

Chapter 4

IGNEOUS ROCKS

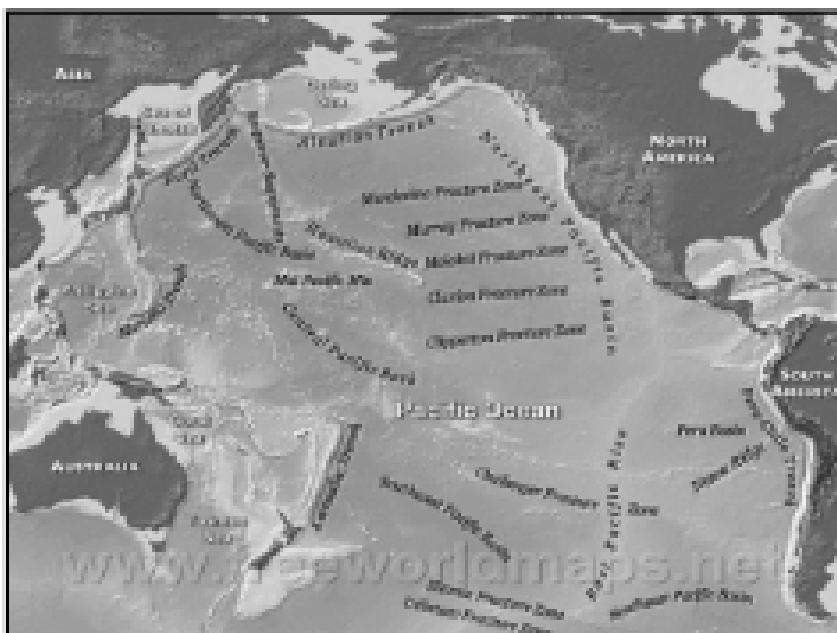
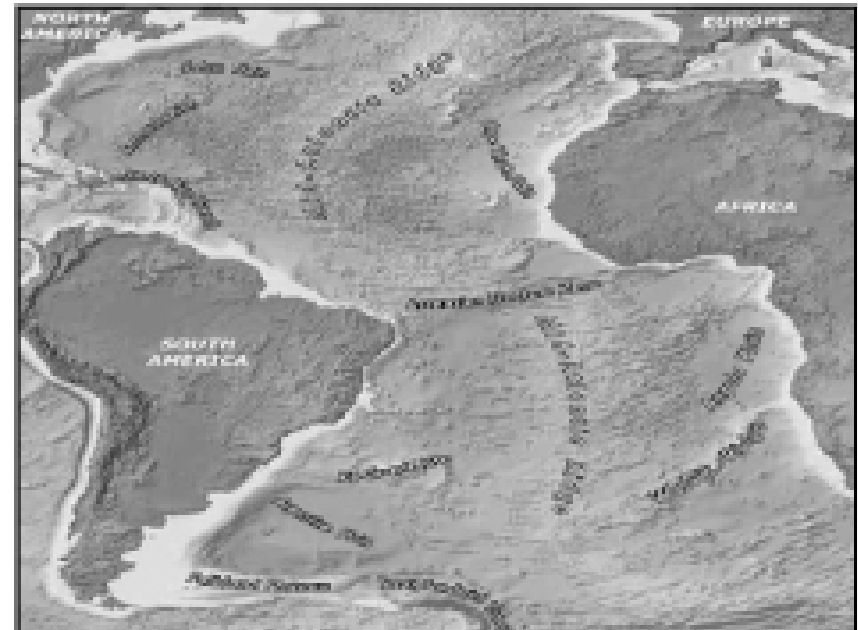
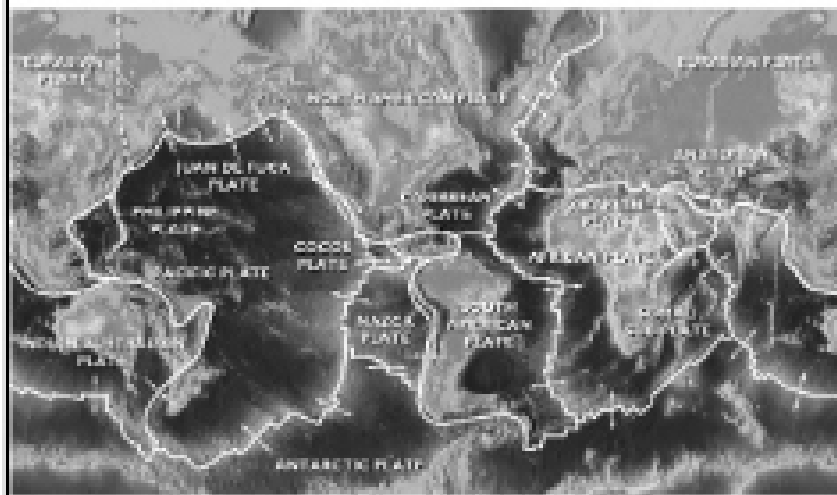
How do oceans and continents differ?

