Earth: How Old is it anyway?

- Then God said, "Let there be an expanse in the midst of the waters, and let it separate the waters from the waters." And God made the expanse, and separated the waters which were below the expanse from the waters which were above the expanse; and it was so. God called the expanse “sky”… – Genesis 1:6-8a

- Then God said, "Let the waters below the heavens be gathered into one place, and let the dry land appear"; and it was so. And God called the dry land earth, and the gathering of the waters He called seas; and God saw that it was good. – Genesis 1:9-10

- He stretched out the northern skies over emptiness (tohu), and suspends the earth over (or on) nothing (absolute) – Job 26:7

- Where were you when I laid the foundations (established or placed) of the earth? Tell me, if you have understanding – Job 38:4

- Of old (long ago; lit. “face that turns”) you have laid the foundation (established or placed) of the earth: and the heavens are the work of your hands – Ps 102:25.

- http://www.youtube.com/watch?v=QDqskItCixA

- “That’s what we know, or what we think we know”…. “We may never know”

- Notice all the hypothetical continents have names!
Outline

1. Genesis 1-11 (Introduction)
2. Genesis 1:1-31 (Universe Part 1) – Big Bang Model
3. Genesis 1:1-31 (Universe Part 2) – Old and Young Earth Models
4. Genesis 1:1-19 (Earth) – Days 1 to 4
5. Genesis 1:1-19 (Earth) – Formation and Age
7. Genesis 1:13-25 (Plants and Animals) – Fossils, Dinosaurs and Evolution
8. Genesis 1:26-2:4a (Man – male and female, Rest)
10. Genesis 3-6:9a (Sin & Curse & Decay)
Earth: Objectives

- Understand the naturalist models on the formation of the earth
- Understand the history and applicability of the “Geologic Timeline”
- Understand the primary “dating” methods for organics (bones and fossils) and inorganics (rocks and minerals)
- Evidence for various ages of the earth
Earth: Formation Theory

• Formed around 4.54 billion years ago by accretion:
  ◦ By gravitation an object attracts more matter, typically gaseous matter into an accretion disc
  ◦ The gaseous matter loses momentum and falls into the central object

• Volcanic outgassing created the primordial atmosphere, but it contained almost no oxygen and would have been toxic to humans and most modern life.

• Much of the Earth was molten because of extreme volcanism and frequent collisions with other bodies.

• One very large collision (by planet “Theia” from the Greek mythological Titan who birthed the moon) is thought to have been responsible for tilting the Earth at an angle and forming the Moon.

• Over time, the planet cooled and formed a solid crust allowing liquid water to exist on the surface (recent studies imply water existed 4.38 billion years ago)

• The first life forms appeared between 3.8 and 3.5 billion years ago.
Earth: Dating Methods

- “Scientists have **not** found a way to determine the exact age of the Earth directly from Earth rocks because Earth's oldest rocks have been recycled and destroyed by the process of plate tectonics. If there are any of Earth's primordial rocks left in their original state, they have not yet been found. Nevertheless, scientists have been able to determine the probable age of the Solar System and to calculate an age for the Earth by **assuming** that the Earth and the rest of the solid bodies in the Solar System formed at the same time and are, therefore, of the same age” – USGS

- Two primary methods **correlated** to this age:
  - Relative Dating
  - Radiometric Dating
Earth: Fossils

- The remains of living creatures (plants and animals) or their tracks.
- Old earthers – A rare event found only in sedimentary rock.
- Many fossils no longer contain their original material, but are composed of mineral deposits that have infiltrated them and taken on their shapes.
- The only substantial evidence that evolution has taken place in past ages, if there is such evidence, is to be found, in the fossils.
- "No biologist has actually seen the origin by evolution of a major group of organisms."—G. Ledyard Stebbins, Process of Organic Evolution, p. 1. [Stebbins is a geneticist.]
- The percentage of still-living species (e.g. living fossils) is very, very high throughout all the strata, and varies from place to place for each stratum in different localities (100’s with links on wikipedia.com)
- To tell the age of most layered rocks, scientists study the fossils these rocks contain and vice-versa.
Earth: Relative Dating

- **Nicholas Steno (~1670) principles:**
  - Rock layers (or strata) are laid down in succession representing "slices" of time.
  - Law of superposition – Any given stratum is probably older than those above it and younger than those below it.

