CIRCUM-PACIFIC MAP SERIES
MAP CP-41
Explanatory pamphlet accompanies map

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

CIRCUM – PACIFIC COUNCIL FOR ENERGY AND MINERAL RESOURCES

CIRCUM-PACIFIC COUNCIL FOR ENERGY AND MINERAL RESOURCES
Michel T. Halbouty, Chair

CIRCUM-PACIFIC MAP PROJECT
John A. Reinemund, Director
George Gryc, General Chair

PLATE-TECTONIC MAP OF THE CIRCUM-PACIFIC REGION

ARCTIC SHEET

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GEOMAGNETIC POLARITY TIME SCALE
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MAP PRODUCTION BY THE U.S. GEOLOGICAL SURVEY
Compilation Coordinated by George Gryc
Cartography by Frank J. Sidlauskas, Jr.

SCALE 1:10 000 000

250 0 250 500 750 1000 1250 1500 KILOMETERS
250 0 250 500 750 MILES
700 0 700 400 600 NAUTICAL MILES

Lambert Azimuthal Equal Area Projection
(Map center point: 70° N., 165° W.)

1992

CIRCUM-PACIFIC MAPS

This map is one in a series covering the Pacific, Arctic, and Antarctic regions. The maps have been compiled as part of the Circum-Pacific Map Project, a cooperative international effort to show the relation of mineral and energy resources to such phenomena as geology, tectonics, and crustal dynamics. The project is one of the activities of the Circum-Pacific Council for Energy and Mineral Resources.

The Map Project is made up of six panels of Earth scientists from countries in the Pacific region who contribute to maps of the four quadrants of the Pacific (Northwest, Northeast, Southwest, Southeast) and the two polar regions (Arctic and Antarctic). Eight series of maps are already published or are being prepared for future publication: Geographic, Base, Plate-Tectonic, Geodynamic, Geologic, Tectonic, Mineral-Resources, and Energy-Resources.

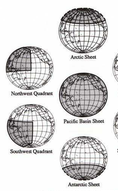
The six overlapping maps cover the Pacific Basin at a scale of 1:10 million, and a seventh map, the Pacific Basin Sheet, covers the entire region at a scale of 1:17 million. All are plotted on the Lambert azimuthal equal-area projection. The index to map sheets shows the boundaries of the quadrants and the boundaries of the Arctic and Antarctic Sheets in the Pacific Ocean.

Geographic names are as recommended by the U.S. Board on Geographic Names, taking into account the recommendations of the Circum-Pacific Map Project panels. Names and boundaries on the maps do not necessarily reflect recognition of the political status of an area by those involved in the preparation and publication of these maps.

PLATE-TECTONIC MAP SERIES

The Plate-Tectonic Map sheets show the active lithospheric plates, their boundaries, and associated geologic phenomena. Present-day movements of the lithospheric plates are illustrated by seismicity, volcanism, absolute motion of the plates, and relative motion at plate boundaries.

The present configuration of continental masses and oceanic basins is the outcome of an evolutionary history at least as old as the Mesozoic. Some of these older movements are recorded on the maps as magnetic reversals in the oceanic crust shown as lineations, by relict spreading axes, and by selected intraplate faults on the continents.



INDEX TO MAP SHEETS

THIS MAP SHEET AVAILABLE FROM
THE U.S. GEOLOGICAL SURVEY
OTHER SHEETS IN THIS SERIES AVAILABLE FROM
THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
BOX 979
TULSA, OKLAHOMA 74101, USA

EXPLANATION

ACTIVE TECTONIC PLATES

Subduction zone—Surface trace of a principal fault in a Benioff seismic zone, a dipping layer of earthquake foci at the top of a descending lithospheric plate; barbs on upper plate

Active transform fault—The principal fault in a broad strike-slip plate boundary

Active spreading ridge—Pattern shows oceanic crust formed during the past 1 million years

INTRAPLATE STRUCTURES

Inactive spreading ridge—Also includes minor active spreading ridges

Major intraplate faults—Arrows show relative displacement of strike-slip fault; barbs on upper plate of thrust fault; ticks on downdropped side of normal fault; dashed where approximately located

MOTION VECTORS

Relative plate movement—In cm/yr. After the model of DeMets and others (1990), a computer generated best fit of 1,122 worldwide spreading rates from seafloor magnetic anomalies, 450 transform faults and earthquake mechanisms; entire rate assigned to principal plate boundary where movement is distributed over several faults

6 **Strike-slip plate boundary**

5 **Converging plate boundary**

2 **Diverging plate boundary**

10 **Absolute motion**—Derived from relative motion calibrated by a best fit of the age and trend of lines of volcanoes formed as the plates move over hotspots; after Gripp and Gordon (1990)

ACTIVE HOTSPOT

Trace of plate movement—Circle shows approximate hotspot position; bar shows movement of associated plate across it during the past 10 m.y.; based on the absolute-motion model of Gripp and Gordon (1990)

MAGNETIC LINEATION

27 **Magnetic anomaly**—Label shows correlation with geomagnetic polarity time scale

