

Preconceptions



[Scrat's Continental Crack-Up](https://www.youtube.com/watch?v=g_IYQdKkWsU&feature=youtu.be)

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What did they get wrong?



What global mechanisms control geology?



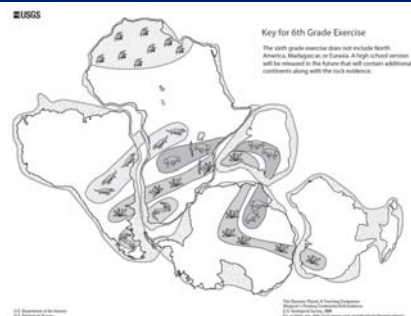
Thinking about continents...

- 1596
 - ▣ Cartographer Abraham Ortelius
 - ▣ Questioned idea that continents have always been where they are
- 1620
 - ▣ English scientist Francis Bacon
 - ▣ Noticed the puzzle piece nature of Africa and South America

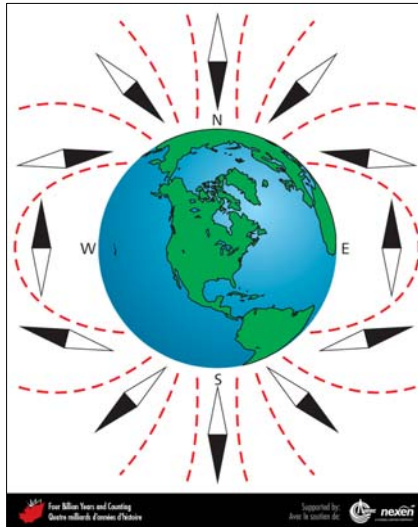


Continental Drift Theory

- 1910
 - ▣ American geologist Frank Taylor
 - ▣ Suggested mountains are due to movement of continents
- 1912
 - ▣ German meteorologist Alfred Wegener
 - ▣ Continental drift theory and the supercontinent Pangea
 - ▣ Distribution of fossils
 - ▣ Resemblance of geological structures
 - ▣ Distribution of ancient glacial deposits found near equator

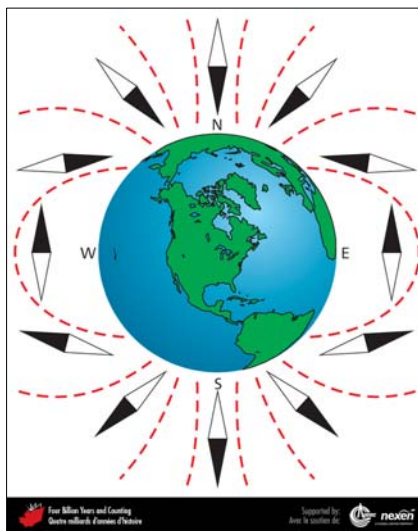


Magnetic Proof



- Proof of continental drift
- 1950s
- Earth has a magnetic field, resembling a dipole magnet
- Iron-bearing minerals cooling in the Earth preserve the inclination of this magnetic field

Magnetic Proof



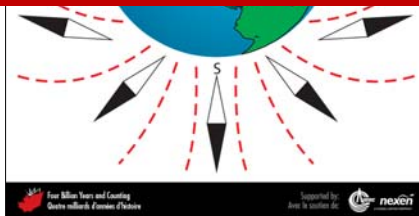
- Inclination is dependant on latitude of mineral at time of cooling
- Using rocks of same age on different continents, we can place the continents in there original location

Magnetic Proof



- Inclination is dependant on latitude of mineral at time of cooling

**But how do the continents move?
By what mechanism?**



Four Billion Years and Counting
Quatre milliards d'années d'histoire

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Mapping the Seafloor

- 1950s
- Laying of submarine telephone cables
- Detection of 65,000km long ridge in Atlantic Ocean
- Detection of deep continuous trenches encircling Pacific ocean