- **Geologists in 1700’s –** Discovered that sequences of strata were often eroded, distorted, tilted, or even inverted after deposition;

- **Early 1800’s –** Strata identified by the fossils they contained.
  - If two strata (however distant in space or different in composition) contained **the same fossils**, chances were good that they had been laid down at the same time.
  - Detailed studies between 1820 and 1850 of the strata and fossils of Europe produced the sequence of geological periods **still used today**.
Earth: Relative Dating

- Stratum does not appear anywhere on earth
- Time scale does not give ages, only relative sequence

“Before the 20th century, archaeologists and geologists were largely limited to the use of relative dating techniques. Estimates of the absolute age of prehistoric and geological events and remains amounted to little more than inspired guesswork, as there was no scientific basis for testing such proposals.” – Encyclopedia.com
Earth: Relative Dating Assumptions

- **The principle of uniformitarianism** – the geologic processes observed in operation at present have worked in much the same way over geologic time ("The present is the key to the past"), as opposed to "**Catastrophism**" (a great catastrophe in the past, e.g. the Flood), which within a few months laid down all the sedimentary rock strata, entombing the animals contained within them, which became fossils.

- **The principle of original horizontality** – the deposition of sediments occurs as essentially horizontal beds.

- **The law of superposition** – a sedimentary rock layer in a tectonically undisturbed sequence is younger than the one beneath it and older than the one above it.

- **The principle of faunal succession** – fossils exist at the same time period throughout the world, their presence or absence provides a relative age of the formations in which they are found.

