

Absolute Age Dating

- Relative age dating just says that one rock unit or geologic event is younger or older than another
 - Dave is older than Steve
- Absolute age dating gives a number to the age
 - Dave is 89 years old and Steve is 12 years old

Early attempts at the age of the Earth

- **Bishop Ussher (1650)**
- Used ages and overlaps of biblical personalities to calculate back to the time of creation
- Creation of the world was pronounced to occur in the year 4004 B.C.

Rate of sedimentation

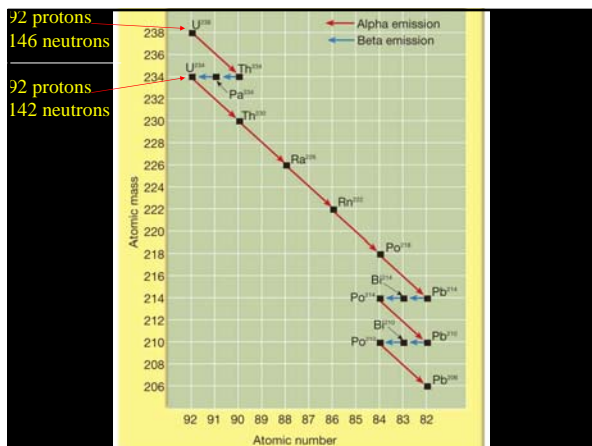
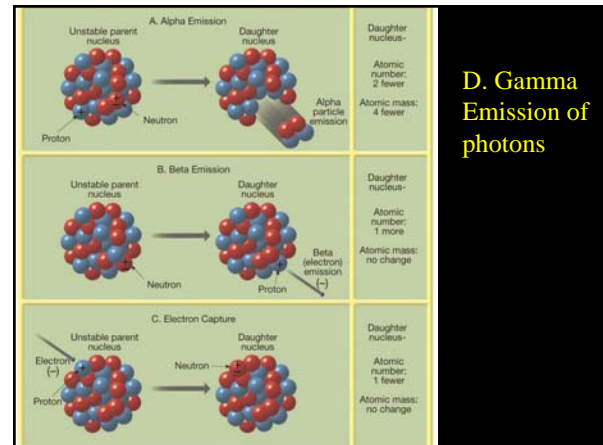
- Determine the rate of sedimentation and divide it into the total thickness of sediment on the Earth
 - Different sediments accumulate at different rates
 - No single location has a complete geologic column
 - Sediment compacts when it lithifies
- Ages calculated ranged from 3 million to 1.5 billion years

Ocean Salinity

- Assume ocean to begin as fresh water
- If amount of salt being transported to the ocean can be calculated, the concentration of salt in the ocean can be used as a measure of the Earth's age
 - Neglected salt removed from ocean by deposition and wind
- Haley and Joly both reached an age of about 90 Million years using this technique

Thermodynamic cooling rate

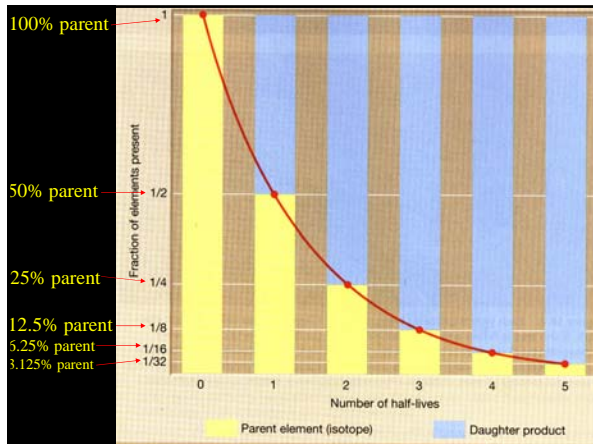
- Lord Kelvin used thermodynamics that required few assumptions and based on precise measurements
- Assume Earth starts as molten and cooled to its present condition
- Calculations made it obvious that the Earth could not be older than 100 million
 - Did not know about heat added to Earth by radioactive decay



Half Life ($t_{1/2}$)

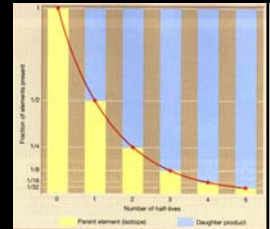
Time for half of a population of parent atoms to decay to their daughter product.

