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To Accompany Map CP-50

Explanatory Notes for the Energy-Resources Map of the Circum-Pacific Region, Pacific Basin Sheet

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CIRCUM-PACIFIC COUNCIL FOR ENERGY AND MINERAL RESOURCES

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U.S. Department of the Interior
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CIRCUM-PACIFIC MAP PROJECT
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EXPLANATORY NOTES FOR THE ENERGY-RESOURCES MAP OF THE CIRCUM-PACIFIC REGION PACIFIC BASIN SHEET

Scale: 1:17,000,000

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2000

Explanatory Notes to Supplement the

ENERGY RESOURCES MAP OF THE CIRCUM-PACIFIC REGION PACIFIC BASIN SHEET

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INTRODUCTION

CIRCUM-PACIFIC MAP PROJECT

The Circum-Pacific Map Project (CPMP) is a cooperative international effort designed to show the relationship of known energy and mineral resources to the major geologic features of the Pacific basin and surrounding continental areas. Available geologic, mineral, and energy-resource data are being complemented by new, project-developed data sets such as magnetic lineations, seafloor mineral deposits, and seafloor sediment. Earth scientists representing some 180 organizations from more than 40 Pacific-region countries are involved in this work.

Six overlapping equal-area regional maps at a scale of 1:10,000,000 form the cartographic base for the project: the four Circum-Pacific Quadrants (Northwest, Southwest, Southeast, and Northeast), and the Antarctic and Arctic Sheets. There is also a Pacific Basin Sheet at a scale of 1:17,000,000. The published map series include the Base Map Series and the Geographic Series (published from 1977 to 1990), the Plate-Tectonic Series (published from 1981 to 1992), the Geodynamic Series (published from 1984 to 1990), and the Geologic Series (published from 1984 to 2000); all include six map sheets. The thematic map series in the process of completing publication include Mineral-Resources and Energy-Resources Maps. Altogether, 60 map sheets are planned.

The maps are prepared cooperatively by the Circum-Pacific Council for Energy and Mineral Resources and the U.S. Geological Survey and are available from USGS, Information Services, Box 25286, Federal Center, Denver, Colorado 80225, U.S.A. Maps published prior to mid-1990 are available from Dr. H. Gary Greene, Circum-Pacific Council for Energy and Mineral Resources, Moss Landing Marine Laboratory, MLML, Box 450, Moss Landing, California 95039-0450, U.S.A

The Circum-Pacific Map Project is organized under six panels of geoscientists representing national earth-science organizations, universities, and natural-resource companies. The six panels correspond to the basic map areas. Current panel chairs are Kenneth J. Drummond (Northeast Quadrant), Tomoyuki Moritani (Northwest Quadrant), George W. Moore (Arctic Region), Ian W.D. Dalziel (Antarctic Region), vacant (Southwest Quadrant), vacant, (Southeast Quadrant). José Corvalán D., chaired the Southeast Quadrant Panel from its inception in 1974 to his death in 1996; the Panel completed compilations of all eight topical maps of that quadrant.

Project coordination and final cartography are being carried out by the U.S. Geological Survey, under the direction of Circum-Pacific Map Project General Chairman George Gryc of Menlo Park, California. Project headquarters are located at 345 Middlefield Road, MS 951, Menlo Park, California 94025, U.S.A. The project has been overseen from its inception by John A. Reinemund, Director of the project since 1982.

The framework for the Circum-Pacific Map Project was developed in 1973 by a specially convened group of 12 North American geoscientists meeting in California. The project was officially launched at the First Circum-Pacific Conference on Energy and Mineral Resources, which met in Honolulu, Hawaii, in August 1974. Sponsors of the conference were the American Association of Petroleum Geologists (AAPG), Pacific Science Association (PSA), and the Coordinating Committee for Offshore Prospecting for Mineral Resources in Offshore Asian Areas (CCOP). The Circum-Pacific Map Project operates as an activity of the Circum-Pacific Council for Energy and Mineral Resources, a nonprofit organization that promotes cooperation among Circum-Pacific countries in the study of energy and mineral resources of the Pacific basin. Founded by Michel T. Halbouty in 1972, the Council also sponsors quadrennial conferences, topical symposia, scientific training seminars, and the Earth Science Series of publications.