The average ocean depth is 3000m.

If the Earth's surface is 30% land and 70% ocean, why is there any land at all?

Why are there not just a few little islands?

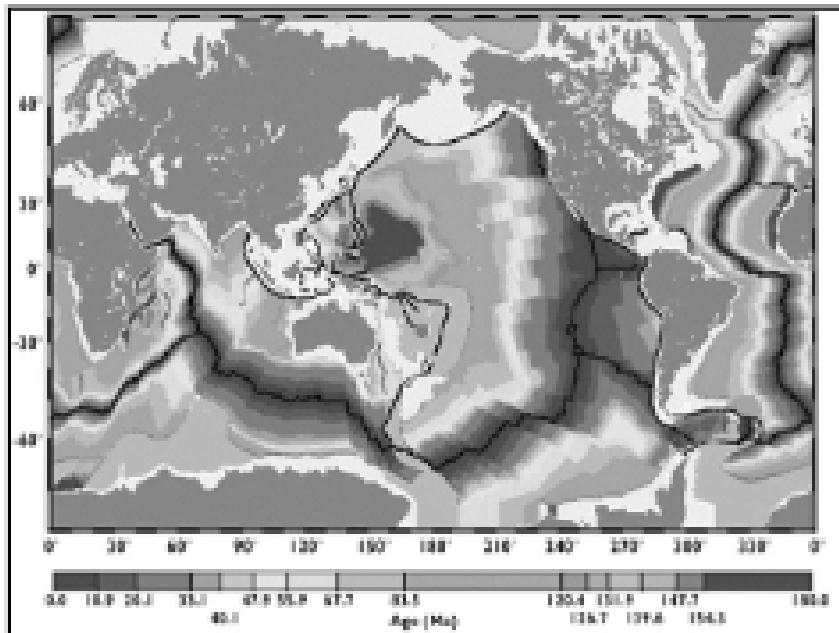
How do oceans and continents differ?



How do oceans and continents differ?

Ocean crust is thin, dense, and young.

Continent crust is thick, light, and old.

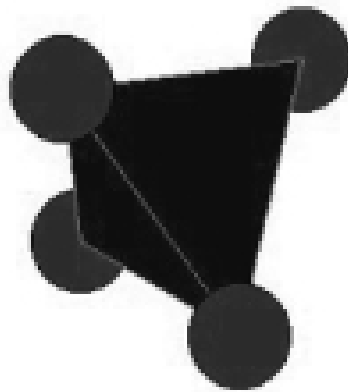


Polymerization of Silica

- Each Si atom is surrounded by 4 oxygens.
- Polymerization is the degree to which the oxygens are shared with other Si atoms.
- Polymerization is the number of Si-O-Si bonds per tetrahedron.
 - Olivine has none: isolated SiO_4 groups
 - Pyroxene has 50% shared: SiO_3 chains
 - Mica has 75% shared: Si_4O_{10} sheets
 - Quartz and feldspar have 100% $(\text{Si,Al})\text{O}_2$ framework.

