GEO130 OCEANOGAPHY FILM
STUDY GUIDE

UPDATED 8.28.2014

TITLE: *How The Earth Was Made*, History Channel, 2007

Synopsis: 4.5 billion years ago Earth was an inhospitable planet of seething molten rock. Today it is the only planet (so far) known to be a home of life. Earth planet dominated by its oceans and from space it is a blue planet. This film documents the evolution of our planet from the hellish globe of molten rock to what it is today.

Concepts: Documentaries often "imply" concepts and do not specifically spell them out. This film covers many concepts of which you should be aware here are the ones I deem as important for this class.

1. **Change is normal, stasis is not**. A human lifetime is a microscopic speck on the timeline of Earth history. The slow pace of geologic time is not part of the human life experience as a result we often think of the environment in which we live as unchanging and what Earth was always like.
2. **Earth sciences do not exist in isolation.** This class covers material from meteorology, geology, astronomy, botany, zoology,ecology, physics and oceanography. Scientists now recognize **Earth System Science** which integrates all these.
3. **Co-evolution**. Earth has evolved, the ocean has evolved, so too has the atmosphere and all life on Earth. Scientists now speak of all these evolving together, or co-evolving. This means much more than evolving at the same time. Co-evolution means all parts of the system interact and influence the evolution of the others. Example: as photosyhthetic plants evolved and oxygenated the ocean and atmosphere all three changed. Oxygen created the ozone layer which allowed life to move onto land and in turn new forms evolved. Iron in the ocean was oxidized and the ocean turned from olive green to blue and a new ocean chemistry developed. Carbon was removed from the system as biomass was buried and atmospheric and oceanic levels of carbon dioxide decresed.
4. Change occurs and both the **uniformitarian** and the **catastrophism** views can be used to explain the evidence that exists.
5. **Feedback** - Feedback occurs when a process operates within a system and modifies the system. The modifications can accelerate change (positive or amplifying feedback) or slow change (negative or stablizing feedback). Negative feedback is self-limiting while positive feedback can lead to runaway changes. In the earth-ocean-atmosphere-chryosphere-biosphere climate system runaway positive feedback is illustrated in the "Snowball Earth" era of Earth history.

5. Reader, viewer, buyer beware you cannot believe everything presented. Be especially aware of advocacy journalism.
6. Science is always a work in progress.

- Modern geology began in Scotland with James Hutton's observation of layerd rocks turned vertically under neath horizontal layered rocks.
- Lord Kelvin calculated the age of Earth using thermodynamics. He estimated it was 20 million years old. He did not know about radiaactivity.
- Radiometric dating using the decay of Uranium to Lead pins the age of Earth at 4.5 billion years.
- By 4.4 BYBP there was a relatively thin solid crust

- Young Earth
- 4.0 BYBP - 1st Radical Change: Molten Earth >>> Water World - 90% of surface
- origin of water a mystery, some from outgassing, some from comets
- Young atmosphere – CO_2 and H_20
- CO2 maybe 1000x today's concentration
- a hot (200F) planet with very high atmospheric pressure
- Fe rich seas = green
- CO_2 rich atmosphere = red
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- 3.4 BYBP - 2nd Radical Change Water World >>> Granite Planet
- upsurge of mantle volcanism cracked crust basalt + water >>> granite
- cratons (granitic core of continents.
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- 2.5 BYBP - 3rd Radical Change green ocean and red atmosphere >>> blue planet
- continents growing >>> changed Earth >>> near shore shallow water environments
- stromatolites - algae mats, green plants, world wide blossoms, **photosynthesis >>> O_2**
- discovered at Shark Bay, Australia
- stromatolites also secrete $CaCO_3$ (calcium carbonate) which removes CO_2 from the system
- Here is where the film was wrong.
- Oxygen did in fact dilute the carbon dioxide but for the greenhouse effect to be reduced and the pressure to be lowered CO_2 had to be removed from the system.
- How did that happen?
- Photosynthesis created biomass, primarily calcium carbonate shells that were buried removing carbon and
- Granite continental crust weathered and the chemical reaction lead to precipitation of calcium carbonate in the ocean.
- At the same time photosystnesis also released oxygen causing the iron to oxidize and the ozone layer to form and allowing for the future evolution of oxygen based metabolism.

- Scientific Revolution – meteorologist Alfred Wegner – continental drift
- he was laughed at because there was no known mechanism to move a huge continent, SCIENTISTS:Open minded and skeptical..
- Scientific Breakthrough – WWII – U.S. Navy charted the sea floor
- mid-ocean ridges – new crust created
- plates – cracked crust
- mantle convection currents moved the plates
- material destroyed and recycled at subduction zones.
- In Iceland the Mid Atlantic Ridge separates about 1" per year

- 1.0 BYBP
- Rhodinia – lifeless supercontinent at the south pole
- life was blooming in oxygenated ocean water
- great removal of carbon from system

- 700 MYBP
- Snowball Earth, still not completely accepted
- continent at south pole >>> cold
- removal of carbon dioxide >>> weaker greenhouse effect >>>cold
- sun still relatively weak >>> cold
- ice-albedo feedback – ice reflects sunlight >>> colder >>> more ice >>> more reflection >>> accelerating feedback (called positive feedback).
- life almost extinguished

- 650MYBP
- -40°F average Earth temp.
- How did Earth recover?
- Rhodinia breaking up – volcanism adds CO_2 to atmosphere >>> greater greenhouse effect
- heat building under thick ice

- 550MYBP
- shallow seas open
- oxygen increasing
- complex life forms had evolved
- Burgess Shale – discovered 08.31.1909 – Canadian Rockies – fossils of Cambrian explosion

- 400 MYBP >>> 300 MYBP
- continents converge – Tropical Earth
- Carboniferous – age of great vegetation, coal, oil natural gas from this

- 250MYBP
- mantle plume eruption – Siberia (Siberian traps) – the word traps from the Swedish "trappa" for stairs referring to the step like hills in the regions landscape.
- Lasted for 1 million years
- 1 million cubic miles of material, enough to bury the U.S. under 1000 ft. of material
- 95% of species became extinct.

- 240 MYBP
- new super continent Pangaea
- Dinosaurs = "terrible lizard"

- 180MYBP
- Pangaea breaks up >>> evidence is diamond mines in S. Africa >>>very violent eruptions
- CO2 up 500% >>> greenhouse gone wild
- tropical Earth >>> all the way to the poles >>> dinosaur planet

- 65MYBP
- dinosaurs gone (maybe – today's birds may be their descendants)
- 70% of species became extinct at the K-T Boundary (Cretaceous-Tertiary)
- rare mineral iridium inj a layer world wide discovered by father and son team Walter ande luis Alverez
- Death from above >>> asteroid impact, 6 mi. diameter hit near Cancun travelling at 20 km/sec = 43,000 mph
- crater 100 miles wide blew debris into the air, blotted out the sun
- at the same time in India Deccan Traps – not as big as Siberia

- 50MYBP
- the age of mammals -
- Alps built – from continental collisions
- Grand Canyon – from uplift and down cutting

- 2MYBP
- multiple ice ages begin

- 10,000 years BP
- last ice advance ends, rapid melting begins

- MID 1700'S
-industrial revolution
-increasing use of fossil fuels
-increasing length of life span
-increasing numbers of people
-life once again making major modifications to Earth systems
-**human activity rivals appearance of photosynthesis and carbonate shells in impact**