

Geology 001 Exam 1 Review – Planet Earth

Review all questions discussed in class (see presentation pdfs for review)

Earth Systems:

Hydrosphere – water vapor, salt water, fresh water, ice. 97% of water is saltwater. Most freshwater is found as ice. Largest reservoir of liquid water is groundwater.

Atmosphere – composition of Earth's atmosphere – Nitrogen, oxygen, greenhouse gases (water vapor, carbon dioxide, methane). Most gas is located near to the surface in the troposphere.

Greenhouse effect – greenhouse gases trap heat radiated from the surface, prevents heat from escaping into space, keeping the Earth habitable.

Ozone layer – located in the stratosphere, absorbs deadly UV radiation from the Sun.

Biosphere – life – interacts and affects other systems (can you name some examples?)

Geosphere – Earth has distinct continents and oceans basins, extensive mountain systems, lack of craters, active volcanoes and earthquakes – active planet inside and out, surface constantly being remade by uplift and erosion.

Solar System: Sun, rocky planets (Mercury, Venus, Earth, Mars), gas giants (Jupiter, Saturn), ice giants (Uranus, Neptune), minor planets (plutinos, asteroids), comets

Earth Materials

Elements are made of atoms. The number of protons in an atom determines what element it is.

Hydrogen and helium were created in the Big Bang at the origin of the universe (Big Bang nucleosynthesis). Heavier elements (lithium – iron) are made by nuclear fusion in the interior of stars (stellar nucleosynthesis). The heaviest elements (atomic mass > iron) are produced by nuclear fusion when massive stars explode in a supernova.

Elements are the building blocks of minerals. Minerals combine to form rocks.

Definition of a mineral (solid, crystalline, naturally occurring, distinct elemental composition, not organic C-H molecules)

Mineral properties (luster, hardness, cleavage, streak, etc.)

Relation of mineral properties to crystal structure (diamond vs. graphite)

Mineral families: Silicate minerals (silicate tetrahedron) – four atomic bonding sites allows complex structures such as chains, sheets, and 3-D frameworks. Silicates are the major rock-forming minerals.

Other minerals families and their uses: Carbonates (calcite – cement, also a rock-forming mineral), Phosphates (apatite – bones, teeth), Sulfates (gypsum – plaster), Halides (halite – salt),

Oxides and Sulfides (simple compounds – ore minerals), Native elements (gold, platinum)

Earth's Interior Structure and Function:

The Earth is heterogeneous and layered – density of the whole planet = 6 gm/cc, density of the crust = 3 gm/cc, layer boundaries come from monitoring seismic waves as they travel through the Earth. S wave shadow zone indicates that the outer core is liquid because P waves can pass through it but S waves cannot.

Source of Earth's internal heat – nuclear fission due to radioactive decay of heavy elements.

Source of Earth's exterior heat that drives circulation in the atmosphere – the Sun.

Layered structure of the Earth: Inner Core (solid), Outer Core (liquid), Mantle (solid),

Asthenosphere (plastic), Lithosphere (upper Mantle + Crust, solid)

Pressure and temperature both increase from the surface to the core of the Earth

Pressure raises the temperature needed to melt a particular material.

Phenomena arising from the layered structure and composition of the Earth:

Planetary magnetic field – generated by a magnetic dynamo set up by the circulation of the iron in the liquid outer core around the solid inner core. The magnetic field shields the Earth from the high energy charged particles of the solar wind, preventing our atmosphere from being eroded away into space and also preventing life on the surface from being exposed to higher levels of radiation from space.

Plate tectonics – lithosphere and asthenosphere. Lithosphere is the plates composed of crust and upper mantle that “floats” on the asthenosphere. Ocean floor crust is mafic (enriched in iron and magnesium) relative to continental crust (sialic – enriched in silicon and aluminum).

Earth’s mantle behaves like a lava lamp, circulating very slowly to deliver heat to the upper mantle where plumes of hot mantle are rising. Where heat is rising, magma erupts to form new ocean floor lithosphere at mid-ocean ridges (diverging plate boundary). Older lithosphere moves away from the ridge and eventually sinks back into the mantle at ocean trenches (converging plate boundary).

Volcanoes at diverging plate boundaries and hot spots erupt hot, fluid lava to form shield volcanoes. At converging boundaries volcanoes erupt explosively with gassy, sticky magma. At converging plate boundaries, water is pulled down into the mantle with the old ocean floor lithosphere. Mixing water with the rock in the upper mantle causes the rock to partially melt at a lower temperature, releasing cool, viscous, gas-rich magma. This magma is also silica rich and forms continental rock when it cools near the surface of the Earth.

The Earth has continents because of this plate tectonic process, which has been making continental rock and adding it to the lithosphere for most of the history of the Earth.

Important questions to be able to answer:

Why does the Earth have so few impact craters relative to other planets such as the Moon and Mars?

Why is the surface of the Earth segregated into continents (elevated regions) and ocean basins (depressed regions)?

What are some examples of interactions between Earth systems? For example, how does the biosphere change the atmosphere?

Why did Carl Sagan (famous astronomer) mean when he said that “We are all made of star stuff.”?

Why do graphite and diamond have such different physical properties even though they are both made out of pure carbon?

Is water a mineral? Why or why not, and under what conditions?

Why are most minerals in the crust of the Earth silicate minerals? What makes silicate minerals so abundant and diverse?

What causes some layers in the Earth to be solid, others are liquid or plastic?

Earth's magnetic field – how is it generated? Why is it important? What is an aurora?

What will happen to the core of the Earth as the Earth continues to cool inside? How will this impact the Earth's magnetic field?

Mars has very little atmosphere and no current magnetic field (however, magnetized rocks in the crust suggests that in the distant past, Mars had a very strong magnetic field). Yet there is evidence for Mars having been a warmer, wetter world early in the history of the solar system. What happened to Mars? How might Mars have gone from being a warm, wet world to being a dry, cold world early in its history?

What causes volcanoes at divergent plate boundaries? What causes volcanoes at convergent plate boundaries? What happens when water is added to rock in the mantle? How does the recycling of the Earth's lithosphere create continental crust? Why don't Mars and Venus have true continents like the Earth does?