

October 12, 2003

PLATE TECTONICS

THEORY OF PLATE TECTONICS

CONTINENTAL DRIFT

ALFRED WEGENER, A.L. du TOIT Concept of continental separation... Trend and geologic features along coastal areas separated by main oceans.

NO MECHANISM TO PRODUCE CONTINENTAL MOVEMENT.

Studies of the ocean floor provided data to support the THEORY OF PLATE TECTONICS.

EARTHQUAKES See figures

Nearly 90% of all earthquake activity occurs in the vicinity of Ocean floor **TRENCHES**.

Only 5% off all earthquakes occur along the length of the Ocean floor **RIDGES**.

The remaining occur in the vicinity of Ocean floor **FRACTURES** or along the trend of the **ALPINE-HYMALAYA MOUNTAIN CHAIN**.

Because their continuity and marked seismicity OCEAN FLOOR STRUCTURES mark BOUNDARIES of large rigid, pieces of the earth's outer shell.

PLATES = LITHOSPHERIC.

LITHOSPHERE. CRUST (OCEANIC OR CONTINENTAL) + UPPER MANTLE
(Up to 100 km thick)

PLATE TECTONICS. The study of Earth's lithospheric plates. (Plate interaction and motions)

ASSUMPTIONS:

1) Plates are rigid and undergo no significant deformation

(Lack of earthquake activity over large areas of the Earth's surface; Distances of places located on the same plates will not change through time).

2) Plates are in relative motion and significant deformation occur along plate boundaries

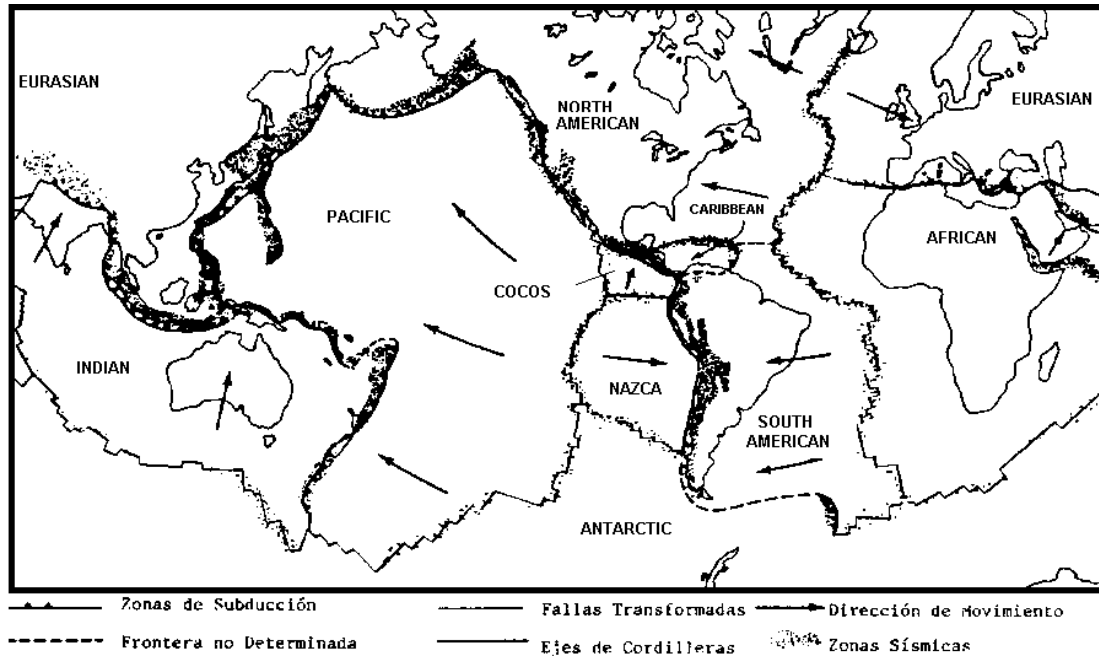
(Concentration of earthquake activity in well-defined zones; Distances of places located on different plates will change through time).

GEOGRAPHY OF THE WORLD'S LITHOSPHERIC PLATES

See figures no. of plates (6 larger plates + smaller ones).

