# Earth (*Terra*)


## Basic information

Density (avg): 5.5 g/cm$^3$

Distance from Sun (avg): 1.0 AU

Orbital Period: 365.25 days

Rotation Period: 1 day

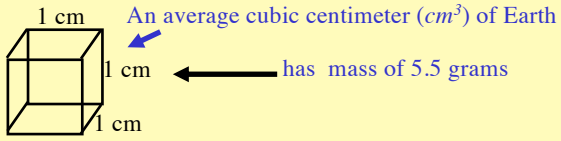
Albedo: ~0.30 ***Q:*** What is this?

Moons: 1

Atmosphere: yes

Axial tilt (relative to Sun): 23.5º

- ***density = mass/volume*** *(Earth: 5.5 g/cm$^3$)*

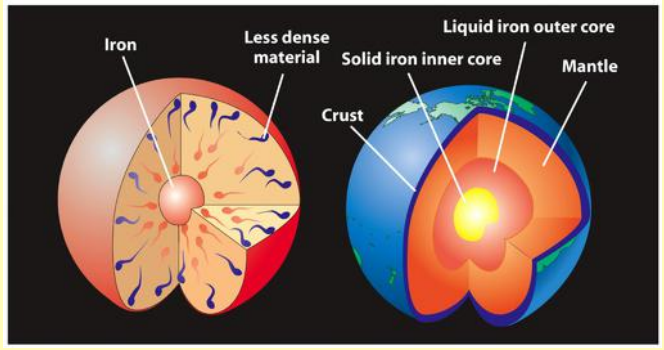



- *surface rocks: densities of 2 - 3 g/cm$^3$*
- *conclusion:* surface rocks *not very* dense **so** interior *must* be *very dense (iron, nickel)*

***Q:*** *How do we know the composition of interior?*

- study of *waves* from *earthquakes* (***geophysics***)
- study of ***meteorites*** - contain *iron, nickel*

## Interior Structure

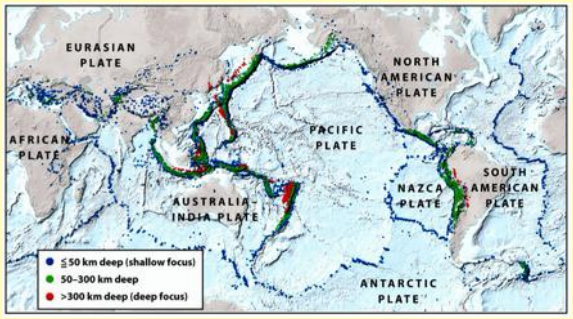



- ***differentiation*** *(separation by density)* due to impact & radioactive heating yields *Earth's layers*

# Plate Tectonics

• ***crust*** is *divided* into regions (***plates***) floating on the ***mantle***; *move* relative to each other (*1960's*)

• *two* major types of plates: ***continental*** & ***oceanic***




• plates moving *away from each other*
• *result:* ***rifting*** (land), ***sea floor spreading*** (ocean)

***(eg)*** mid-ocean ridges, Red Sea/Great Rift Valley

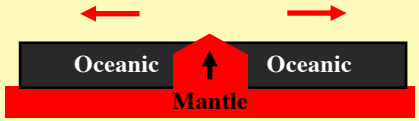
• ***subduction***: *oceanic* moving *under continental*
• *result: deep* earthquakes, coastal volcanoes

***(eg)*** Vancouver, Seattle (Cascadia)

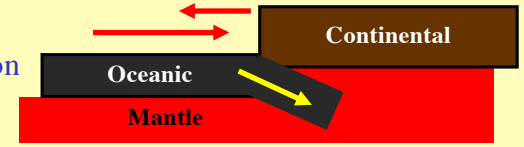
• *continental* plates *running into* each other
• *result: tall* mountains