- "If a pile were to be made by using the greatest thickness of sedimentary beds of each geological age, it would be at least 100 miles high. ...It is, of course, impossible to have even a considerable fraction of this great pile available at any one place. The Grand Canyon of the Colorado, for example, is only one mile deep." *Geology*, p.417. **Von Engeln & Caster**,
“The intelligent layman has long suspected circular reasoning in the use of rocks to date fossils and fossils to date rocks.” - J.E. O’Rourke, American Journal of Science, 1976, 276:51.
<table>
<thead>
<tr>
<th>Time Period</th>
<th>Human Artifacts in the Geological Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>MID-PLEISTOCENE</td>
<td>SKULL ........................................ Olmo, Italy</td>
</tr>
<tr>
<td></td>
<td>SKELETON .................................. Clichy, France</td>
</tr>
<tr>
<td></td>
<td>SKELETON .................................. Dally Hill, England</td>
</tr>
<tr>
<td>LOWER PLEISTOCENE</td>
<td>PELVIS ...................................... Natchez, North America</td>
</tr>
<tr>
<td></td>
<td>JAW ........................................... Abbeville, France</td>
</tr>
<tr>
<td></td>
<td>UPPER ARMBONE ................................ Kanapoi, Africa</td>
</tr>
<tr>
<td>PLIOCENE</td>
<td>SKULL ........................................ Cahuenga, California</td>
</tr>
<tr>
<td></td>
<td>SKULL ...................................... Castenedo, Italy</td>
</tr>
<tr>
<td></td>
<td>SKULL ...................................... Tepito, Mexico</td>
</tr>
<tr>
<td></td>
<td>FOOTPRINTS .................................. Lactoli, Africa</td>
</tr>
<tr>
<td></td>
<td>SANDAL PRINT ................................ Carson City, Nevada</td>
</tr>
<tr>
<td>MIOCENE/OLIGOCENE</td>
<td>SKULL ........................................ Stanford, California</td>
</tr>
<tr>
<td></td>
<td>JAW .......................................... Tucson, Arizona</td>
</tr>
<tr>
<td></td>
<td>SHOE PRINT .................................. Gobi Desert, Asia</td>
</tr>
<tr>
<td>EOCENE</td>
<td>SKULL ........................................ Stanford, California</td>
</tr>
<tr>
<td></td>
<td>TOOTH ........................................... Bear Creek, Montana</td>
</tr>
<tr>
<td>PALEOCENE</td>
<td>CAST IRON CUBE ................................ Wofberg, Austria</td>
</tr>
<tr>
<td>CRETACEOUS</td>
<td>SKELETON (2) .................................. La Sal, Utah</td>
</tr>
<tr>
<td></td>
<td>SKULL ...................................... Gilman, Colorado</td>
</tr>
<tr>
<td></td>
<td>FOOTPRINTS &amp; FINGER ................................ Glen Rose, Texas</td>
</tr>
<tr>
<td></td>
<td>CAST METAL NODULES ................................... Franco</td>
</tr>
<tr>
<td></td>
<td>METAL HAMMER ...................................... London, Texas</td>
</tr>
<tr>
<td>JURASSIC/ TRIASSIC</td>
<td>LED &amp; FOOT BRACE ................................ Spring Valley, Nev.</td>
</tr>
<tr>
<td>PERMIAN</td>
<td>FOOTPRINTS ........................................... Secora, New Mexico</td>
</tr>
<tr>
<td></td>
<td>FOOTPRINTS ........................................ St. Louis, Missouri</td>
</tr>
<tr>
<td></td>
<td>HANDBRENS ..................................... Ruedale Mtns., N. Mex.</td>
</tr>
<tr>
<td>PENNSYLVANIAN</td>
<td>FOOTPRINTS ............................................ Berea, Kentucky</td>
</tr>
<tr>
<td></td>
<td>IVORY PRINT .................................... Oklahoma</td>
</tr>
<tr>
<td></td>
<td>TOOK ............................................ Abden-Provence, France</td>
</tr>
<tr>
<td></td>
<td>GOLD CHAIN ...................................... Illinois</td>
</tr>
<tr>
<td>MISSISSIPPIAN/DEVONIAN</td>
<td>FOOTPRINTS ............................................ Berea, Kentucky</td>
</tr>
<tr>
<td></td>
<td>PRECISION PATTERN ................................ Pittsburgh, Pa.</td>
</tr>
<tr>
<td>SILURIAN/ORDOVICIAN</td>
<td>FOOTPRINTS ............................................ Secora, New Mexico</td>
</tr>
<tr>
<td></td>
<td>SANDAL PRINT .................................. Lake Winnebago, Eng.</td>
</tr>
<tr>
<td>CAMBRIAN</td>
<td>SKELETON ...................................... Franklin County, Missouri</td>
</tr>
<tr>
<td></td>
<td>SANDAL &amp; FOOTPRINT ................................ Antelope Digs, Ut.</td>
</tr>
<tr>
<td></td>
<td>IRON BAMS ....................................... Lochmase, Scotland</td>
</tr>
</tbody>
</table>

Collectively called Precambrian, comprises about 88% of the geologic time scale
Earth: Radiometric Dating

- **Gravity**: weakest force, keeps us on the earth, keeps the earth around the sun
- **Electricity and Magnetism**: sunlight warms the planet, chemistry, transistors, computers, cell phones, power
- **Nuclear weak force**: responsible for radioactivity, fission
- **Nuclear strong force**: responsible for binding neutrons and protons in the nucleus
- **Does Not address dark matter or dark energy**

**Forces of the Standard Model**
Earth: Radiometric Dating

Temperature of universe

- $10^{32}$ K
- $10^{27}$ K
- $10^{15}$ K
- $10^{13}$ K
- 3 K

Time after Big Bang

- $10^{-43}$ s
- $10^{-35}$ s
- $10^{-12}$ s
- $10^{-6}$ s
- $5 \times 10^{17}$ s ( = now)

Forces:
- Strong nuclear force
- Electromagnetic force
- Weak nuclear force
- Gravity
Earth: Radiometric Dating

- Process by which an unstable atom loses energy by emitting particles of ionizing radiation (neutrons) from nucleus
- 3800 radioactive isotopes with half-lives from $10^{-24}$ to $10^{30}$ seconds (yocto-second to 32 quadrillion years)
- Over forty different radiometric dating techniques, each based on a different radioactive isotopes.

