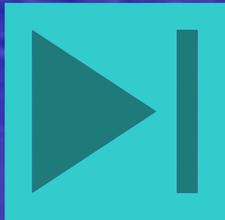


PLATE TECTONICS THEORY

Continental drift

Sea floor spreading

SEA FLOOR SPREADING



SURFACE FEATURES OF THE EARTH

A- CONTINENTAL MARGINS.

They are active (Earthquakes and volcanoes) or inactive passive (aseismic).

It includes:

- 1-continental shelf
- 2- continental slope
- 3- continental rise

B- OCEAN BASIN FLOOR

- 1- Abyssal plains.
- 2- Submarine mounts, gouets
- 3- Trenches
- 4- Oceanic ridge



PALAEOMAGNETISM (ROCK MAGNETISM)

Some mineral (paramagnetic minerals) capable to retain a record of the past direction of the earth's magnetic field. It contains atoms possess an odd number of electrons.

* magnetic fields are generated by the spin and orbital motions of the electrons.

- **Induced magnetization**: when paramagnetic material placed in a weak external magnetic field (Earth), the atomic poles rotate to become parallel to the external field.

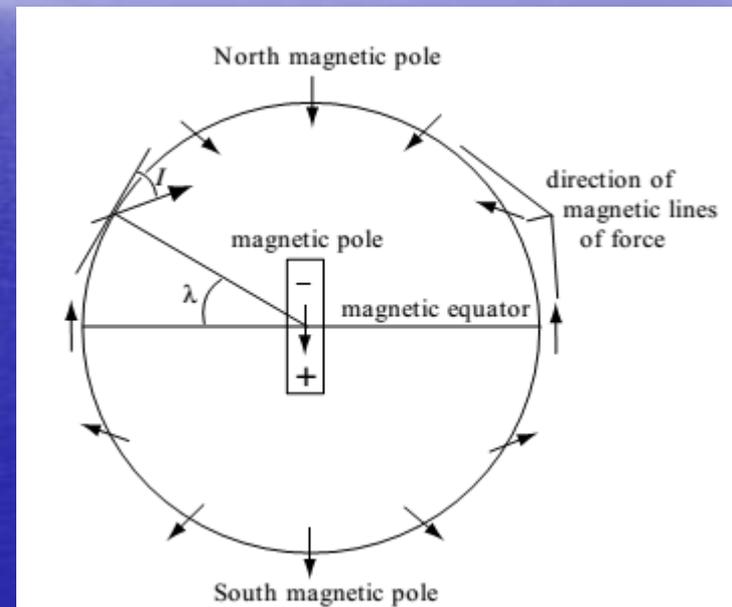
Ferromagnetic: contain large number of unpaired electrons that develop magnetic domains. Below **Curie temperature** (580°C) which is temperature above which the energy level prohibits interatomic magnetic bonding.

- **Remnant magnetism**: after removal a preferred direction it resulting and retained. (CRM, TRM, SRM)

Relation between Inclination (I) and Latitude (λ)