- Uranium-238 → Lead-206 4.5 Billion yrs
- Uranium-235 → Lead-207 713 Million yrs
- Thorium-232 → Lead-208 14.1 Billion yrs
- Rubidium-87 → Strontium-87 47.0 Billion yrs
- Potassium-40 → Argon-40 1.3 Billion yrs
- Carbon-14 → Nitrogen-14 5730 years



Date calculations

- Assume system starts with 100% parent and 0% daughter
- Given the half life is 10 million years, what is the calculated age for the following
 - 50% parent remaining
 - 25% parent remaining
 - 12.5% parent remaining
 - 6.25% parent remaining
 - 3.125% parent remaining



Atomic dating assumptions/requirements

1. Rock or mineral system is closed
2. Initial ratio of parent to daughter must be determined
3. Half life must be constant through time
4. Measurements of parent and daughter must be accurate (need minimum amt)
5. A realistic value must be applied to daughter amount (can't be too small)

Useful Systems

- Uranium -> Lead
 - U is an incompatible element that is concentrated in late-stage granitic crust
 - Long half life, good for old continental rocks
- Rubidium -> Strontium
 - Rubidium has the same charge and similar ionic radius as Potassium
 - Good for dating Kspar and micas in old continental crust

Useful Systems

- Potassium -> Argon
 - Potassium is abundant; half life = 1.25 b.y.
 - Must guard against argon loss
- Carbon-14
 - Can date any *young* materials with carbon
 - Short half life; rule of thumb yields dating range back to about 30,000 y

Feasibility of rock types

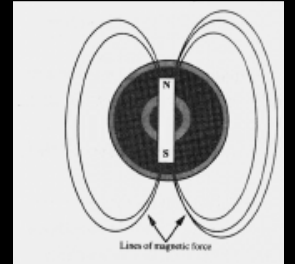
- Sedimentary usually not possible
 - Made of particles of varying ages
- Metamorphic may work but must be careful
 - Can get both time of crystallization and metamorphism in some cases
- Igneous is the best rock type for radiometric dating
 - Ash beds very useful due to the large areas they cover

Apollo 11 - High-K basalt

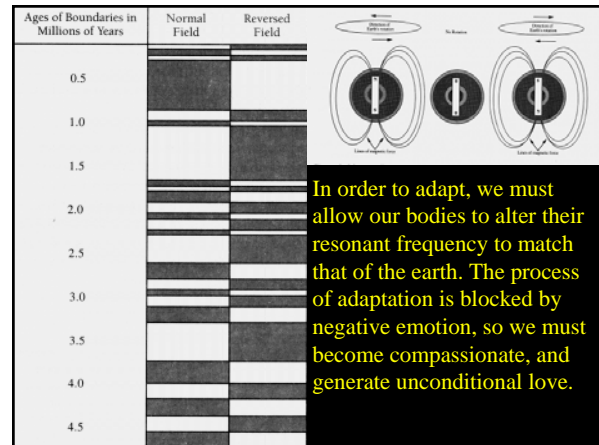
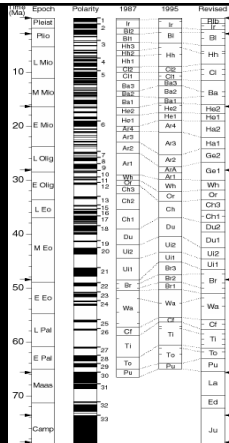
Technique	Age (in billions of years)
40Ar/39Ar whole rock	3.49 +- 0.05
40Ar/39Ar whole rock	3.52 +- 0.04
40Ar/39Ar plagioclase	3.57 +- 0.05
40Ar/39Ar plagioclase	3.56 +- 0.06
40Ar/39Ar ilmenite	3.58 +- 0.05
40Ar/39Ar pyroxene	3.55 +- 0.05
Rb-Sr isochron	3.57 +- 0.05
Sm-Nd isochron	3.57 +- 0.03