<table>
<thead>
<tr>
<th>Radioactive Isotope (Parent)</th>
<th>Product (Daughter)</th>
<th>Half-Life (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samarium-147</td>
<td>Neodymium-143</td>
<td>106 billion</td>
</tr>
<tr>
<td>Rubidium-87</td>
<td>Strontium-87</td>
<td>48.8 billion</td>
</tr>
<tr>
<td>Rhenium-187</td>
<td>Osmium-187</td>
<td>42 billion</td>
</tr>
<tr>
<td>Lutetium-176</td>
<td>Hafnium-176</td>
<td>38 billion</td>
</tr>
<tr>
<td>Thorium-232</td>
<td>Lead-208</td>
<td>14 billion</td>
</tr>
<tr>
<td>Uranium-238</td>
<td>Lead-206</td>
<td>4.5 billion</td>
</tr>
<tr>
<td>Potassium-40</td>
<td>Argon-40</td>
<td>1.26 billion</td>
</tr>
<tr>
<td>Uranium-235</td>
<td>Lead-207</td>
<td>0.7 billion</td>
</tr>
<tr>
<td>Beryllium-10</td>
<td>Boron-10</td>
<td>1.52 million</td>
</tr>
<tr>
<td>Chlorine-36</td>
<td>Argon-36</td>
<td>300,000</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Nitrogen-14</td>
<td>5715</td>
</tr>
<tr>
<td>Uranium-234</td>
<td>Thorium-230</td>
<td>248,000</td>
</tr>
<tr>
<td>Thorium-230</td>
<td>Radium-226</td>
<td>75,400</td>
</tr>
</tbody>
</table>
Earth: Radiometric Dating

Some of the atoms eventually change from one element to another by a process called radioactive decay. Probabilistic sample!

- \( D = D_0 + N(t) \left( e^{\lambda t} - 1 \right) \)
- \( t \) is age of the sample,
- \( D \) is number of atoms of the daughter isotope in the sample,
- \( D_0 \) is number of atoms of the daughter isotope in the original composition,
- \( N \) is number of atoms of the parent isotope in the sample at time \( t \) (the present), given by \( N(t) = N_0 e^{-\lambda t} \), and
- \( \lambda \) is the decay constant of the parent isotope, equal to the inverse of the radioactive half-life of the parent isotope, times the natural logarithm of 2.
Earth: Radiometric Dating

- Standard equation for radiometric decay for all isotopes.
- Half-life is the time when the expected value of the number of entities that have decayed is equal to half the original number. (Probability)
- Decay constant determined by “counting” (by mass spectrometer) the number of atoms that have decayed within a period of time.

\[ t = \frac{1}{\lambda} \ln \left(1 + \frac{D}{P}\right) \]

where \( t \) is the age of the rock or mineral specimen, \( D \) is the number of atoms of a daughter product today, \( P \) is the number of atoms of the parent isotope today, \( \ln \) is the natural logarithm (logarithm to base e), and \( \lambda \) is the appropriate decay constant.

(The decay constant for each parent isotope is related to its half-life, \( t^{1/2} \) by the following expression: \( t^{1/2} = \frac{\ln 2}{\lambda} \).)
Earth: Radiometric Dating Assumptions

- Rate of decay is measured with a “Geiger Counter”
- “All rocks and minerals contain long-lived radioactive elements that were incorporated into Earth when the Solar System formed” – USGS. So, assumption is that the solar system is 4.5 billion years old and initial concentrations were known
- Igneous rocks are most suited for radiometric dating.
- Metamorphic rocks may also be radiometrically dated. However, radiometric dating generally yields the age of metamorphism, not the age of the original rock.
- Sedimentary rocks cannot be dated
- “Radiometric methods used today were actually hand-picked to coincide with the dates previously assumed for the geologic column diagrams” – Jan Peczkis
Earth: Dating Assumptions

• The isotope concentrations can be measured very accurately, but isotope concentrations are not dates.