$$I = \tan^{-1} (2 \tan \lambda)$$

$$\lambda = \tan^{-1} [(\tan I)/2]$$



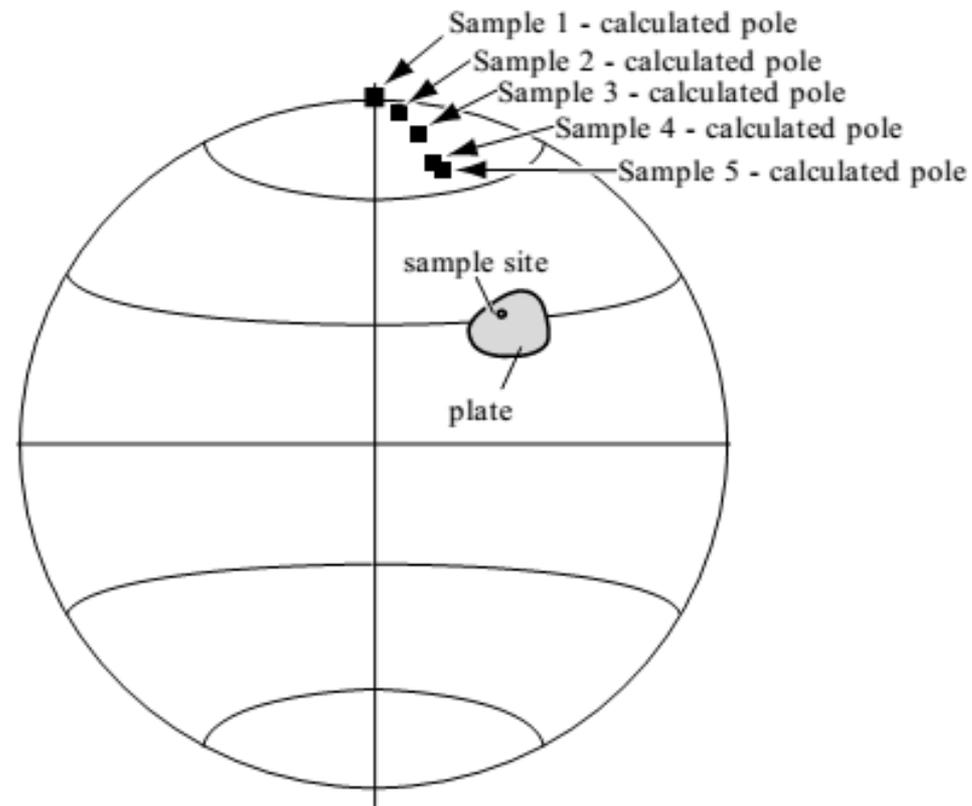
Determine the inclination of the earth's magnetic field at the following latitudes:

20°N

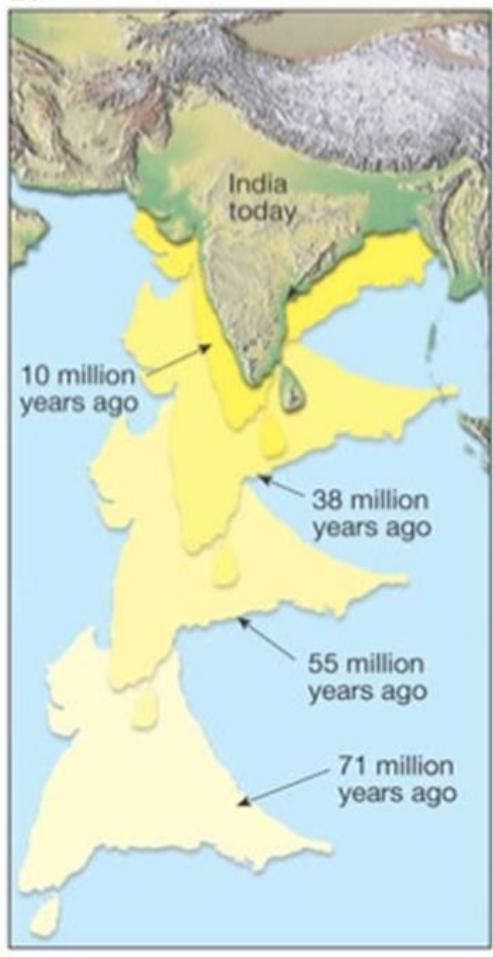
45°S

78°N

10°S.