ENERGY-RESOURCES MAP OF THE PACIFIC BASIN SHEET

The Energy-Resources Map of the Circum-Pacific Region, Basin Sheet is a compilation at a scale of 1:17,000,000 of a series of four overlapping 1:10,000,000-scale map sheets. The maps in the 1:10,000,000 series includes the Northeast Quadrant, Southeast Quadrant, Northwest Quadrant, and the Southwest Quadrant, and an Arctic Sheet.

Information depicted on the Energy-Resources Map of the Circum-Pacific Region, Basin Sheet includes a generalized geologic background, oil and gas fields, oil sands, oil shale, coal deposits, geothermal energy sites, hot springs, onshore basin isopachs, and sediment isopachs in ocean areas.

The geologic background for the Energy-Resources Map shows the relevance of the "economic basement" to the sedimentary basin areas. Depicted in a generalized format are Precambrian basement, igneous intrusives, volcanic cover, and deformed sedimentary fold belts. Bathymetry and sediment isopachs comprise the background for the oceanic areas.

Active plate boundaries shown in red are taken from the Plate-Tectonic Map of the Circum-Pacific Region (Moore, 1981). Spreading axes are depicted as lines of uniform width (1 mm) rather than by lines of varying width to represent spreading rates as is done on the Plate-Tectonic Maps.

The purpose of this report is to supplement the Energy-Resources Map of the Circum-Pacific Region, Basin Sheet with additional data, explanations, and references that could not be depicted on the face of the map. The notes for the Basin Sheet have been excerpted from the earlier published Explanatory Notes for the four Quadrant Maps. For more detail the reader is referred to the Explanatory Notes accompanying the 1:10,000,000 Energy-Resources maps for the four quadrants.

The Energy-Resources Map of the Circum-Pacific Region, Northeast Quadrant was prepared under the direction of Panel Chairman Kenneth J. Drummond, Mobil Oil Canada, Calgary, Alberta, Canada. The major compilation was completed by Drummond and Paul W. Richards, formerly of the U.S. Geological Survey, Reston, Virginia, with the assistance and advice of Northeast Quadrant panel members and with contributions for the overlap area with the Southeast Quadrant (South American continent), provided by José Corvalán D., Santiago, Chile, Southeast Quadrant Panel Chairman, and Marcelo Yrigoyen, Exxon, Argentina, coordinator of the Energy-Resources Map of the Southeast Quadrant. Other principal investigators and sources of data are indicated in the references section on the map sheet and in the bibliographic references. The Northeast Quadrant panel (1986) was composed of the following members: Prasada Rao, Belize; R.L. Chase, Kenneth M. Dawson, Hubert Gabrielse, and Geoffrey B. Leech, Canada; R. Castillo M. and F. Rudín, Costa Rica; Julio Salazar, El Salvador; Gabriel Dengo, and Oscar Salazar, Guatemala; José Maria Gutiérrez, Honduras; Guillermo P. Salas, Mexico; Mauricio Darce and Glen Hodgson, Nicaragua; Julio Mérida, Panama; James E. Case, Philip W. Guild, Allen Lowrie, Ray G. Martin, George W. Moore, and David W. Scholl, United States. The Explanatory Notes for the Energy-Resources Map of the Northeast Quadrant were translated into Spanish by Gerardo Soto, Escuela Centroamericano de Geologia, Universidad de Costa Rica, San José, Costa Rica. The section on Geothermal Resources was written by Theresa R. Swint-Iki.

The Energy-Resources Map of the Circum-Pacific Region, Southeast Quadrant was prepared under the direction of Panel Chairman José Corvalan D., Servicio Nacional de Geologia y Mineria, Santiago, Chile, plus the coordination of General Chairman George Gryc and the technical advice of Warren O. Addicott and Theresa R. Swint-Iki. The major compilation was carried out by Marcelo R. Yrigoyen, Trend Argentina, S.A., Buenos Aires, Argentina (formerly with Esso Exploration Inc., Buenos Aires, Argentina) with the assistance and advice of the Southeast Quadrant Panel members. For the overlap area with the Northeast Quadrant, information from the Energy-Resources Map of that quadrant, compiled by Kenneth J. Drummond, Mobil Oil of Canada, Calgary, Alberta, Canada, was used. Other principal investigators and sources of data are indicated in the references sections of the maps Sheet 1, Resources, and Sheet 2, Sedimentary Basins, and in the references included herein.

