

## Geology 001 Exam 2 Review – Rock Cycle and Isostasy, Continental Drift, Seafloor Spreading, and Plate Tectonics

Review all questions discussed in class (see Presentation PDFs for review)

### Rock Cycle:

**Igneous Rock:** Basaltic magma originates from direct melting of the mantle at mid-ocean ridges (divergent plate boundaries) and hotspots – produces ocean floor crust.

Andesitic magma forms where plates collide (convergent plate boundaries) and oceanic crust is subducted back into the mantle. Water mixes with mantle rock, causing partial melting to produce a more silica-rich magma that forms continental crust. Rhyolitic magma forms when existing continental crust is remelted, usually at plate collision boundaries.

**Weathering:** the physical and chemical breakdown of rock uplifted and exposed to the atmosphere and weather. Weathering produces loose mineral grains (sediments) and dissolved ions. Sediments are deposited in basins (depressions) and dissolved ions are transported to the sea, making the sea salty.

**Sedimentary Rock:** Main types of sedimentary rock: detrital (conglomerate, sandstone, mudstone), carbonate (limestone, dolostone), evaporite (rock salt, rock gypsum), and organic (coal). Fossils are preserved in sedimentary rock. Fossil fuels (coal, oil, natural gas) form from buried organic material and are trapped in sedimentary rocks.

Uplift of sedimentary rock leads to erosion and the formation of new sedimentary rock.

Deep burial of sedimentary rock forms metamorphic rock. Foliated metamorphic rock (slate, phyllite, schist, gneiss) vs. nonfoliated metamorphic rock (marble, quartzite). Metamorphism is usually associated with plate collisions and mountain building, which causes the deep burial of large volumes of crust. Metamorphism is progressive – deeper burial leads to higher and higher temperature and pressure = greater and greater changes to the texture and mineral composition of the rock. If the rock gets too hot it starts to melt, producing a migmatite. If it melts completely it goes back to being a magma – back to the start of the rock cycle.

**Isostasy:** Mechanisms of uplift and subsidence – related to isostasy (lithosphere floating in equilibrium on the asthenosphere) – changes in density of the crust (heating / cooling), changes in thickness of the crust (plate collisions – thicken crust, erosion – thins crust). Erosion of mountain range from above causes rebound of rock in deep roots back toward the surface. High grade metamorphic rock exposed at the surface today was once the deep roots of an ancient mountain range.

### The Continental Drift Hypothesis:

Early Champions: Alfred Wegner, Alexander DuToit

Pangea, Laurasia / Gondwanaland

What were the lines of evidence advanced in support of continental drift?

Permian-age fossil and sedimentary rock distributions

Distribution of Permian-age glacial features – Permian glacial striations don't make sense plotted on modern geography.

What new technologies made exploration of the deep ocean floor possible?

Sonar

Magnetometry

Features of the seafloor were discovered by these technologies;

Midocean ridges, trenches, aseismic ridges, seamounts, guyotes

The Seafloor Spreading Hypothesis:

Magma is erupted from the mantle at mid-ocean ridges, causing the seafloor to move away from the ridge. Eventually, old seafloor sinks (subducts) back into the mantle and is recycled.

Remnant magnetism – polarity and orientation of the Earth's magnetic field preserved in rock bearing iron minerals.

Apparent polar wandering – the observation based on remnant magnetism that the Earth's magnetic pole appears to have moved over time across the globe. Apparent because it could be explained two ways: either the magnetic pole moved over time or the continents did.

Since different continents show the pole being in different places at the same time, geologists concluded that the continents must have moved over time.

Magnetic polarity reversals – occur randomly at different intervals through time. Pattern of magnetic reversals is unique for any interval of geologic time (bar code) – rock layers can be dated based on their magnetic reversal pattern because as layers accumulate through time they record the unique pattern of reversals of the Earth's magnetic field.

Seafloor magnetic polarity stripes – symmetrical across mid-ocean ridges, caused by seafloor spreading and the cooling of magma at the ridge recording the unique pattern of magnetic polarity reversals through time.

Geologists are forced to accept seafloor spreading and continental drift when it is shown that the pattern of magnetic polarity stripes on the seafloor matches the pattern of the Earth's magnetic polarity reversals through time – no other explanation for this is possible.

Questions for Discussion / Review

1. Why does the Earth have so many different kinds of rock?
2. How do igneous rocks form? Sedimentary rocks? Metamorphic rocks?
3. What were some of the reasons why continental drift failed to gain wide acceptance as a theory?
4. What technologies useful to the study of the Earth came out of World War II and the subsequent Cold War?
5. What is seafloor spreading? How does it explain the features of the ocean floor such as guyotes, seamounts, aseismic ridges, mid-ocean ridges, and trenches?
6. Why was the seafloor spreading hypothesis not accepted by most geologists when it was first proposed?
7. How were surveys of remnant magnetic polarity conducted over the ocean floor used to prove conclusively that seafloor spreading was real?
8. How does plate tectonic theory explain each of the following?
  - Global distribution of earthquakes and depth distribution of earthquakes
  - Global distribution of volcanoes
  - Global distribution of seafloor age