

GLY1000 Lecture Study Guide TEST 1

Age of Earth – 4.5 billion years

Internal processes - A process in the Earth system caused by Earth's internal heat (ex. Volcanism, plate motion)

External processes - A geomorphologic process (ex. down slope movement, erosion) that is the consequence of gravity or the interaction between the solid Earth and its fluid envelope (air and water). Energy for these processes comes from gravity and sunlight.

Theory - A scientific idea supported by an abundance of evidence that has passed many tests and failed none

A good hypothesis: verifiability, predictive power, and reproduction

How do we know Earth spins?

- Foucault Pendulum. As the Earth rotates the inertia of a pendulum keeps it in as close to the same plane as it can. This is a consequence of Newton's Laws of Motion.

Geocentric view – “Earth is the center” / **Helocentric view** – “Sun is center”

Ptolemy - Ptolemy's most important geographical innovation was to record longitudes and latitudes in degrees for roughly 8,000 locations on his world map, making it possible to make an exact duplicate of his map.

Eratosthenes calculations - Deduced that the Sun's rays at noon on this day must be exactly perpendicular to the Earth's surface at Syene, and that if the Earth was spherical, then the Sun's rays could not simultaneously be perpendicular to the Earth's surface at Alexandria. Measured shadow, then footsteps from Alexandria to Syene and calculated the Earth's circumference.

Earth's distance to the Moon: 4.063×10^8 light years

Earth's distance to the Sun: 0.00001581 light years

Earth's distance to nearest Star: 4.3 light years

Doppler Effect – The phenomenon in which the frequency of wave energy appears to change when a moving source of wave energy passes an observer

Doppler Shift - Applies to light when objects are moving very fast. We call this change red shift and blue shift

Expanding universe theory - States that the whole Universe must be expanding because galaxies in every direction seem to be moving away from us

Age of the Universe – 13.7 billion years, measured current rate then back-calculated

Supporting evidence:

- (1) Discovery of the expanding Universe,
- (2) Modeling formation of elements
- (3) Star evolution

Rate of expansion of universe: Space itself is pulling apart at the seams, expanding at a rate of 74.3 plus or minus 2.1 kilometers (46.2 plus or minus 1.3 miles) per second per megaparsec (a megaparsec is roughly 3 million light-years).

Nebular Hypothesis - Suggested that the origin of the solar system could be traced to a rotating cloud of gas and fine dust. (Immanuel Kant)

Where do elements come from and which were first in our universe?

Immediately after the Universe's formation (big bang, 14 bya), it began to expand and cool. The radiant energy produced quark-antiquarks and electron-positrons, and other particle-antiparticle pairs. However, as the particles and antiparticles collided in the high-energy gas, they would annihilate back into electromagnetic energy. As the universe expanded the average energy of the radiation became smaller. Hydrogen and Helium.

Galaxy - formed ~13.4 billion years ago from globular clusters, spiral shaped, cannibalizing neighboring galaxy now

Solar system – (NOT DURING BIG BANG) completed around 4.5 bya.

Heat source - The flow of heat from Earth's interior to the surface is estimated at 47 terawatts and comes from two main sources in roughly equal amounts: the radiogenic heat produced by the radioactive decay of isotopes in the mantle and crust, and the primordial heat left over from the formation of the Earth.

Chemical composition of Earth:

- Mantle: O, Si, Al
- Core: Fe, Ni

Evolution of atmosphere(s) on Earth - H & He was lost to space because gravity can't hold lighter gases, and undifferentiated Earth had no magnetic field (Van allen belt)

Second: from differentiation outgassing and impacts similar to modern volcanic gases

Bulk composition of Earth (elemental):

- Iron: 34.6%
- Oxygen: 29.5%
- Silicon: 15.2%
- Magnesium: 12.7%
- Other: 8%

Development of Earth's oceans (timing, source and evidence):

- Water is a major component of volcanic gas.