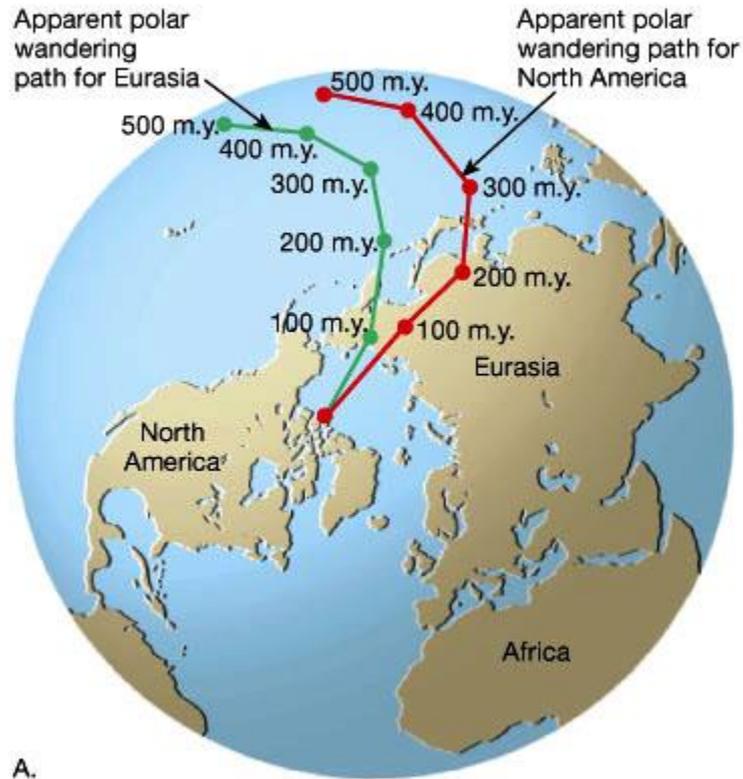


Sample number	Age (Ma)	Inclination (degrees)	Paleolatitude (degrees)	Minimum rate (mm/year)
1 (present position)	0	49	30	44
2	15	55	36	56
3	25	60	41	67
4	40	67	50	22
5	45	68	51	



If a plate moves from a high-latitude position toward the equator over time, younger rocks will show progressively more gently plunging magnetic inclinations. In this case, from the point of view of a “fixed” plate, the calculated paleomagnetic poles from progressively younger samples would appear to move “away” from the plate or northward in the northern hemisphere. This apparent movement of paleomagnetic poles is termed **apparent polar wander**. Conversely, if a plate moves poleward from equatorial latitudes with time, younger rocks will show progressively steeper magnetic inclinations. By studying systematic changes in magnetic inclination through time, paleomagnetists can track the north–south motion of a plate.

APPARENT POLAR WANDERING CURVES (APW)



SEA FLOOR SPREADING

Proposed by Hess 1961, Dietz 1962 (to explain cont. drift).

They performed a magnetic anomaly map over ocean.

* It indicates a uniform patterns of stripes (+ve and -ve anomalies):

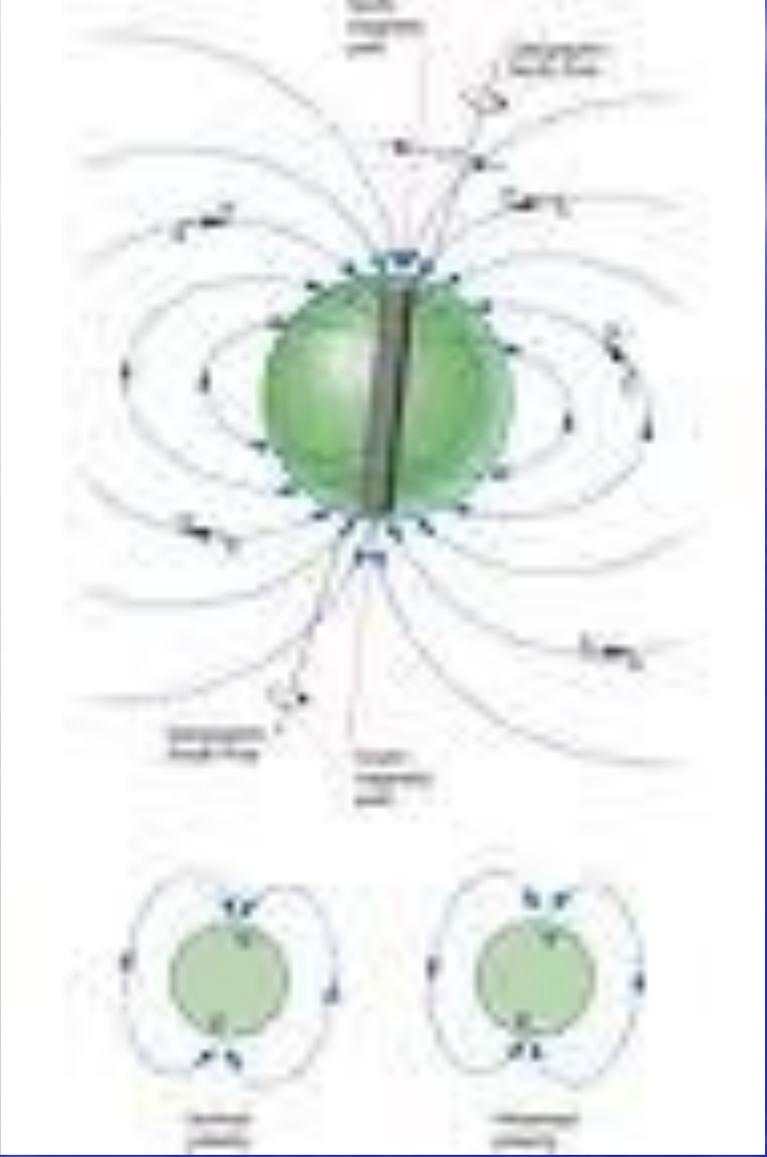
- Trend for hundreds of kms.
- Present in all oceanic areas and 10 – 20 km wide.
- Parallel to the crests of the mid oceanic ridge
- Symmetrical about the ridge axis.