WILLIAM CRAWFORD / IOOP

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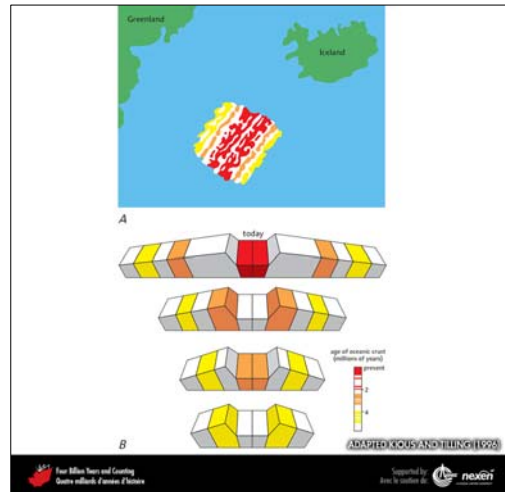
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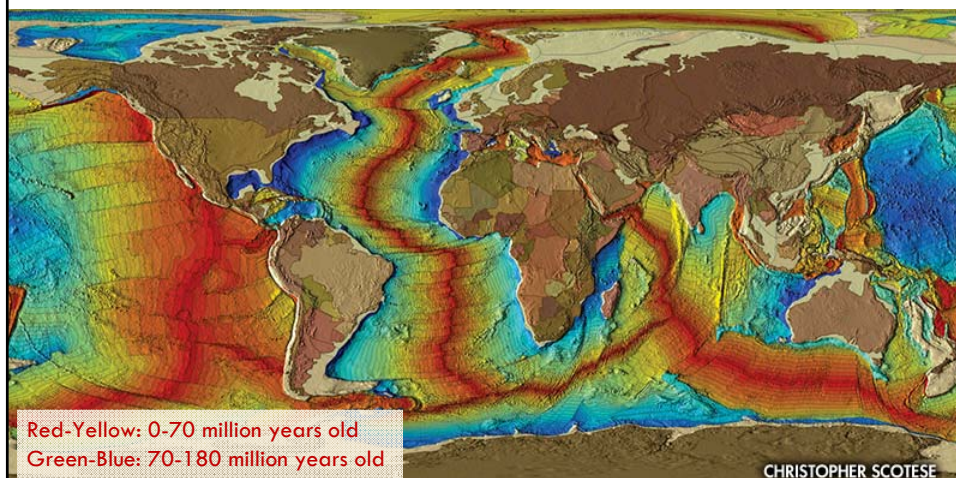
Mapping the Seafloor

1960s

- Sea floor drilling - ocean floor is primarily basalt with a thin sediment layer
- Magnetometers measured magnetic polarity of ocean floor
 - Notice of stripes parallel to ridge
 - Magnetic reversals
 - Symmetrical across ridge
- Conveyor belt like process



Age of the Seafloor



Red-Yellow: 0-70 million years old
Green-Blue: 70-180 million years old

CHRISTOPHER SCOTSE



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Seafloor Spreading

□ 1962

- ▣ American geologist Harry Hess
- ▣ Oceanic ridge lies above diverging upwelling currents of convection cells in the mantle
- ▣ Currents spread laterally at base of lithosphere
- ▣ Pulling apart lithosphere – intruded by mafic magma
- ▣ Pushing older seafloor away from ridge

***BUT... oldest seafloor is only 180 million years old?
Where did the older crust go?***

CHRISTOPHER SCOTT SE



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Oceanic Trenches of the Pacific



- Japan
 - ▣ Many recorded earthquakes
 - ▣ Active volcanoes
 - ▣ Deep oceanic trench
- Western coast of South America
 - ▣ Many recorded earthquakes
 - ▣ Active volcanoes
 - ▣ Deep oceanic trench

Oceanic Trenches of the Pacific



- Japan
 - ▣ Many recorded earthquakes
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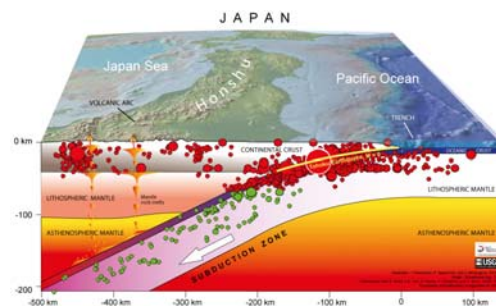
In-class exercise – Earthquake Evidence and Plate Boundaries



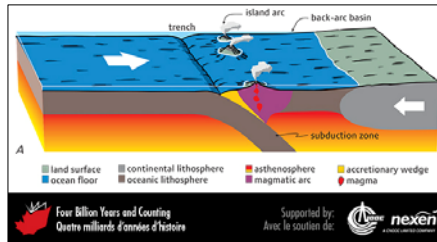
- ▣ Many recorded earthquakes
- ▣ Active volcanoes
- ▣ Deep oceanic trench

Japanese Earthquakes

- 1928
- Geophysicist Kiyoo Wadati
- Maps the depth and location of epicenters of earthquakes
- Discovered an inclined surface sloping 60° beneath the Japanese Island, and beginning at the base of the deep trench



Subduction



- Earthquakes result of downward movement of ocean floor on large scale reverse faults
- Older seafloor sinks into the mantle along these subduction zones

Transform Faults

- Early 1960s
- Canadian researcher Tuzo Wilson
- Large scale seismically active transform faults
- Truncating and offsetting ridges and subduction zones