• To derive ages from such measurements, 3 major assumptions are made:

  1. Heritage Assumption – The starting conditions are known (for example, that there was no daughter isotope present at the start, or that we know how much was there – e.g. Big Bang).

  2. Decay Rate Assumption – Decay rates have always been constant and unaffected by other phenomena (temperature, pressure, radioactivity)

  3. Closed System Assumption – Systems were closed or isolated so that no parent or daughter isotopes were lost or added (no leaks)
Earth: Radiometric Dating (USGS)

- Earth rocks – Western Greenland, (4 independent methods) at 3.7-3.8 billion years. Rocks 3.4-3.6 billion years in age have been found in southern Africa, western Australia, and the Great Lakes region of North America. The debris from which the sedimentary rocks formed must have come from even older crustal rocks. The oldest dated minerals (4.0-4.2 billion years) are tiny zircon crystals found in sedimentary rocks in western Australia (tested the igneous rock not sedimentary).

- Moon rocks – These rocks, only a few from Apollo missions at between 4.4-4.5 billion years in age (2 independent methods).

- Meteorites – The majority of the 70 meteorites have ages of 4.4-4.6 billion years (5 independent methods).

- Multiple methods are used on multiple samples to correlate the age.
# Earth: Dating Igneous Rock

<table>
<thead>
<tr>
<th>Rock Sample Obtained From</th>
<th>Known Age from Historical or Archaeological Data</th>
<th>Rocks Age from Radiometric Dating</th>
<th>Method Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunset Crater, Arizona (1085)</td>
<td>1,000 yrs</td>
<td>210,000--230,000 yrs</td>
<td>K/Ar</td>
</tr>
<tr>
<td>Russian Volcano 8</td>
<td>24,000 yrs</td>
<td>50 m.---14.6 b. yrs</td>
<td>K/Ar</td>
</tr>
<tr>
<td>Mt Rangitoto, New Zealand 9</td>
<td>3,300 yrs</td>
<td>485,000 yrs</td>
<td>K/Ar</td>
</tr>
<tr>
<td>Vulcan's Throne, Grand Canyon 10</td>
<td>10,000 yrs max.</td>
<td>114,000--120,000 yrs</td>
<td>K/Ar</td>
</tr>
<tr>
<td>Hualalai Volcano, Hawaii 11,12,13</td>
<td>200 yrs</td>
<td>140 m.---670 m. yrs</td>
<td>Helium</td>
</tr>
<tr>
<td>Hualalai Volcano, Hawaii 11,12,13</td>
<td>200 yrs</td>
<td>160 m.---2.96 b. yrs</td>
<td>K/Ar</td>
</tr>
<tr>
<td>*Mt. Kilauea, Hawaii 14</td>
<td>200 yrs</td>
<td>0 yrs at 1400 meters depth</td>
<td>K/Ar</td>
</tr>
<tr>
<td>*Mt. Kilauea, Hawaii 14</td>
<td>200 yrs</td>
<td>10-14 m.y. at 3420 meters depth</td>
<td>K/Ar</td>
</tr>
<tr>
<td>*Mt. Kilauea, Hawaii 14</td>
<td>200 yrs</td>
<td>13-29 m.y. at 4680 meters depth</td>
<td>K/Ar</td>
</tr>
<tr>
<td>Mt. Etna</td>
<td>2100 yrs</td>
<td>25 million</td>
<td></td>
</tr>
<tr>
<td>Mt. Ngaurhoe, New Zealand</td>
<td>50 yrs</td>
<td>275,000 yrs</td>
<td></td>
</tr>
<tr>
<td>Mt. Etna Basalt, Sicily</td>
<td>30 yrs</td>
<td>350,000 yrs</td>
<td></td>
</tr>
<tr>
<td>Mt. St. Helens</td>
<td>30 yrs</td>
<td>up to 2.8 million</td>
<td>K/Ar</td>
</tr>
</tbody>
</table>
Earth – Decay rates not constant

- Physicist Ernest Rutherford, known as the father of nuclear physics, in the 1930s conducted experiments indicating the radioactive decay rate is constant, meaning it cannot be altered by external influences.