***(eg)*** Himalayas

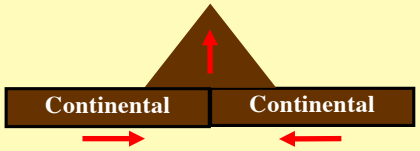
***(eg)*** mid-ocean rifting




***(eg)*** subduction




***(eg)*** continental collision



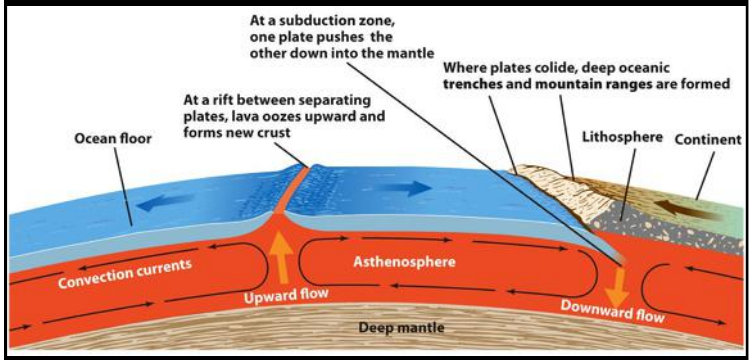

• plates *sliding past each other*
• ***transform*** motion

• result - *shallow* earthquakes

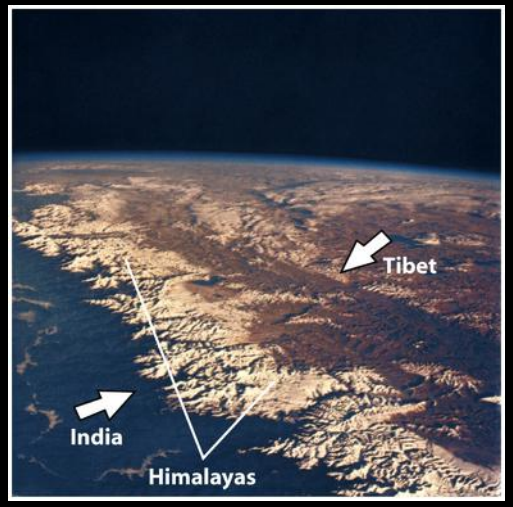
***(eg)*** San Andreas Fault

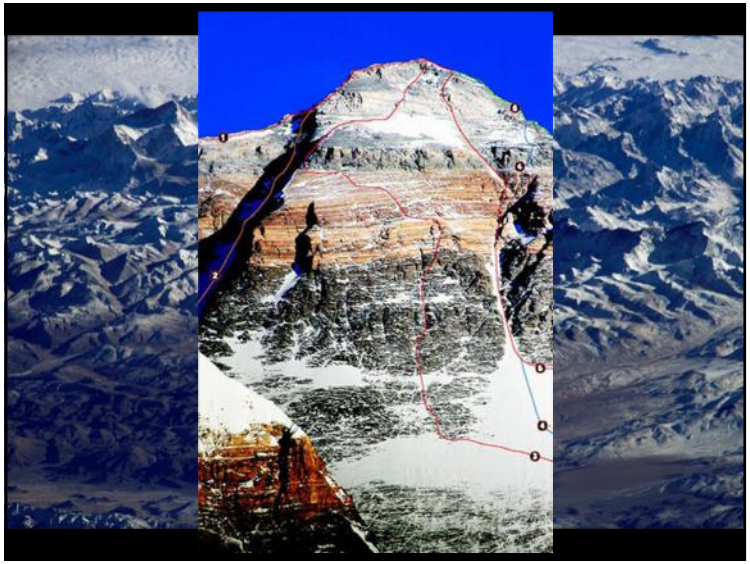

• ***surface*** continuously *altered* by plate motions

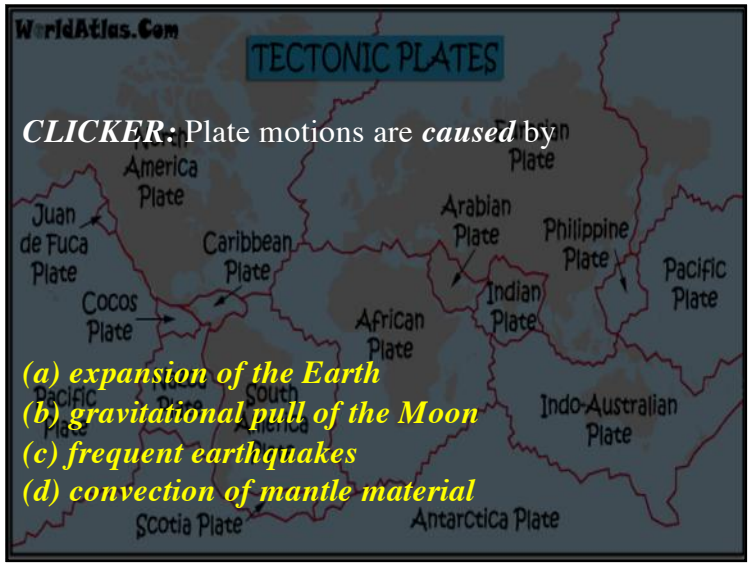
# Plate Tectonics




# Mid-Atlantic Ridge

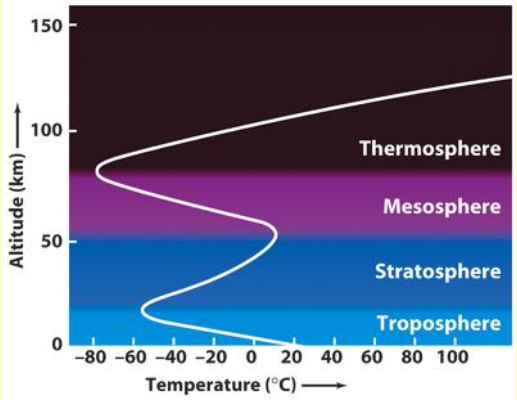





# Earth's Atmosphere

• *layers* based on *change of temperature* with *altitude*




***Troposphere**: up to ~11 km*
- *contains all mountains, weather, 75% of particles in atmosphere*

***Stratosphere**: 11 - 50 km*
- *contains ozone layer ($O_3$)*
- *airplanes cruise here*

