

Physical Geology Introduction (Part 1)

- The Science of Geology
- Nature of Scientific Inquiry
- Hypotheses
- Theories
- Earth as a System
- Earth's Heat Engines
- The Rock Cycle



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Geology: The Study of Earth



- Geology comes from the Greek words *geo* (Earth) and *logos* (discourse) and is the study of Earth
- Earth is a dynamic body with many interacting parts
- Earth is constantly changing at rates that vary in size and space:
 - Rapid and violent changes such as volcanic eruptions and earthquake
 - Much slower changes such as the movement of lithospheric plates and mountain building

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The Science of Geology



- Geology - the science that pursues an understanding of planet Earth:
 - Physical geology - examines the materials composing Earth and seeks to understand the many processes that operate beneath and upon its surface
 - Historical geology - seeks an understanding of the origin of Earth and its development through time

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The Science of Geology



- Many important relationships exist between people and the natural environment
- Problems and issues addressed by geology include:
 - Natural hazards
 - Mineral resources
 - World population growth
 - Environmental issues

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The Nature of Scientific Inquiry

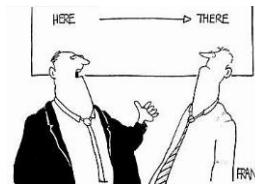


- Science assumes the natural world is consistent and predictable
- Goal of science is to discover patterns in nature and use the knowledge to make predictions
- Scientists collect data through observation and measurements

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The Nature of Scientific Inquiry

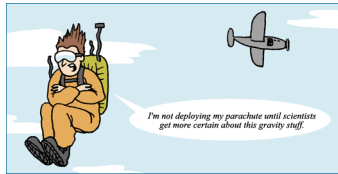
- Scientific method involves:
 - Gathering facts through observations
 - Formulation of hypotheses and theories
- There is no fixed path that scientists follow that leads to scientific knowledge:
 - The approach depends on the study at hand



"It's a simple model... but it works for me..."

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The Nature of Scientific Inquiry



How or why things happen is explained using a:

- Hypothesis: a tentative (or untested) explanation
- Theory: a well-tested and widely accepted view that the scientific community agrees best explains certain observable facts

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Hypothesis

- A hypothesis is:
 - A generalized statement designed to EXPLAIN a limited set of scientific observations.
 - The best hypothesis is one that explains ALL of the existing observations.
- A hypothesis must be:
 - Able to predict (or deduce) future observations - i.e. be testable.
 - Falsifiable - i.e. there must be the possibility it could be proven WRONG.



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- Testing a hypothesis:
 - Collect additional data that would be predicted (deduced) on the basis of the hypothesis.
 - If the data are inconsistent with the prediction, hypothesis **MUST** be modified or abandoned.
 - If the data are consistent with the prediction, they support the hypothesis

Hypothesis



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Steps in Investigation

Observation

Questions from observation

Hypotheses (Proposed explanation)

Collect data to test predictions

Conclusion

What Was Discovered

Gasoline in groundwater

From leak in buried tank?

How do we test our hypothesis?

From tank

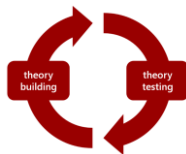
Not from tank

No leak in tank; wrong kind of gasoline in tank

Contamination is from elsewhere

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Theory



- Repeated verification of a hypothesis may result in the formation of a **THEORY**
- A theory is:
 - “A well tested and widely accepted view that scientists agree best explain certain observational facts.”
 - Like the hypotheses from which it grew, it must also be testable and falsifiable!
 - Therefore, all theories are considered provisional.
 - Nonetheless, theories are the end points of science!