Polymerization of Silica

Tetrahedron



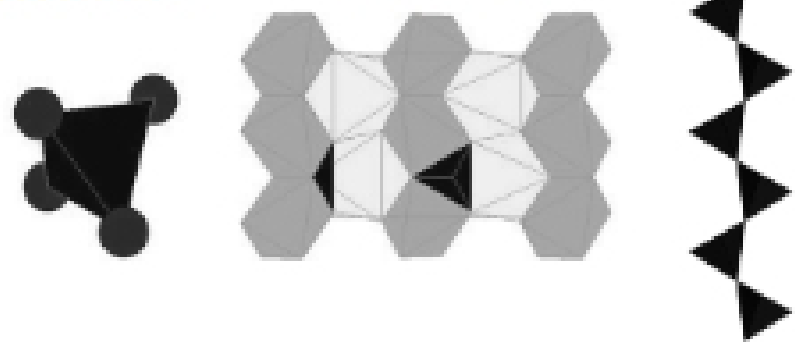
Polymerization of Silica

Pyroxene

MgSiO_3

Olivine (Mg_2SiO_4)

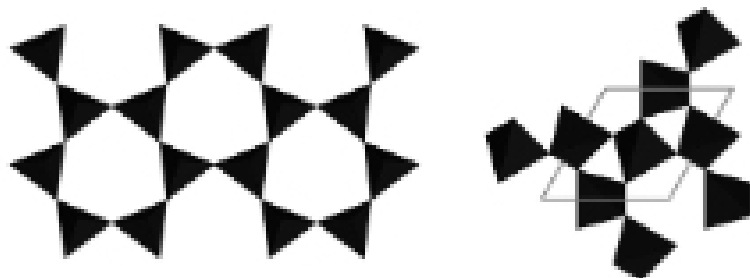
Tetrahedron



Polymerization of Silica

Mica (Sheet)

Quartz (Framework)



MAGMA

- Magma is the term for any molten silicate material, whether below the surface or on top.
- Volcanic rocks are erupted on the surface.
 - Volcanic rocks are fine-grained (<1 mm)
- Intrusive igneous rocks crystallize from magma below the surface.
 - Intrusive igneous rocks are coarse-grained (> 1mm)
 - Pegmatites are very coarse-grained (> 1cm)

Igneous Rocks: Learning Goals

- ***What does 'igneous' mean?***
- ***Composition***
- ***Mineralogy***
 - *Mantle*
 - *Oceanic Crust*
 - *Continental Crust*
- ***Igneous Fractionation***
 - *How the chemistry evolves*

Intrusive Igneous Rocks

- ***Composition***
- ***Mineralogy***
- ***Geologic Setting***
 - *Mantle*
 - *Oceanic Crust*
 - *Continental Crust*
- ***Igneous Fractionation***
 - *How the chemistry evolves*

Igneous Rock Compositions

- ***Rock compositions are described in weight percents of oxides:***
- ***SiO₂, MgO, FeO, Al₂O₃, etc***
- ***The principal variation in igneous rock compositions is silica (SiO₂) content.***
- ***The degree of polymerization of silica increases with silica content. (in both crystals and melt).***

Igneous Rock Compositions

- ***Igneous rocks vary in composition (SiO₂ content)***
 - *ultramafic (~40 wt%) (peridotite)*
 - *mafic (45-55%) (gabbro / basalt)*
 - *intermediate (55-65%) (diorite/andesite)*
 - *silicic (65-75 wt %) (rhyolite/granite)*
- ***The mantle is peridotite (ultramafic).***
- ***The ocean crust is gabbro (mafic).***
- ***The continents are granite (silicic)***

Igneous Rock Names and Compositions

<u>Composition Name</u>	<u>Intrusive Rock Name</u>	<u>Volcanic Rock Name</u>
• Ultramafic	• Peridotite	• (Komatiite)
• Mafic	• Gabbro	• Basalt
• Intermediate	• Diorite	• Andesite
• Silicic (felsic)	• Granite	• Rhyolite

Igneous Rock Mineralogy

- ***Peridotite (Ultramafic)***
 - Olivine ((Mg,Fe)₂SiO₄)
 - Pyroxene ((Mg,Fe,Ca)SiO₃)
 - Garnet (MgAl₂SiO₆) or
 - Spinel (MgAl₂O₄)
- ***Gabbro (Mafic)***
 - Feldspar (CaAl₂Si₂O₈)
 - Pyroxene ((Mg,Fe,Ca)SiO₃)
 - Olivine ((Mg,Fe)₂SiO₄)