EARTHQUAKE EPICENTERS

Focal depth—Colored dots indicate 1964 through 1987 magnitude 5.7 through 7.4 events; triangles of matching colors labeled by date and magnitude indicate 1899 through 1990 events of magnitude 7.5 or greater (generally surface-wave magnitude)

Depth (km)
0
70
300
700

06 Mar 1988 (7.6)
15 Jun 1911 (8.7)
25 May 1907 (7.9)

VOLCANIC CENTERS

Active in historic time—Generally during past 1,000 yr and documented during or soon after eruption; volcano named in color if active from 1964 to 1992

Active in Holocene time—During past 10,000 yr; not documented historically

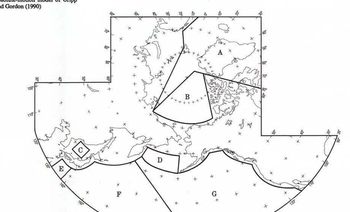
Holocene thermal activity—Includes solfataras and volcano-related thermal springs; no direct evidence for Holocene volcanic eruption

BASE MAP

Bathymetric contours—Depth of water in meters

0–200
200–2000
2000–4000
4000–6000
6000–8000
8000–

City—1,000,000 or more people
City—less than 1,000,000 people
International boundary



INDEX TO MAGNETIC-LINEATION SOURCES

(A) Srivastava and Tapscott, 1986; W.R. Roest and S.P. Srivastava, unpub. data, 1988; (B) Kovacs and others, 1990; (C) Inezaki and Uyeda, 1975; Hayashida and others, 1991; (D) Cooper and others, 1976; D.W. Scholl, unpub. data, 1990; (E) Chamot-Rook and others, 1987; (F) Nakanishi and others, 1989; (G) Atwater and Severinghaus, 1989.

SOURCES OF DATA

TECTONIC ELEMENTS
Principal sources were Beikman (1980), Gnanz and others (1990), King (1969), King and Beikman (1974), Ma (1989), Mexico Direccion General de Geografia (1981), Okulitch and others (1989), Stewart and Johannesen (1979), Tilman and others (1979), Trifonov (1987), Wheeler and others (1988), and Zonenshain and others (1990). Additional contributions were provided by Robert A. Duncan, Oregon State University; Kazuya Fujita, Michigan State University; Hubert Gabrielse, Geological Survey of Canada; Thomas W.C. Hilde, Texas A&M University; Boris A. Natal'in, Russia Institute of Tectonics and Geophysics; Chikao Nishiwaki, Japan Institute for International Mineral Resources Development; Tomatsu Nozawa, Geological Survey of Japan; Leonid M. Parfenov, Russia Institute of Geology; Guillermo P. Salas, Mexico Consejo de Recursos Minerales; and Maurice J. Terman, U.S. Geological Survey.

MAGNETIC LINEATIONS
See index map for principal sources. Additional contributions from colleagues at Lamont-Doherty Geological Observatory.

HOLOCENE VOLCANOES
Plotted with additions from the computerized Smithsonian Institution Volcano Reference file (Simkin and others, 1981) by the U.S. Geological Survey, Reston, Virginia. The contributions to the file by many compilers of the International Association of Volcanology and the Vulcanological Society of Japan are especially acknowledged. Submarine-rift volcanism is not included.

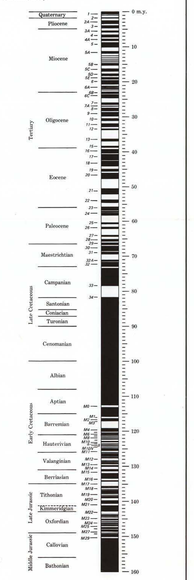
EARTHQUAKE EPICENTERS
Compiled from the Earthquake Data File of the U.S. Geological Survey and computer plotted at the National Oceanic and Atmospheric Administration.

PLATE-MOTION VECTORS
Absolute-motion vectors plotted from the plate-rotation poles and angular velocities of Gripp and Gordon (1990). Relative-motion vectors from DeMets and others (1990) and Gripp and Gordon (1990).

BASE MAP
From the Arctic Sheet of the Geographic Map of the Circum-Pacific Region, American Association of Petroleum Geologists (1990), on which the bathymetry was compiled by Frank J. Sidlauskas, Jr., U.S. Geological Survey, Reston, Virginia, and the topography by Thomas A. Berkman, Department of Geosciences, Oregon State University, Corvallis, Oregon. Latitude and longitude grid lines, shorelines, and drainage are computer plotted.

GEOMAGNETIC POLARITY TIME SCALE

During periods shown in black, the Earth's north and south magnetic poles conformed to those at present, and during periods shown in white, the poles were reversed; numbers and letters identify magnetic intervals and reversals recorded by systematically oriented magnetization of mineral grains in seafloor lava and mapped as magnetic lineations (after LaBrecque and others, 1977; Larson and Hilde, 1975; and Van Hinte, 1976).