***Mesosphere**: 50 - 80 km*
- *atmosphere is very thin & cold*

***Thermosphere**: 80 - 150 km*
- *Sun's UV radiation ionizes the gas which reflect radio waves (AM radio)*
- *aurora occur here*

# A Long Drop!

***(eg) Col. Joe Kittinger, 1960***
- *~31 km (100,000')*
- ***Felix Baumgartner, 2012***
- *~39 km (128,000'); v ~ 1357 kph*
- ***Alan Eustace, 2014***
- *~41km (136,000'); v ~ 1322 kph*

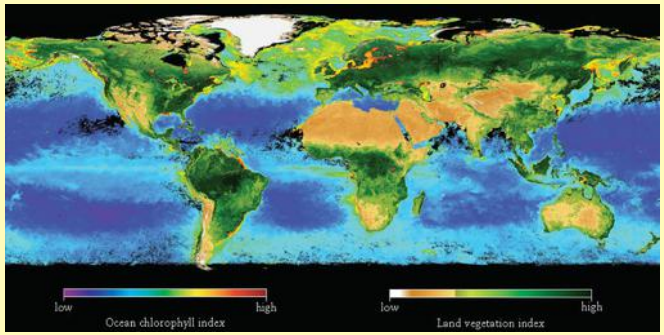
# Atmospheric Evolution

- ***original*** atmosphere: ***H***, ***He***
- heavy *volcanism:* ***$CO_2$***, ***$N_2$*** & ***$H_2O$***
- atmosphere *100x denser*

| | Venus | Earth | Mars |
|---|---|---|---|
| Nitrogen ($N_2$) | 3.5% | 78.08% | 2.7% |
| Oxygen ($O_2$) | almost zero | 20.95% | almost zero |
| Carbon dioxide ($CO_2$) | 96.5% | 0.035% | 95.3% |
| Water vapor ($H_2O$) | 0.003% | about 1% | 0.03% |
| Other gases | almost zero | almost zero | 2% |

