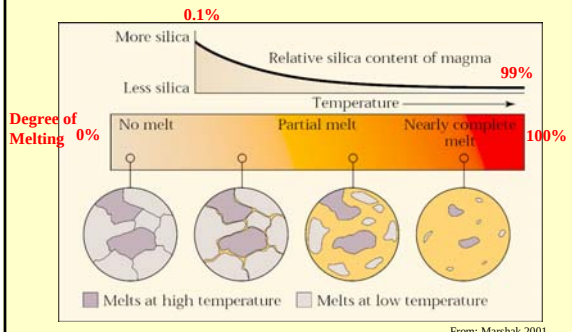
## Partial Melting

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## Partial Melting

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## Contamination

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- Contamination results from:
  - 

    and/or
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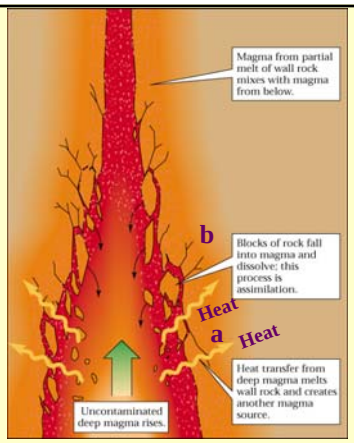
## Contamination

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## Fractional Crystallization

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- Generally mafic minerals crystallize at a higher temperature
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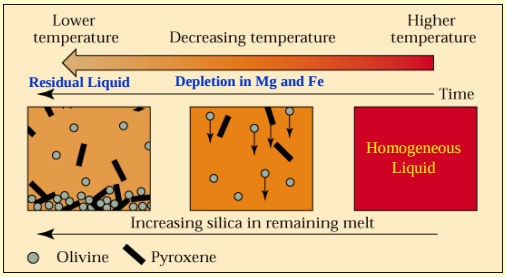
## Fractional Crystallization

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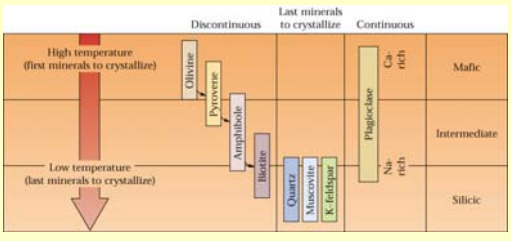
## Bowen's Reaction Series

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## Movement of Magma

- Once generated magma does not stay near its source
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-
-
- But why does it move?



## Movement of Magma

- Magma has a lower density than surrounding rock due to:
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-
-



## Movement of Magma

- Rate of movement is a reflection of **viscosity**
- Viscosity dependant on:
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    -
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## Viscosity

Hotter, mafic lavas have a relatively low viscosity and form thin flows that spread over wide regions.

eg. Hawaii


Cooler, silica-rich lavas have a high viscosity and tend to stick very near to the volcanic vent.

eg. Mount St. Helen's


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## Magma into Rock - HOW?

- Magma crystallizes
- For crystallization to occur the magma must
- Cooler environment may be:
  - or
  -

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## Magma into Rock - HOW?

- Cooling is dependent on
  - eg.
- Intruded rocks
- Extruded rocks

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## Magma into Rock - HOW?

- Factors effecting the rate of cooling for plutonic rocks include:
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  –
  –



## Rate of Cooling

Depth of Intrusion

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## Rate of Cooling

Size and Shape of the magma chamber

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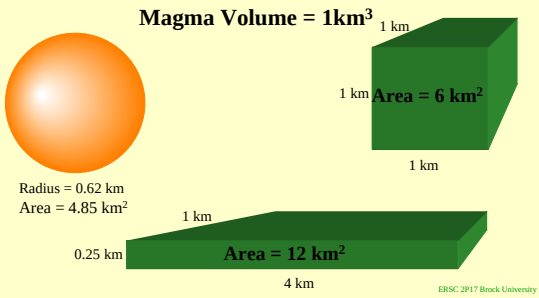
## Rate of Cooling

- Size and Shape of the magma chamber

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## Rate of Cooling

Size and Shape of the magma chamber

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– eg.

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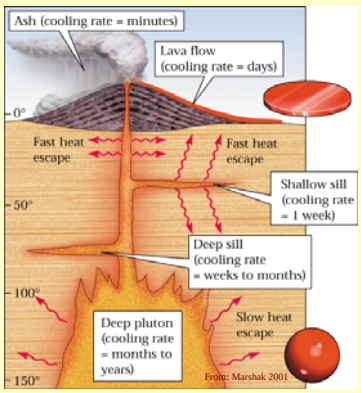
Cooling rates within an igneous rock system

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## Rate of Cooling

Presence of groundwater

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