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Earth As a System

- Earth is a dynamic planet with many interacting parts or spheres
- Earth System Science:
 - Aims to study Earth as a system composed of numerous interacting parts or subsystems
 - Employs an interdisciplinary approach to solve global environmental problems



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Earth As a System

- What is a system?
 - Any size group of interacting parts that form a complex whole
- Examples of systems:
 - Cooling system in cars,
 - nervous system in animals
- Most natural systems driven by sources of energy that move matter and/or energy from one place to another



The five interacting spheres of Earth Systems

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An Open Versus Closed System

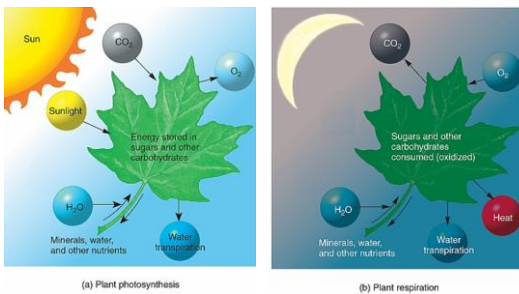


- Open system:
 - Energy and matter flow into and out of system
- Closed system:
 - System shut off from surrounding environment
 - Self contained in that energy and/or matter does not enter or leave the system

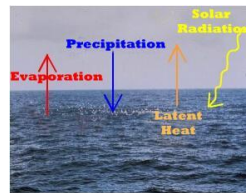
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Leaf As A Natural Open System

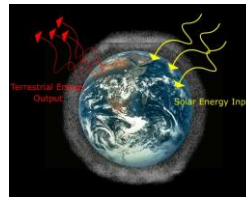
Both energy and matter enter and leave the system



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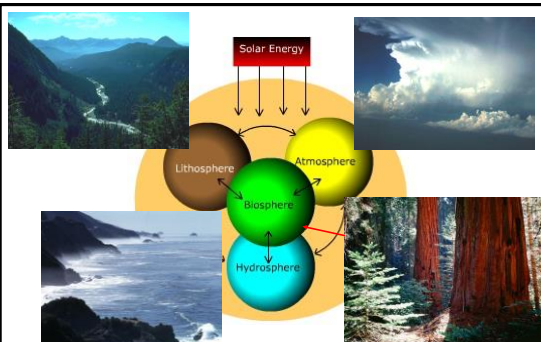


Ocean is an open system: Energy and matter flow into and out of the system



Earth is a closed system with respect to matter: Although energy enters and leaves earth freely, virtually no matter is exchanged between earth and the universe

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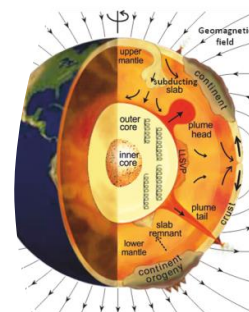


Although Earth is a closed system, the "spheres" that comprise it are open, exchanging both matter and energy.

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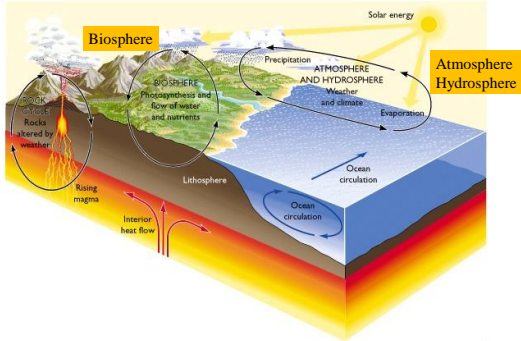
What Drives Our Planet?

- Earth Systems is powered by heat engines
- Earth has two heat engines:
 - External
 - Internal



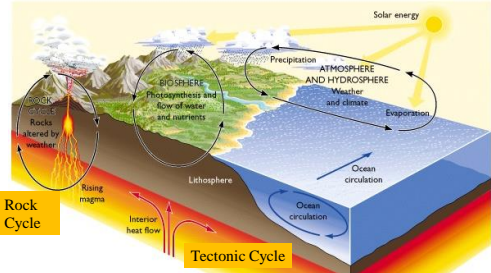
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Earth's External Heat Engine is powered by the Sun that drives Earth's fluid envelopes (atmosphere and hydrosphere) and biosphere



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Earth's External Heat Engine is powered by the Sun that drives Earth's fluid envelopes (atmosphere and hydrosphere) and biosphere

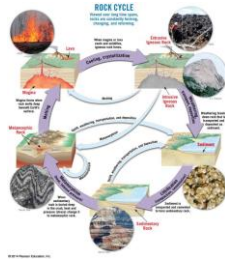


Earth's Internal Heat Engine is powered by geothermal heat that drives the tectonic and rock cycles within the solid Earth

