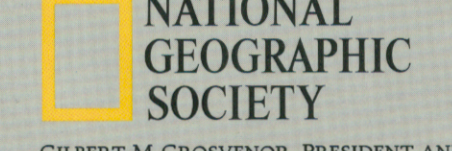


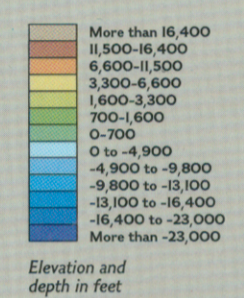
The Earth's Fractured Surface

Produced by the Cartographic Division

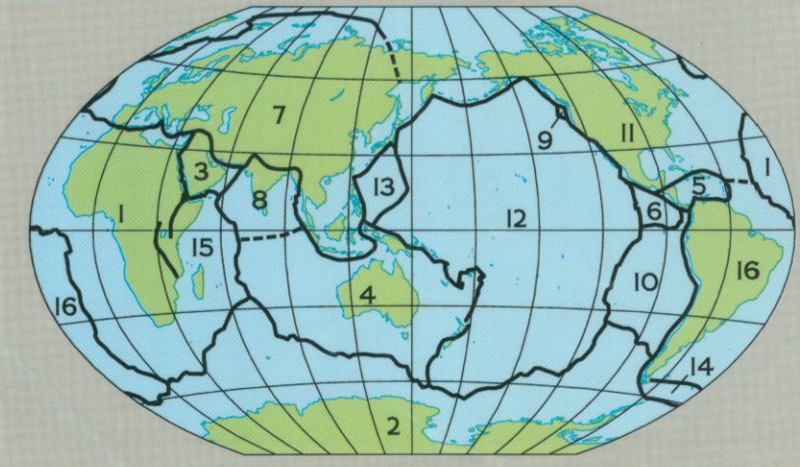


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WILLIAM L. ALLEN, EDITOR, NATIONAL GEOGRAPHIC MAGAZINE
JOHN F. SHURE, CHIEF CARTOGRAPHER
Washington, D.C., April 1995

Winkel Tripel Projection
SCALE 1:48,000,000 or 1 INCH = 758 MILES AT THE EQUATOR



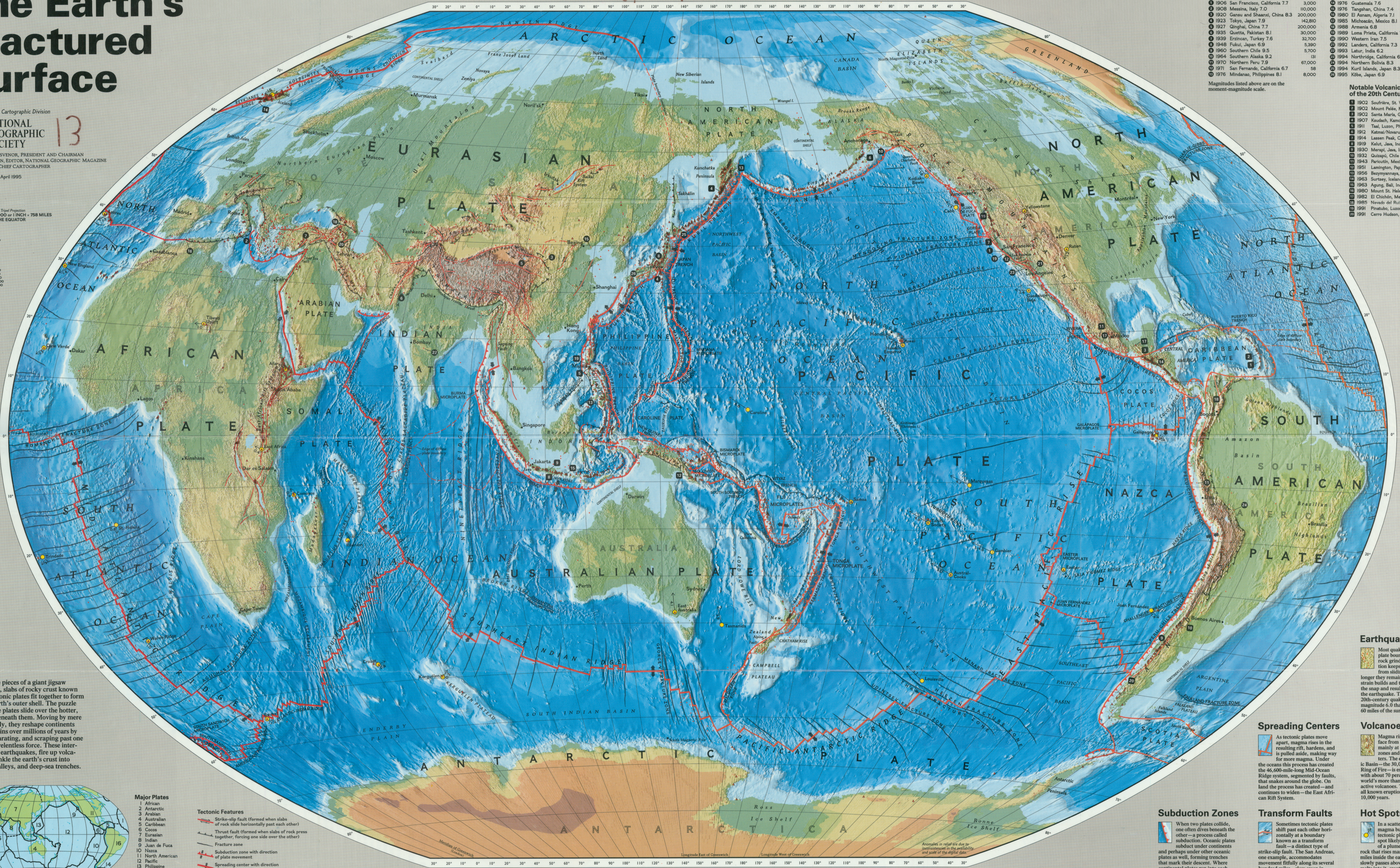
Like the pieces of a giant jigsaw puzzle, slabs of rocky crust known as tectonic plates fit together to form the earth's outer shell. The puzzle changes as the plates slide over the hotter, softer rocks beneath them. Moving by mere inches annually, they reshape continents and ocean basins over millions of years by colliding, separating, and scraping past one another with relentless force. These interactions set off earthquakes, fire up volcanoes, and wrinkle the earth's crust into mountains, valleys, and deep-sea trenches.