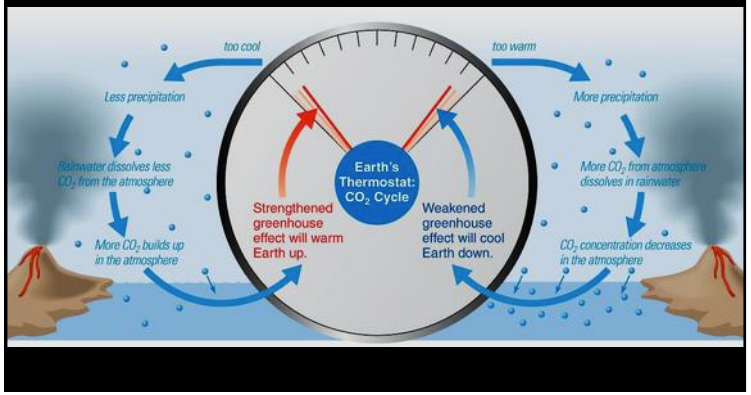
***Q:*** *Why is it so different from what it was?*

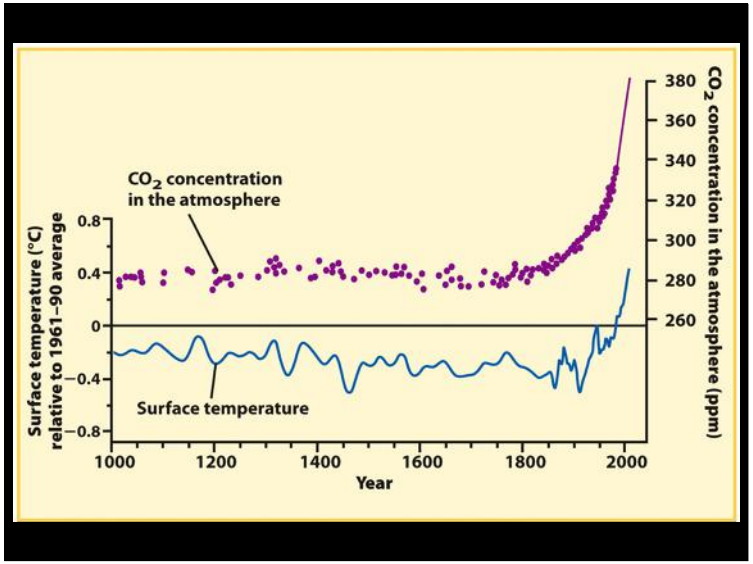
- *oceans* and *life* (***stromatolites***: *~ 3.5+ Gy* ago)




- *oceans absorb* ***$CO_2$*** & form ***carbonates***
- *plant life* (algae, etc.) ***absorb $CO_2$***, ***emit $O_2$***

# $CO_2$ moderation






***CLICKER:***
***Where did the $CO_2$ in Earth's atmosphere go?***

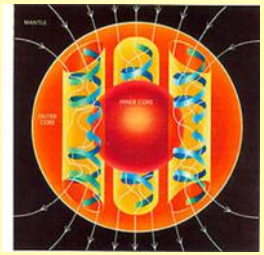
***(a) nowhere –Earth's original $CO_2$ is still all there***
***(b) it escaped into space***
***(c) it froze into icecaps at the Earth's poles***
***(d) it was dissolved in the oceans & stored as rock***