Geomagnetic reversal

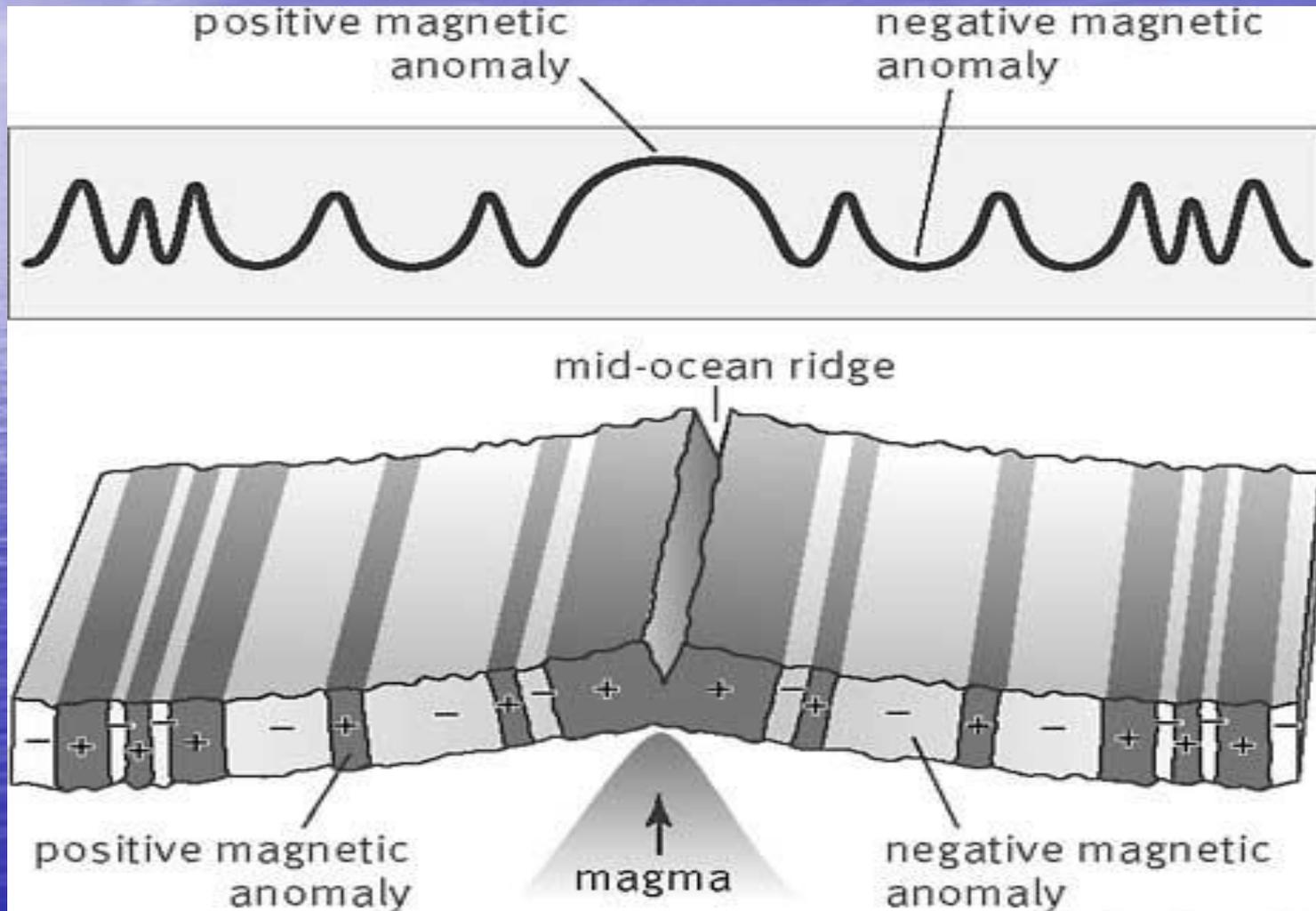
Magneto–hydro dynamic process:

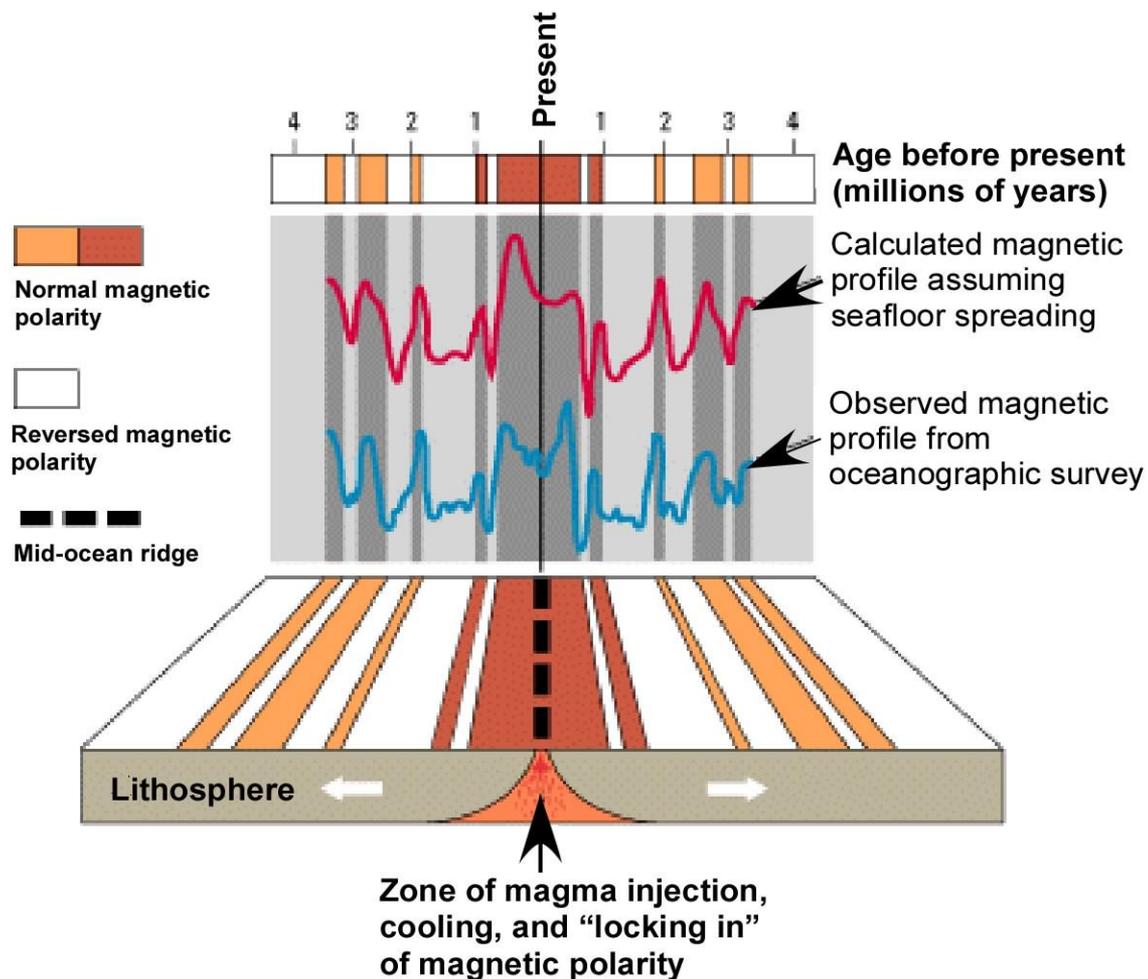
rotating mobile fluid in the outer core which is a good electrical conductor. convecting fluid acts as a dynamo and generates electric current which create magnetic field (complex model).

- Fuller (1987) points to that reverse magnetism occurs in localized regions of the core.
- Localized development of reversal magnetic flux:
 - Reverse originate in some parts of the southern hemisphere.
 - There is a progressive decrease and needs about 5000 years.
 - * Periodicity is highly variable.
- In the last 100 years, scientists notice that the strength of Earth magnetic field less 5 %