- Major Plates**
- 1 African
 - 2 Antarctic
 - 3 Arabian
 - 4 Australian
 - 5 Caribbean
 - 6 Cocos
 - 7 Eurasian
 - 8 Indian
 - 9 Juan de Fuca
 - 10 Nazca
 - 11 North American
 - 12 Pacific
 - 13 Philippine
 - 14 Scotia
 - 15 South American
 - 16 South American

- Tectonic Features**
- Strike-slip fault (formed when slabs of rock slide horizontally past each other)
 - Thrust fault (formed when slabs of rock press together, forcing one side over the other)
 - Fracture zone
 - Subduction zone with direction of plate movement
 - Spreading center with direction of plate movement
 - Hot spot with motion of overlying plate (inch/year)

MCC Geology Dept.



Notable Earthquakes of the 20th Century

Date	Location	Magnitude	Deaths
1906	San Francisco, California	7.7	3,000
1908	Messina, Italy	7.0	110,000
1920	Gansu and Shaanxi, China	8.3	200,000
1923	Tokyo, Japan	7.9	142,800
1927	Qinghai, China	7.7	200,000
1935	Quetta, Pakistan	8.1	30,000
1939	Erzincan, Turkey	7.6	32,700
1948	Fukui, Japan	6.9	5,390
1960	Southern Chile	9.5	5,700
1964	Southern Alaska	9.2	131
1970	Northern Peru	7.9	67,000
1971	San Fernando, California	6.7	58
1976	Mindanao, Philippines	8.1	8,000

Magnitudes listed above are on the moment-magnitude scale.

Notable Volcanic Eruptions of the 20th Century

Date	Location	Deaths
1902	Soufrière, St. Vincent	22,780
1902	Mount Pelée, Martinique	265,000
1902	Santa María, Guatemala	2,590
1907	Kudach, Kamchatka, Russia	9,500
1911	Taal, Luzon, Philippines	25,000
1912	Katmai/Novarupta, Alaska	62
1914	Lassen Peak, California	50,000
1919	Kalut, Java, Indonesia	1
1930	Merapi, Java, Indonesia	9,750
1932	Quilapú, Chile	60
1943	Parícutin, Mexico	10
1951	Langina, Papua New Guinea	10
1956	Bezymusskaya, Kamchatka, Russia	10
1963	Surtsey, Iceland	10
1963	Agung, Bali, Indonesia	10
1960	Mount St. Helens, Washington	10
1982	El Chichón, Mexico	10
1985	Navado del Ruiz, Colombia	10
1991	Pinatubo, Luzon, Philippines	10
1991	Cerro Hudson, Chile	10

Earthquakes

Most quakes occur near plate boundaries, where rock grinds past rock. Friction keeps the plate edges from sliding smoothly. The longer they remain stuck, the more strain builds and the more violent the snap and resulting vibrations—the earthquakes. This map shows all known eruptions over the past 60 miles of the surface.

Spreading Centers

As tectonic plates move apart, magma rises to the surface from inside the earth. Under the oceans this process has created the 46,600-mile-long Mid-Ocean Ridge system, segmented by faults, that snakes around the globe. On land the process has created—and continues to widen—the East African Rift System.

Volcanoes

Magma rises to the surface from inside the earth mainly at subduction zones and spreading centers. The edge of the Pacific Basin—the 30,000-mile-long Ring of Fire—is especially volatile, with about 70 percent of the world's more than 500 historically active volcanoes. This map shows all known eruptions over the past 10,000 years.

Transform Faults

Sometimes tectonic plates shift past each other horizontally at a boundary known as a transform fault—a distinct type of strike-slip fault. The San Andreas, one example, accommodates movement fitfully along its several hundred miles—slow creep in some places, frequent small jumps or rare big ones in others.

Subduction Zones

When two plates collide, one often dives beneath the other—a process called subduction. Oceanic plates subduct under continents and perhaps under other oceanic plates as well, forming trenches that mark their descent. Where continental plates run into each other, they buckle, creating ranges such as the Himalayas.

Hot Spots

In a scattering of places, magma burns through a tectonic plate. Each hot spot likely marks the top of a plume of semimolten rock that rises many hundreds of miles inside the earth. As a plate slowly passes above, the plume melts into it, creating a chain of volcanoes such as those in the Hawaiian Islands.