# Magnetic Field

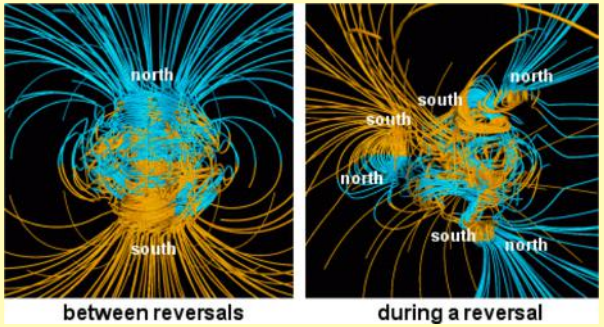
- ***Dynamo Theory***: formation of the ***magnetic field***
- *conducting material* (*ions*) ***convect*** within ***outer liquid core*** due to *heating* & *fast rotation* of Earth
- *moving charge* creates a *current* which creates *magnetic field*

***DEMO:*** magnetic induction

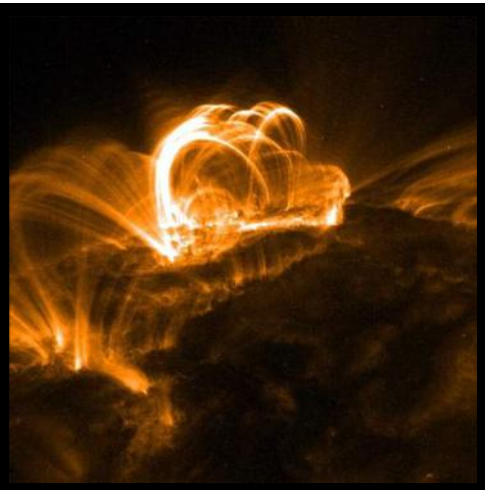
- convection is ***unstable*** due to *uneven heating by solid core*



- Earth's field ***resembles*** that of a *bar magnet*



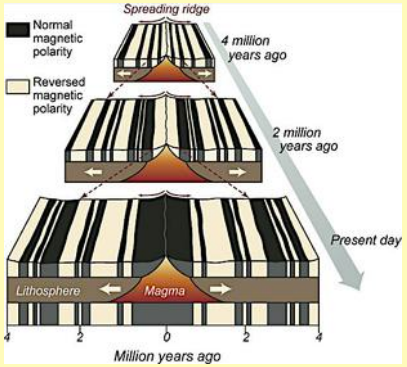

- ~ *300,000 years* the magnetic poles ***flip*** or *reverse*
- during ***reversals*** *field strength ~ 10%* of normal
- ***reversals*** take ~ *1000 years*

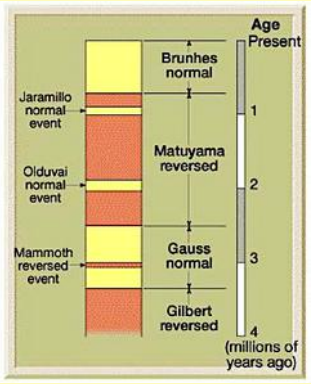


***(eg)*** *tangled magnetic fields visible on the Sun*

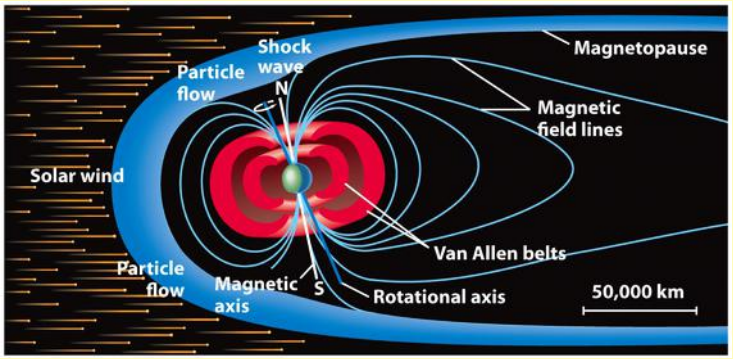
- curent field orientation ~ *750,000 years old*

***Q: How*** do we ***know*** this?




- ***solar wind*** (*charged particles from the Sun*) ***interacts*** with Earth's ***magnetic field***




- **charged** particles *follow magnetic field lines*

Northern & Southern Lights
(***Aurora Borealis*** & ***Australis***)

# Aurora from space