Geology 1001: Section 4
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PLATE TECTONICS

Movement of continental bodies.

Definition: A theory of global tectonics in which lithosphere is divided into a number of plates whose pattern of horizontal movement is that of torsionally rigid bodies that interact with one another at their boundaries, causing seismic and tectonic activity along these boundaries.

Nearly every aspect of geology is affected by plate tectonics

Basic Assumptions:

- **Earth's lithosphere consists of**
- **Plates move relative to one another by:**

  1.
  2.
  3.

- **Three types of convergent boundaries:**
  1. **Ocean plates subduct**
  2. **Ocean plates subduct**
  3. **Two continental plates**

- **Most earthquake activity, volcanism, faulting, mountain building**

- **Plates**

A HISTORICAL PERSPECTIVE

1. Francis Bacon (1620) - noted the parallelism of the shorelines across the Atlantic Ocean.

2. Benjamin Franklin (1782) - "The crust of the Earth must be a shell floating on a fluid interior. Thus the surface of the globe would be capable of being broken and disordered by violent movements of the fluid on which it rested".

3. Edward Suess (late 1800s) - proposed putting together the Southern continents to form a supercontinent called .

4. Alfred Wegener (1912)
(German meteorologist)

- first conception of theory of plate tectonics
- suggested, based on evidence, that there was at one time a major supercontinent named
  that was made up of all the continents .

  (in southern hemisphere)

- This supercontinent broke up about

- termed this hypothetical dispersal:
  ___.

- Evidence used to support theory:
  - ___ -
    noted similarity of

  - ___ - Distribution of

  - Ancient___ - similar on widely separate regions
    e.g.

  - Problem: Wegener could not come up with a ___; as a consequence his ideas were dismissed by the scientific "mainstream".

5. Arthur Holmes (1928) - suggested the driving mechanism might be

   - These ideas were also dismissed as too speculative.

6. NEEDED DATA AND OBSERVATIONS TO PROPERLY TEST THE THEORY!

7. Sea Floor mapping, Deep sea drilling:

   After World War II, seafloor underwent extensive topographic mapping:

   - discovered the oceanic mountain/rift system, spreading centers.

   - revealed ocean's role in plate motion.

8. Harry Hess and Robert Dietz (early 1960s)
   - proposed the idea of

   i.e. the formation of new sea floor at the cracks in the ridges followed by lateral spreading.

   - This was confirmed by the presence of

IDEAS of CONTINENTAL DRIFT and SEA FLOOR SPREADING were COMBINED to develop the CONCEPT OF PLATE TECTONICS.

THIS WAS A TRUE SCIENTIFIC REVOLUTION....Birth of Plate Tectonic Theory

PLATE TECTONICS OVERVIEW

There are about 12 rigid lithospheric plates that slide over the partially molten asthenosphere

THREE KINDS OF PLATE BOUNDARIES

1. Divergent boundaries
    - partially molten
    - new crust
    - basaltic
    - shallow focus
    - extension
    - high heat flow
    - volumetrically,
2. Transform boundaries
    - conservative
    - fault
    - earthquakes

3. Convergent boundaries

- subduction of
- produces
- deep sea
- folded and faulted
- shallow and deep
- the weight may pull

- Determining Plate Velocity

1. Some plates appear to be
   e.g. African plate, diverging at same rate

2. Plate movement over Hot Spots
   - localized regions where

   - produces series of volcanoes

   = seamounts

   = guyots

   - measure movement of

   - e.g. Hawaii, produces data for Pacific Plate = 10 cm / yr

3. Magnetic Field Reversals - polarity of Earth's magnetic field , recorded in

   - Magnetic anomaly stripes as

   -Vine and Matthews (1960) proposed that magnetic anomalies were evidence of

   - positive and negative magnetic anomalies in igneous rocks crystallized at the ridges serve as

   - use magnetometers to determine magnetic polarity of basalt,

   - by calibrating the absolute time of given anomalies, it is possible to determine

4. Satellite Tracking - bounce laser beams off specific places and measure travel time, change in travel time = change in position

5. Rates of ridge systems are;

   – highest spreading rate is at the ridge (10-12 cm/yr.)

   – the lowest is at the ridge (2 cm/yr.).

– **Deep-sea Drilling - program of drilling of ocean crust begun in 1968**
- established the type
, depth of
and local ages of

- no oceanic sediments are older than

- rates of divergence and convergence are now known throughout the world