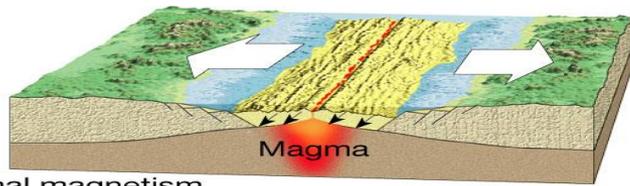
Magnetic reversal



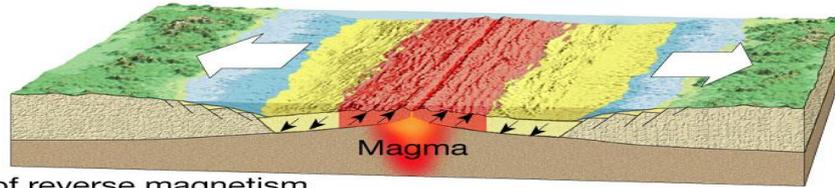


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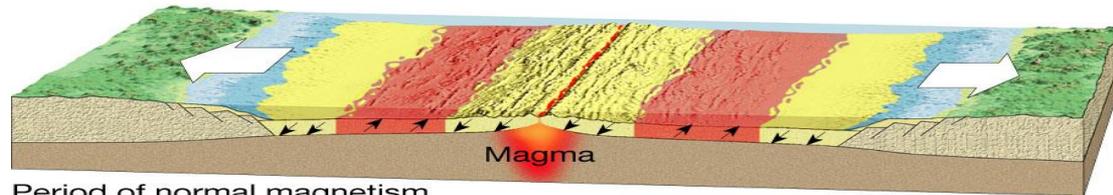
Figure 1. Observed vs. calculated magnetic profile for the ocean floor across the East Pacific Rise (modified from Kious and Tilling, 1996)