VOLCANOES, EARTHQUAKES AND PLATE TECTONICS

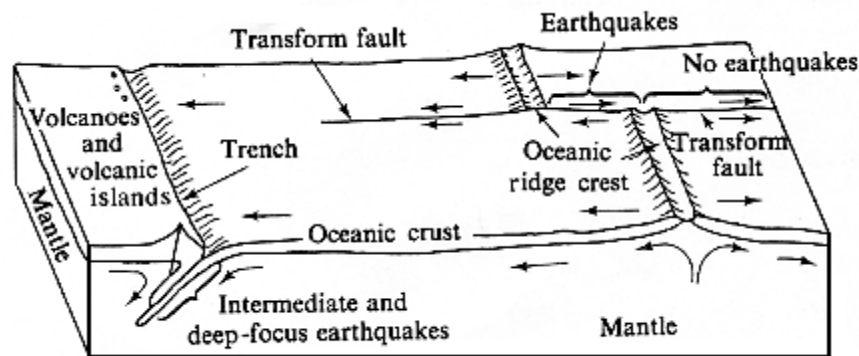
October 12, 2003



October 12, 2003

TYPES OF PLATE BOUNDARIES

Type of Boundary	Types of Plates Involved	Topography	Geologic Events	Modern Examples
Divergent $\leftarrow \rightarrow$	Ocean-Ocean	Mid-ocean ridge	Sea-floor spreading, shallow earthquakes , rising magma, volcanoes .	Mid-Atlantic Ridge
	Continent-Continent	Rift Valley	Continents torn apart, earthquakes, rising magma, volcanoes .	East African Rift
Convergent $\rightarrow \leftarrow$	Ocean-Ocean	Island arcs and ocean trenches	Subduction, deep earthquakes , rising magma, volcanoes , deformation of rocks.	Western Aleutians
	Ocean-Continent	Mountains and ocean trenches (Continental arcs)	Subduction, deep earthquakes , rising magma, volcanoes , deformation of rocks	Andes Cascades MVB
	Continent-Continent	Mountains	Deep earthquakes , deformation of rocks	Himalayas
Transform Fault $\swarrow \nwarrow$	Ocean-Ocean	Major offset of mid-ocean ridge axis	Earthquakes	Offset of East Pacific rise in South Pacific
	Continent-Continent	Small deformed mountain ranges, deformation along fault	Earthquakes , deformation of rocks	San Andreas Fault



October 12, 2003

HOT SPOTS

Linear chains of volcanoes are locally developed within the interior portions of lithospheric plates. They are not related to divergence or convergence.