- Evidence for liquid oceans: pillow basalts, Bya deposits suggesting marine deposition

First appearance of life - 3.5-4.0 BYA

- Early life forms – little evidence; no hard parts (teeth, bones, shells)
- Earliest rocks with single-celled, eukaryotic organisms

Current population of Earth and carrying capacity - Scientists think Earth has a maximum carrying capacity of 9/10 billion people. Current population 7.125 billion.

Earth's magnetic field – (geomagnetic field) The magnetic field that extends from the Earth's interior to where it meets the solar wind, a stream of charged particles emanating from the Sun. Its magnitude at the Earth's surface ranges from 25 to 65 microteslas

Van Allen belts - A radiation belt is a layer of energetic charged particles that is held in place around a magnetized planet, such as the Earth, by the planet's magnetic field. The Earth has two such belts and sometimes others may be temporarily created.

Current atmospheric composition - Nitrogen (78%) and oxygen (21%) with small concentrations of other trace gases. Nearly all atmospheric water vapor or moisture is found in the troposphere, so it is the layer where most of Earth's weather takes place.

Hypsometric curve - A graph that plots surface elevation on the vertical axis and the percentage of the Earth's surface on the horizontal axis

Alfred Wegener's continental drift hypothesis - hypothesis proposed that the continents had once been joined, and over time had drifted apart.

• Evidence: fit of continents, fossil distribution, location of glacial formation, glacial deposits
Pangea - Supercontinent that assembled at the end of the Paleozoic era

Problems with continental drift - Some scientists were opposed to his theory since neither Alfred nor anyone else had any proposed mechanism that actually caused the continents to move.

Stress: force is applied

- Compressive (squeeze) / Tensional (pull/stretch) / Shearing (dif. directions)

Strain: the deformation resulting from stress

Factors related to strain: temperature, confining pressure, time, type of stress

Plastic behavior - materials that can undergo extensive plastic deformation before rupture (ex. Paper clip)

Rigid behavior - materials that rupture before any plastic deformation (ex. Glass)

EARTH has two physical layers:

1. **Lithosphere** - The strong, rigid outer shell of the earth that encases the asthenosphere and contains the crust and the uppermost part of the mantle down to an average depth of about 100km and forms the rigid plates

2. **Asthenosphere**- The weak layer of soft but solid rock comprising the lower part of the upper mantle and over which the plates slide. Movement in the asthenosphere occurs by plastic deformation.

EARTH's chemical layers:

1. **Crust** – Thick layer of rock, outermost layer.

2. **Mantle** – Below the crust

3. **Inner core** – Innermost, consists of liquid iron alloy

Distribution of volcanoes and earthquakes - Concentrated belts and chains at plate boundaries

Seafloor topography - Ridges, trenches, hills (mostly volcanoes)

Seafloor spreading - a process where new crust is made at mid ocean ridges and old crust is recycled at a subduction zone. Harry Hess- 1960s, US Navy SONAR operator

Subduction occurs: at Convergent plate boundaries where continental meets oceanic

Paleomagnetism and reversals (anomalies) - the study of the record of the Earth's magnetic field in rocks, sediment, or archeological materials. Certain minerals in rocks lock-in a record of the direction and intensity of the magnetic field when they form. This record provides information on the past behavior of Earth's magnetic field and the past location of tectonic plates. The record of geomagnetic reversals preserved in volcanic and sedimentary rock sequences (magnetostratigraphy) provides a time-scale that is used as a geochronologic tool.

Age of ocean crust: 200 million + years

Plate movement rates: 1-10 cm/yr

Hotspots - a portion of the Earth's surface which experiences volcanism. This may be caused by a rising mantle plume. Hotspots may be far from tectonic plate boundaries. A volcanic hotspot is where lava pushes up from under the mantle and creates a volcano.

Hotspots are located: On, near, or far from tectonic plate boundaries

Types of plates boundaries and examples:

- divergent: found in mid-oceanic ridges (normal faulting)
- convergent: can be found on land where mountains have formed (reverse fault)
- transform-plate boundary: can be found in ocean basins (strike-slip fault)