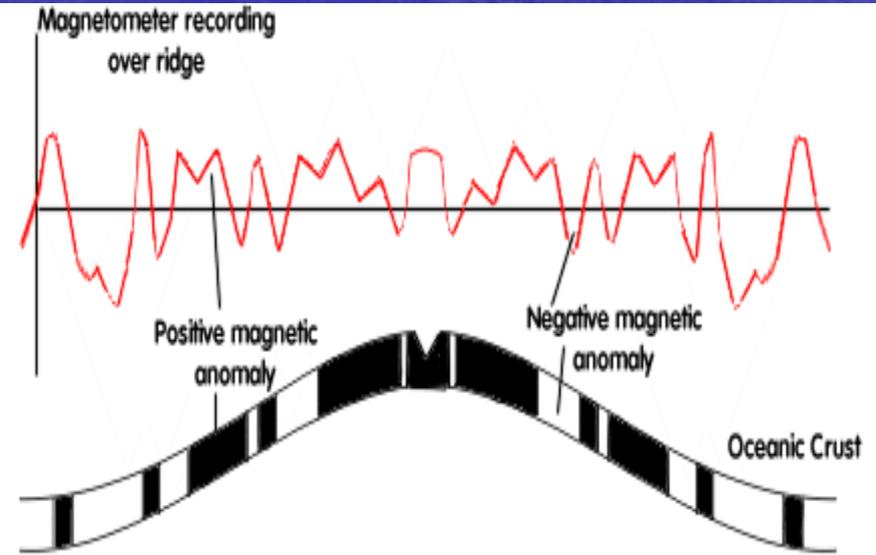
Period of normal magnetism



Period of reverse magnetism



Period of normal magnetism



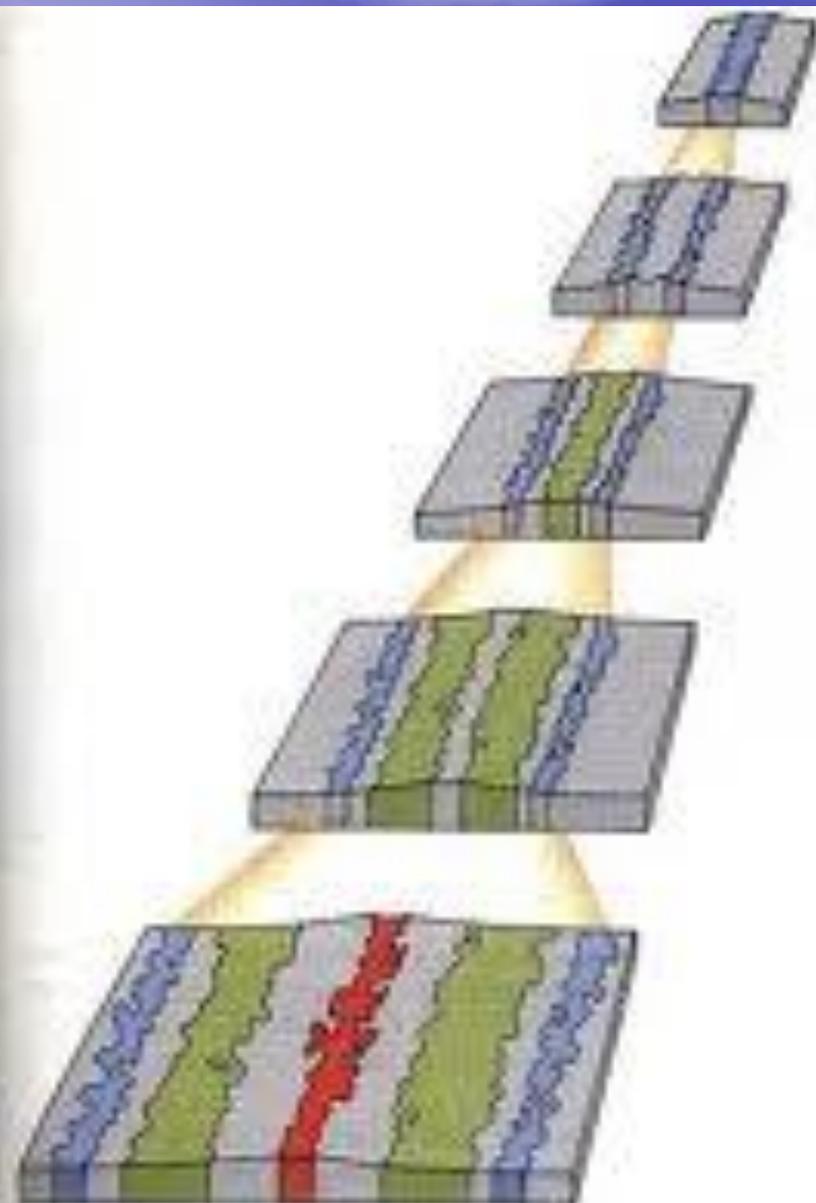
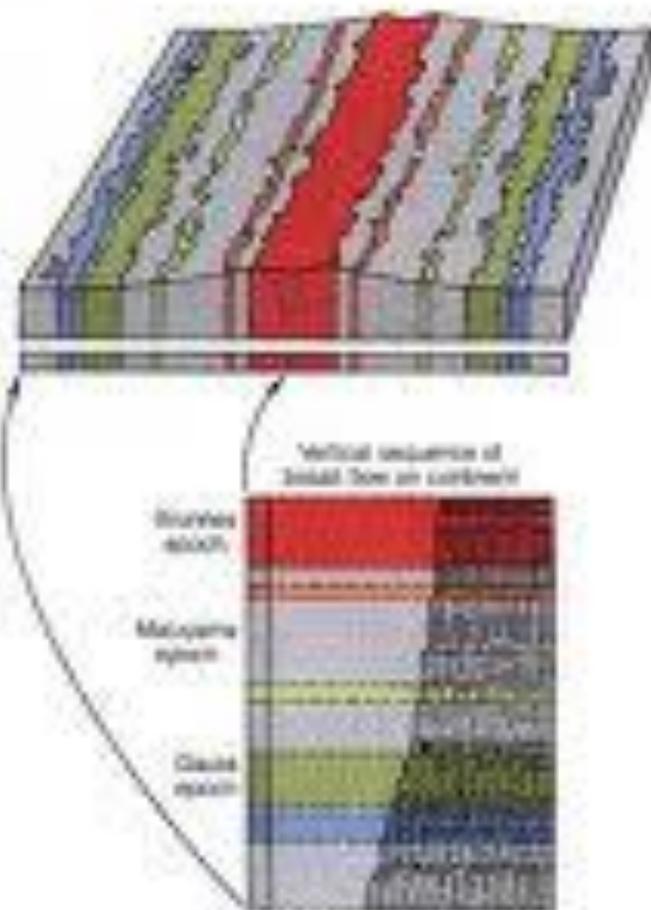


Figure The pattern of positive and negative gravity anomalies parallel to the oceanic ridges was developed as new ocean floor was added to the oceanic crust at the ridge spreading center.



- * Source of high magnetic anomalies is L2 layer.
- * L2 divided into a series of blocks running parallel to the ridge crest with magnetization either normal or reversal

SEA FLOOR SPREADING

"New oceanic lithosphere is created by the upwelling and partial melting of material from the asthenosphere at the ocean ridge, as oceanic plates moved apart.