REFERENCES CITED

Atwater, T., and Severinghaus, J., 1989, Tectonic map of the northeast Pacific Ocean: Geological Society of America Geology of North America, v. N. pl. 3, 3 sheets, scale 1:4,500,000.
Beikman, H.M., 1980, Geologic map of Alaska: U.S. Geological Survey, scale 1:2,500,000.
Chamot-Rook, N., Renard, V., and Le Pichon, X, 1987, Magnetic anomalies in the Shikoku Basin: A new interpretation: Earth and Planetary Science Letters, v. 83, p. 214-226.
Cooper, A.K., Marlow, M.S., and Scholl, D.W., 1976, Mesozoic magnetic lineations in the Bering Sea marginal basin: Journal of Geophysical Research, v. 81, p. 1916-1934.
DeMets, C., Gordon, R.G., Argus, D.F., and Stein, S., 1990, Current plate motions: Geophysical Journal International, v. 101, p. 425-478.
Grantz, A., Green, A.R., Smith, D.G., Lahr, J.C., and Fujita, K., 1990, Major Phanerozoic tectonic features of the Arctic Ocean region: Geological Society of America Geology of North America, v. L, pl. 11, scale 1:6,000,000.
Gripp, A.E., and Gordon, R.G., 1990, Current plate velocities relative to the hotspots incorporating the Nuvel-1 global plate motion model: Geophysical Research Letters, v. 17, p.1109-1112.
Hayashida, A., Pakst, T., and Torii, M., 1991, Paleomagnetism of the early Miocene Kent Group and the timing of counter-clockwise rotation for the opening of the Japan Sea: Geophysical Research Letters, v. 18, p. 1095-1098.
Inezaki, N., and Uyeda, S., 1975, Geomagnetic anomaly pattern of the Japan Sea: Marine Geophysical Researches, v. 2, p. 51-59.
King, P.B., 1969, Tectonic map of North America: U.S. Geological Survey, scale 1:5,000,000.
King, P.B., and Beikman, H.M., 1974, Geologic map of the United States: U.S. Geological Survey, scale 1:2,500,000.
Kovacs, L.C., Johnson, G.L., Srivastava, S.P., Taylor, P.T., and Vogt, P.R., 1990, Residual magnetic anomaly chart of the Arctic Ocean Region: Geological Society of America Geology of North America, v. L, pl. 4, scale 1:6,000,000.
LaBrecque, J.L., Kent, D. V., and Cande, S. C. 1977, Revised magnetic polarity time scale for Late Cretaceous and Cenozoic time: Geology, v. 5, p. 330-335.
Larson, R.L., and Hilde, T.W.C., 1975, A revised time scale of magnetic reversals for the Early Cretaceous and Late Jurassic: Journal of Geophysical Research, v. 80, p. 2586-2594.
Ma, Z., ed., 1989, Lithospheric dynamics atlas of China: China State Seismological Bureau, 71 p.
Mexico Direccion General de Geografia, 1981, Carta Geologica: Estados Unidos Mexicanos, 8 sheets, scale 1:1,000,000.
Nakanishi, M., Tamaki, K., and Kobayashi, K., 1989, Mesozoic magnetic anomaly lineations and seafloor spreading history of the northwestern Pacific: Journal of Geophysical Research, v. 94, p. 15,437-15,462.
Okulitch, A.V., Lopatin, B.G., and Jackson, H.R., 1989, Circumpolar geological map of the Arctic: Geological Survey of Canada Map 1745A, scale 1:6,000,000.
Simkin, T., Siebert, L., McClelland, L., Bridge, D., Newhall, C., and Latter, J.H., 1981, Volcanoes of the world: a regional guide to more than 1,500 active and dormant volcanoes: Stroudsburg, Pennsylvania, Hutchinson Ross, 232 p.
Srivastava, S.P., and Tapscott, C.R., 1986, Plate kinematics of the North Atlantic: Geological Society of America Geology of North America, v. M, p. 379-404.
Stewart, J.H., and Johannesen, D.C., 1979, Map showing regional tilt patterns of late Cenozoic Basin-Range fault blocks in western United States: U.S. Geological Survey Open-File Report 79-1134, scale 1:2,500,000.
Tilman, S.M., and others, 1979, Tectonic map of the eastern USSR and adjacent regions: USSR Ministry of Geology, scale 1:2,500, 000.
Trifonov, V.G., 1987, Map of active faults of the USSR and adjoining areas: USSR Academy of Sciences, scale 1:8,000,000.
Van Hinte, J.E., 1976, A Jurassic and Cretaceous time scale: American Association of Petroleum Geologists Bulletin, v. 60, p. 489-516.
Wheeler, J.O., Brookfield, A.J., Gabrielse, H., Monger, J.W.H., Tipper, H.W., and Woodsworth, G.J., 1988, Terrane map of the Canadian Cordillera: Geological Survey of Canada Open File 1894, 4 sheets, scale 1:2,000,000.
Zonenshain, L.P., Kuzmin, M.I., and Natapov, L.M., 1990, Geology of the USSR: a plate-tectonic synthesis: American Geophysical Union Geodynamics Series, v. 21, 242 p.

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