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The Rock Cycle

- The Rock Cycle is one of several cycles driven by Earth's heat engines
- Illustrates how one rock type can be converted into another rock type under the appropriate conditions



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Basic Rock Types

- Igneous rocks:**
 - Formed from cooling and solidification of magma (molten rock)
 - Examples include granite and basalt



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Basic Rock Types

- Sedimentary rocks:**
 - Sediments are derived from weathering of preexisting rock
 - Sediments accumulate as layers at Earth's surface
 - Buried sediments are converted into rocks
 - Examples include sandstone and limestone



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Basic Rock Types

- Metamorphic rocks:**
 - Formed by "changing" preexisting igneous, sedimentary, or other metamorphic rocks
 - Driving forces are increased heat and pressure
 - Examples include gneiss and marble

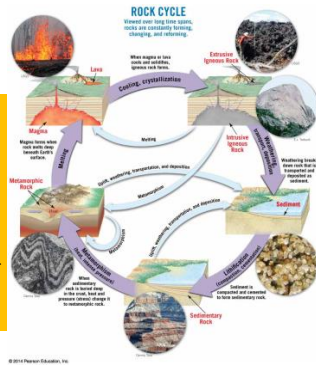


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Rocks and the Rock Cycle

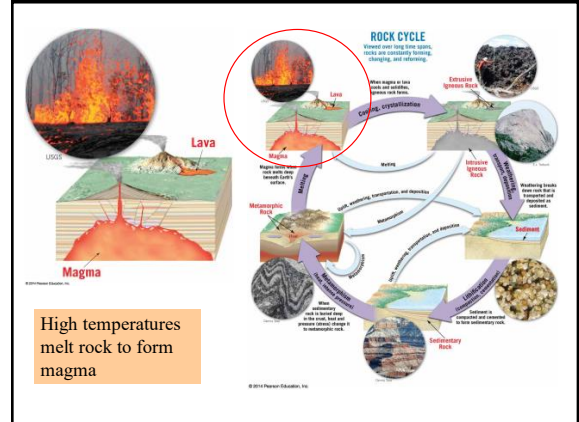
The Rock Cycle:

- The loop that involves the processes by which one rock type changes to another
- Illustrates the various processes and paths on Earth's surface and interior that can change one rock type into another



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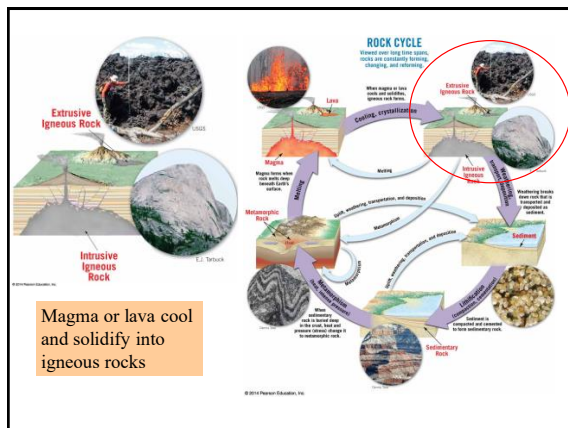
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High temperatures melt rock to form magma

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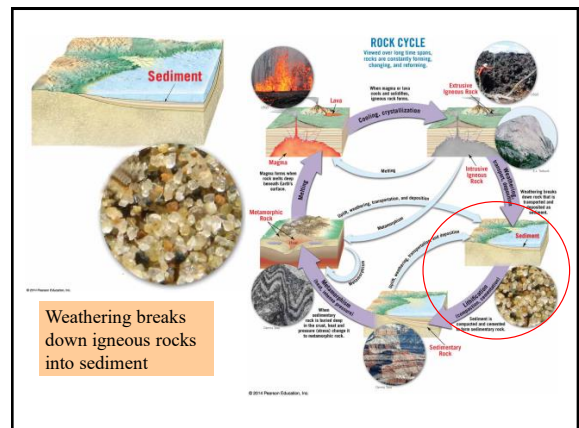
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Magma or lava cool and solidify into igneous rocks