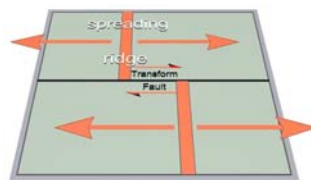


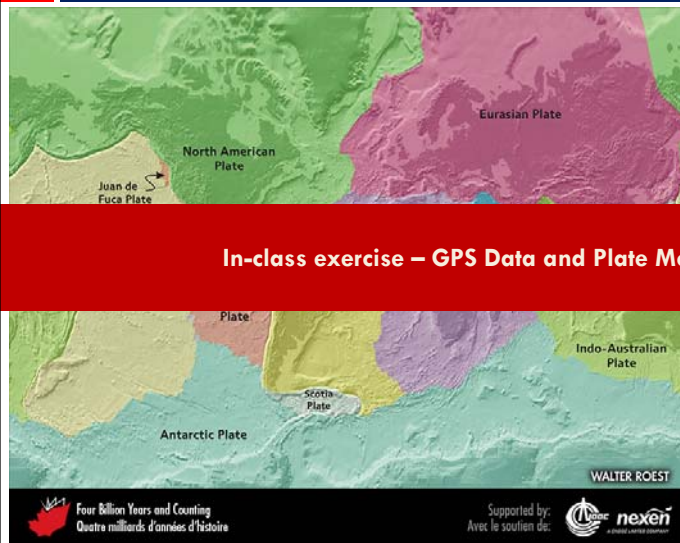
Plate Boundaries

<https://www.youtube.com/watch?v=Z1b3yNqlfKw>



- Earth divided into rigid lithospheric plates
- Boundaries defined by transform faults, spreading ridges and subduction zones
- Plates are constantly moving relative to each other

Plate Boundaries



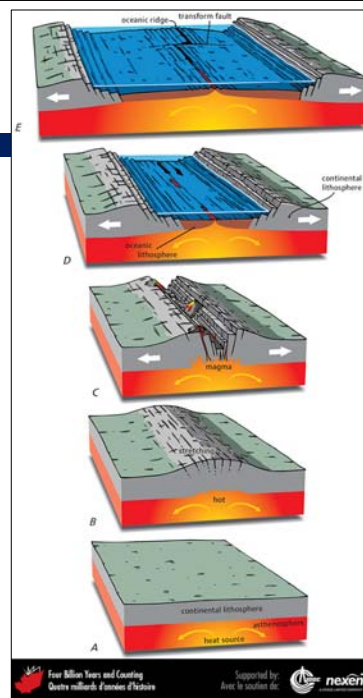
In-class exercise – GPS Data and Plate Motion

- Earth divided into rigid lithospheric plates
- Boundaries defined by transform faults, spreading ridges and subduction zones
- Plates are constantly moving relative to each other

Divergent Boundaries

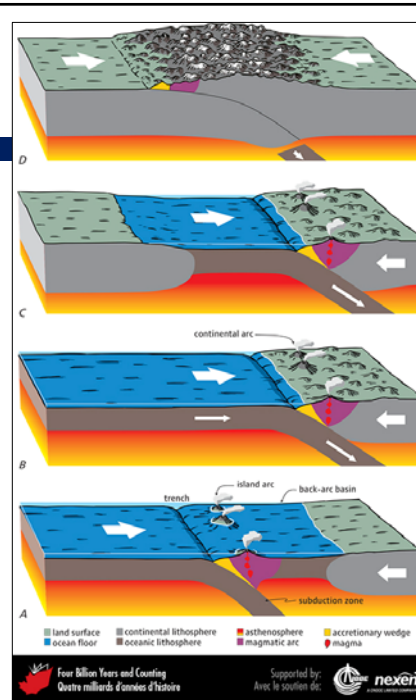
Rifting

- A. Upwelling heat from mantle
- B. Doming of continental land
- C. Rifting and extrusion of magma
- D. Small ocean basin formed
- E. Large ocean basin with a mid-ocean ridge



Convergent Boundaries

- Ocean-ocean convergence
 - Island Arcs
 - Ex: Japan
- Ocean-continent convergence
 - Continental Arc
 - Ex: Andes in S. America
- Continent-continent convergence
 - Mountain belts – orogens
 - Ex: Himalayas



Mountain Building - Orogenesis

<https://www.youtube.com/watch?v=d9bKXY0OMxc>

Plate Tectonics – A Summary



- Unifying theory that took centuries to develop
- Describes the mechanisms by which the geology we see today is created
 - Earth is divided into rigid lithospheric plates which are constantly moving relative to each other
 - Plate movement is driven by convection in the mantle
 - Plate boundaries are either convergent (subduction and mountain building) or divergent (rifting and mid-ocean ridges)