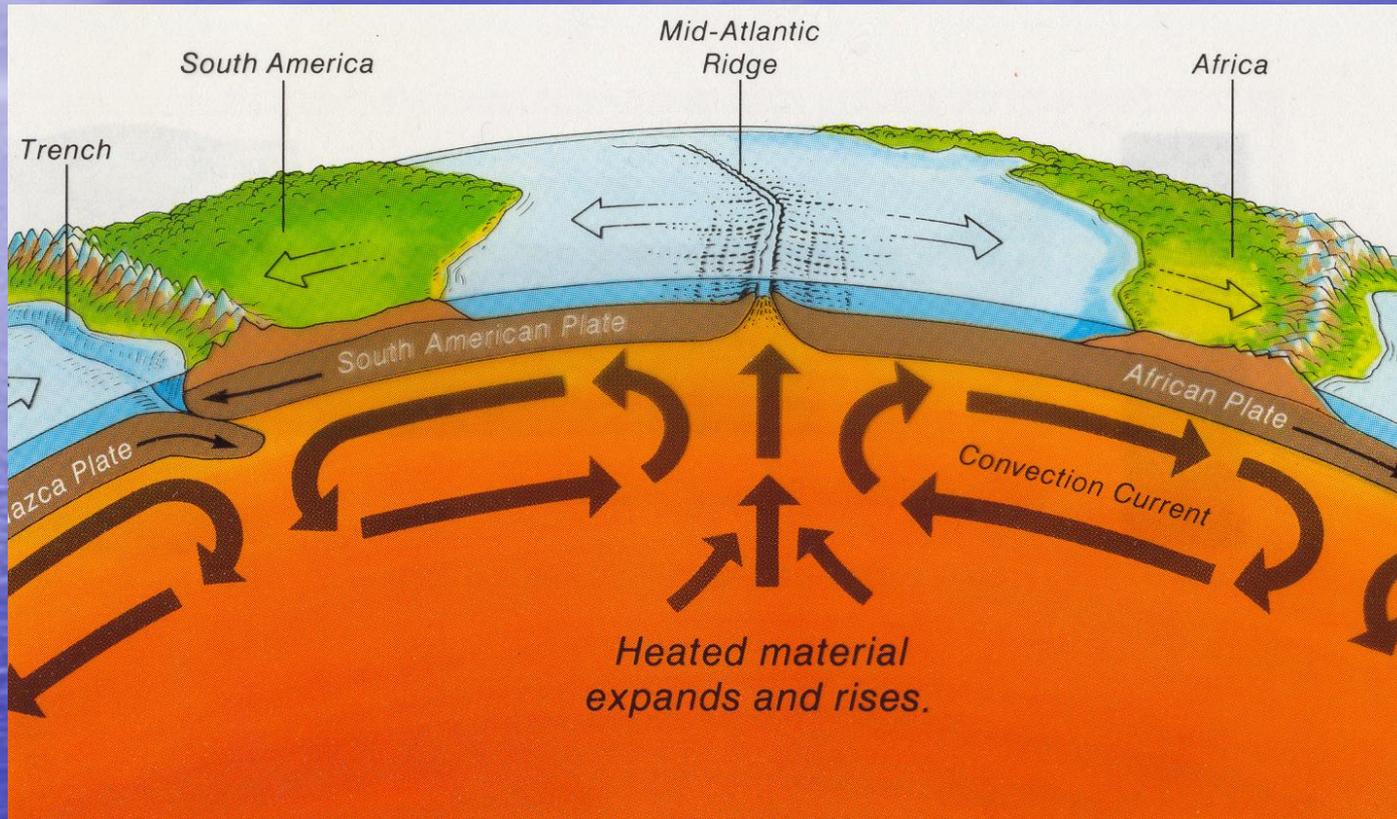
- The separation of Africa from S. America had resulted in the formation of the Atlantic before 180M.y.

The Vine-Mathew's hypotheses (1966)

- To explain the origin of magnetic strips on the sides of the ocean floor.
- new oceanic crust is created by solidification of injected magma at the crest oceans ridge.
- cooling below curie point allow magnetization of basaltic material.

SPREADING CENTERS		SPREADING RATE
East Pacific Rise	12 N ⁰	16-20 cm/yr
RED SEA	18 N ⁰	2-3 cm/yr

Convection Currents



The force responsible for plate movement is _____.

Magnetostratigraphy

Calibrating geomagnetic reversal