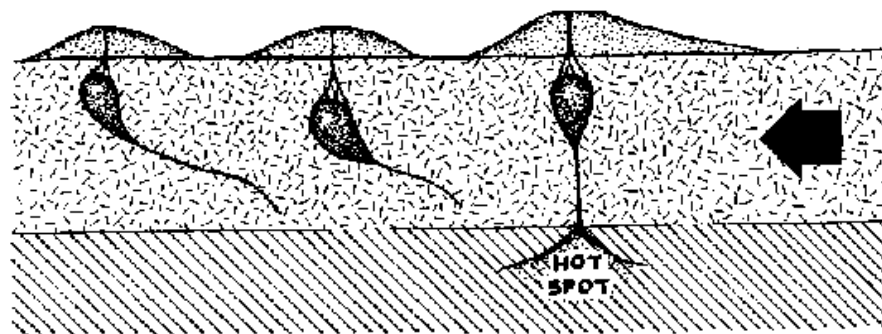
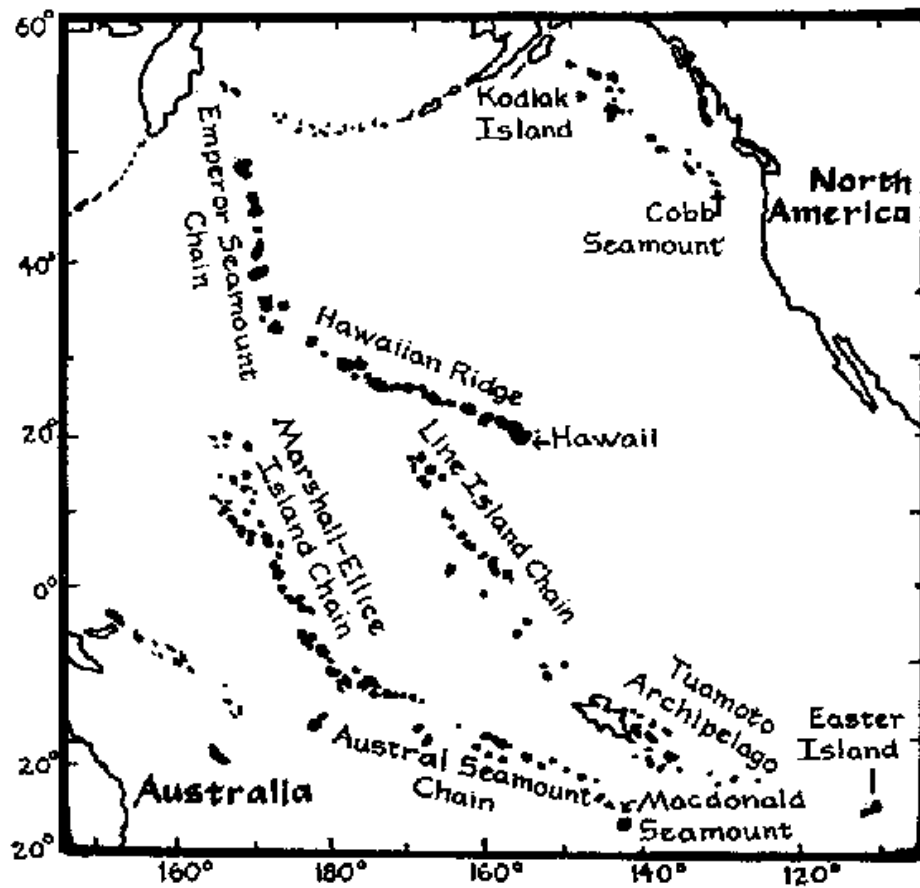
They developed from magmas, which reach the earth's surface from upwellings deep within the mantle (**HOT SPOTS OR MANTLE PLUMES**). They maintain relatively fixed position within the earth's mantle for prolonged periods. If a lithospheric plate overrides them, a linear chain of volcanic features develops.

The age of the volcanoes will systematically increase away from the hot spot. +====>
Variation in age can be used to help determine both the **directions and the rates of lithospheric plate movement**.

VOLCANOES, EARTHQUAKES AND PLATE TECTONICS

October 12, 2003

Chain of seamounts and volcanic islands in the Pacific Ocean (Dalrymple et al., 1973)



Schematic diagram showing the mechanism by which chains of volcanoes are thought to form as the oceanic lithosphere goes over a relatively fixed "hot spot" in the mantle.

VOLCANOES, EARTHQUAKES AND PLATE TECTONICS

October 12, 2003

Volcanism and Plate Tectonics

LAVA TYPE	ERUPTIVE STYLE	TYPICAL LANDFORMS	PRODUCTS AND EFFECTS	TECTONIC SETTING (Boundary)	NORTH AMERICAN EXAMPLES
Basaltic	Quiet	Lava plateaus, shield volcanoes, +/- Cinder cones	‘A’a and Pahoe flows, vesicular basalts, pillow lavas, columnar basalts	= Divergent (oceanic rift or ridge, or continental rift). = Subduction zone. = Oceanic Hot spot.	Columbia river basalts (WA, OR) Belknap Crater (OR) Craters of the Moon (ID)
Andesitic to basaltic	Fairly explosive, pyroclastic	Composite volcanoes, Cider cones	Relatively viscous lava, Lahars, Tuffs, Welded tuffs,	= Subduction zone.	Cascades (BC, WA, OR, CA) Aleutians (AK) MVB (MEX)
Rhyolitic	Very explosive, pyroclastic	Volcanic Domes, Calderas	Extremely viscous lava, ash-flow deposits, welded tuffs	= Continental Subduction zone. = Continental rift. = Continental Hot spot.	Yellowstone Plateau (WY, MT). Jemez Mountains (Rio Grande Rift; NM). Long Valley Caldera (Sierra Nevada, CA)

Based on Chernicoff and Fox, 2000. Essentials of Geology. Second Edition. Houghton, Mifflin Company.