- Astroparticle Physics article (Vol. 37, Sept 2012):
  - Evidence that the phenomenon (radioactive decay) is influenced by the Earth's distance from the sun (e.g. decay rates are different in January and July, when the Earth is closest and farthest from the sun, respectively).
  - "When the Earth is farther away (fewer solar neutrinos) the decay rate is a little slower," Jenkins (Purdue) said. "When we are closer (more solar neutrinos) the decay a little faster."
  - "What this is telling us is that the sun does influence radioactive decay," Fischbach (Purdue) said. Neutrinos have the least mass of any known subatomic particle, yet it is plausible that they are somehow affecting the decay rate, he said.

- "Since neutrinos have essentially no mass or charge, the idea that they could be interacting with anything is foreign to physics," Jenkins said. "So, we are saying something that doesn't interact with anything is changing something that can't be changed. Either neutrinos are affecting decay rate or perhaps an unknown particle is."
Earth: Dating Fossils

- **Age of Organics** – Carbon-14 radiometric dating is used to determine the age of organics (animal and plant) fossils. So, let’s use Carbon-14 dating?

- **Age of Fossils** – Since dinosaur fossils are assumed as millions of years, we can’t use Carbon-14 (carbon-14 half-life is only 5,730 years). But, fossils form in sedimentary rock (sediment quickly covers a dinosaur’s body, and the sediment and the bones gradually turn into rock). So, let’s date the sedimentary rock?

- **Age of Sedimentary Rock** – Radiometric dating doesn’t work with sedimentary rock. So, how do we date the rock? Two choices:
  - Use geologic column based on strata
  - Use nearby layers of igneous rock. To determine the ages of these specimens, scientists use **uranium-238**, **uranium-235** and **potassium-40**, each of which has a half-life of more than a million years. These elements don't exist in dinosaur fossils but in igneous rock (cooled magma/lava).

- **Conclusion** – Either the age of nearby igneous rock or the relative age in the geologic column is used to determine age of dinosaur fossils

- In 1990, a sample of various dinosaur bones were sent to the University of Arizona for a “blind” Carbon-14 dating procedure. The oldest date they got was 16,000 years. (beyond the validity of Carbon 14 dating). Conclusion – “Samples must have been contaminated”
Earth: Young Earth Evidence

- Large numbers of Polonium radio-halos in granite indicate very quick changes in decay rates
- Using carbon-14 dating on fossils, coal, oil, and diamonds (Old-earther’s claim inappropriate method)
- Decay of the earth’s magnetic field (Old-earther’s claim oscillation)
- Canyons have formed rapidly in many locations
- Fossil fuels – Hydrocarbons (primarily coal, oil or natural gas) formed from the remains of dead plants and animals 360-286 million years ago subjected to large pressure and temperature.
  - Coal formation process is not occurring today
  - Oil formation is occurring today
  - Deposits are too large to be from only 2 billion years of life
  - Have been shown to form rapidly in laboratory tests (Argonne labs – 36 weeks)
  - Oil deposits with tree trunks
- Dinosaur blood cells in fossils (Evolutionists claim fossils dated by strata)
- Human remains in the geologic column (Evolutionists claim forgery, extraterrestrials, or erosion between strata)
- Petrified waterwheel of Australia (300,000 yrs old by K/Ar dating)
Petrified water wheel in Australia – Wood that is now rock after 60 yrs
Summary: Earth Formation and Age

- Carbon-14 dating seems to be a valid dating method for all organics (including Dinosaurs, Coal, Oil, Diamonds, etc).
- Questionable validation for U-235 and K/Ar decay constant
- Circular logic for geologic column and fossil record
- Circular logic for age of universe and age of earth
- Evidence exists for old earth and young earth
  - Sedimentary rocks are primarily a result of the Noahic flood (To be discussed later).
  - Fossils represent a certain geographic area and not geologic age; e.g. marine fossils on top of mountain ranges
  - Significant fossil deposition at the flood, combined with high pressures produced fossil fuels
- See Psalm 104 – “The Creation Psalm”
- Next week – origin of life