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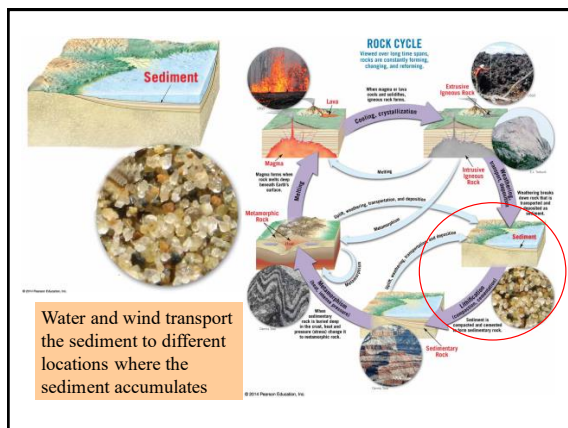
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Weathering breaks down igneous rocks into sediment

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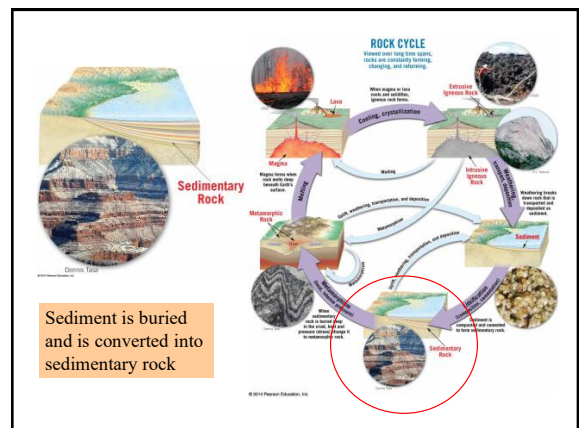
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Water and wind transport the sediment to different locations where the sediment accumulates

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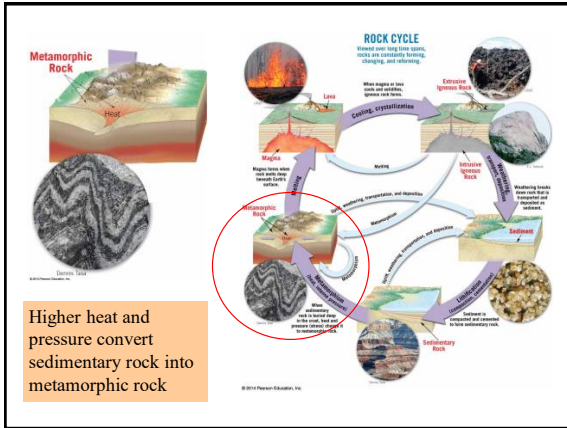
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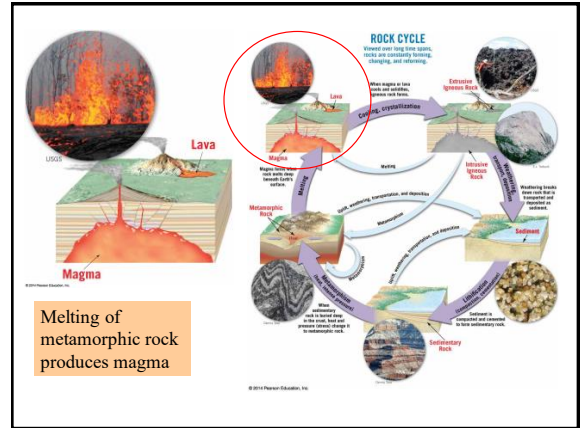
Sediment is buried and is converted into sedimentary rock

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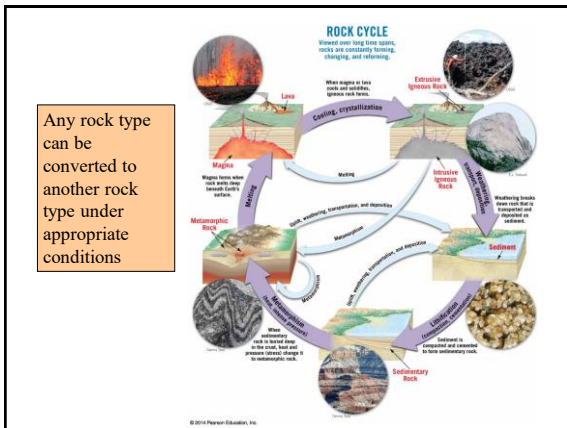
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