Magnetic Reversals

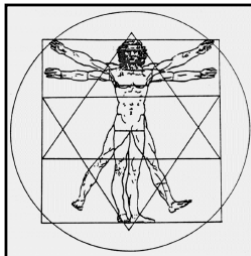
- Earth has a magnetic field
- Atoms of Iron act like individual atoms
- When temperature drops below 500 degrees C the Iron lines up with Earth's magnetic field



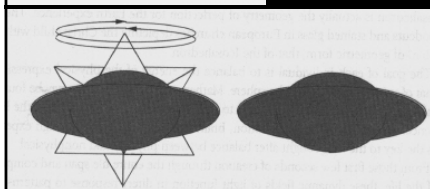
- Rocks have been found with reversed polarity
- Only good explanation is that the Earth's magnetic field has reversed
- Use of absolute age dating allows a magnetic reversal time scale



In order to adapt, we must allow our bodies to alter their resonant frequency to match that of the earth. The process of adaptation is blocked by negative emotion, so we must become compassionate, and generate unconditional love.



Shortly before Earth Shift, some people may achieve resonance in advance of the mass of humanity, and their "mer-ka-ba fields" - counter-posed tetrahedronal fields - will counter-rotate and merge to form a saucer-shaped light body, carrying those people into the fourth dimension. This is the



Rapture. Sacred sites are places of a low magnetic field, allowing an easier-alteration.

Some of the oldest rocks on earth are found in Western Greenland. Because of their great age, they have been especially well studied. The table below gives the ages, in billions of years, from twelve different studies using five different techniques on one particular rock formation in Western Greenland, the Amitsoq gneisses.

Technique	Age Range (billion years)
uranium-lead	3.60±0.05
lead-lead	3.56±0.10
lead-lead	3.74±0.12
lead-lead	3.62±0.13
rubidium-strontium	3.64±0.06
rubidium-strontium	3.62±0.14
rubidium-strontium	3.67±0.09
rubidium-strontium	3.66±0.10
rubidium-strontium	3.61±0.22
rubidium-strontium	3.56±0.14
lutetium-hafnium	3.55±0.22
samarium-neodymium	3.56±0.20

(compiled from Dalrymple, 1991)

Note that scientists give their results with a stated uncertainty. They take into account all the possible errors and give a range within which they are 95% sure that the actual value lies. The top number, 3.60±0.05, refers to the range 3.60±0.05 to 3.60-0.05. The size of this range is every bit as important as the actual number. A number with a small uncertainty range is more accurate than a number with a larger range. For the numbers given above, one can see that all of the ranges overlap and agree between 3.62 and 3.65 billion years as the age of the rock. Several studies also showed that, because of the great ages of these rocks, they have been through several mild metamorphic heating events that disturbed the ages given by potassium-bearing minerals (not listed here). As pointed out earlier, different radiometric dating methods agree with each other most of the time, over many thousands of measurements. Other examples of agreement between a number of different measurements of the same rocks are given in the references below.

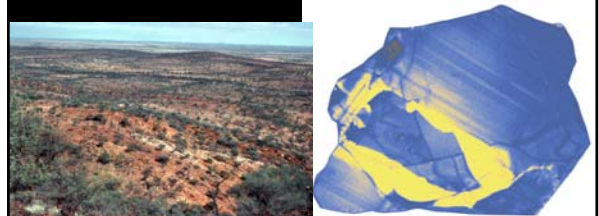
Oldest Rocks Found on Earth

- Acasta Gneiss from the Canadian Shield (NW Territories near Great Slave Lake)
- 4.055 Billion years old (505 My after Earth origin)
- Previously oldest rocks from Greenland (lightly metamorphosed ss/sh) at 3.8 billion



Oldest Mineral Found on Earth

- A zircon crystal from the Jack Hills of Western Australia has been dated at 4.4 Ga
- Gives evidence of water



Must look for:
Relatively unmetamorphosed
Black
Fine grained (chert)
Life-like shapes and size
Proper carbon isotope ratio