The Energy-Resources Map of the Circum-Pacific Region, Northwest Quadrant was prepared under the direction of the present Panel Chairman Tomoyuki Moritani, formerly of the Geological Survey of Japan, and the previous chairman Eiji Inoue, formerly of the Geological Survey of Japan. The final compilation of the map was coordinated by Tomoaki Sumii, Koji Wakita, Osamu Matsubayashi, and Keizo Fujii, all of the Geological Survey of Japan, with the assistance and advice of past and present Northwest Quadrant panel members and the staff of the Geological Survey of Japan, notably by Yoshiaki Sato, Kazuo Hoshino, Eiichi Honza, Manabu Tanahashi, Koichi Nakamura, Yasufumi Ishiwada, Yataka Ikebe, and Shunichi Sano. The contributions of Zhai Guangming of the Research Institute of Petroleum Exploration and Development, People's Republic of China, and Chong Su Kim of the Korean Institute of Energy Resources are acknowledged with appreciation. Kenneth J. Drummond, Mobil Oil Company of Canada, contributed to Table 2 of these notes, and Theresa R. Swint-Iki, U. S. Geological Survey, contributed to the index maps and tables in these notes. Other principal investigators and sources of data are indicated in the references section on the map sheet and in the bilbliographic references that follow. Affiliations represent time of compilation.

The Energy-Resources Map of the Circum-Pacific Region, Southwest Quadrant was compiled under the direction of Panel Chairman, R. W. Johnson and by W. David Palfreyman, both of the Australian Geological Survey Organisation (AGSO). Energy-resources data were compiled from a number of geoscience maps of various scales produced by AGSO, Australian State and Territorial government geoscience organizations, similar organizations in the southwest Pacific region, and various private companies and universities.

BACKGROUND INFORMATION

LAND AREAS

The background data on land are generalized from the 1:10,000,000-scale geologic maps of the four Quadrants. Significant tectonic and lithologic units have been combined into only seven divisions. The classification is designed to show the significance of host-rock units or terranes to the occurrence of energy resources. The background units are depicted in pale colors so as not to detract from the resource data. The faults depicted are selected and updated from the Plate-Tectonic Map (Drummond, 1981).

The background units include ultramafic rocks, crystalline basement rocks, Late Proterozoic and Phanerozoic continental margin rocks, metamorphic complexes, intrusive igneous rocks of Phanerozoic age, volcanic cover, and major sedimentary basins and platform deposits.

Crystalline basement

The basement terrane variously comprises crystalline Precambrian rocks, both on the shields and within the Cordillera, Precambrian sedimentary rocks, Cordilleran metamorphic complexes, oceanic basement terrane, accreted island-arc terrane, and igneous intrusions. The rocks classified as crystalline basement include mixed felsic and mafic gneisses, granitoid and more mafic intrusive rocks, and "greenstone belts" of stratified sedimentary and volcanic rocks. Formed over a period of some two billion years, in Archean and Early Proterozoic time, they had a long history of deformation and, in places, repeated metamorphism. Orogenic activity was essentially completed by the end of the Early Proterozoic. Since then, except for minor faulting and some post-orogenic intrusive and extrusive magmatism, slow warping and erosion have been the dominant geologic processes in those areas of the exposed shields of the Circum-Pacific Region. The basement extends at fairly shallow depths under the broad zones of platform cover rocks adjacent to the shields.

Continental margin rocks of Late Proterozoic and Phanerozoic age

Late Proterozoic rocks are supracrustal, largely clastic sediments derived by erosion from the now stabilized crystalline basement, although carbonate sediments constitute significant proportions in some places. Volcanic rocks are minor and related to continental rifting. On and near the exposed shields, the outcrop patterns are roughly equidimensional, reflecting the undeformed flat-lying character of the rocks that comprise them, whereas along the margins of the Cordillera, rocks of this age are exposed in linear belts that resulted from orogenic activity (folding, faulting, uplift, and erosion) of later geologic time. Metamorphism is generally absent to low grade, although in places it reaches higher grades. Some of the rocks shown on the map as metamorphic complexes are known to include rocks of Proterozoic age metamorphosed in Phanerozoic time.

Metamorphic complexes

Areas shown as metamorphic complexes include a variety of rocks ranging in age from late Precambrian to Tertiary that were highly deformed, metamorphosed, and in places intruded by granitoid rocks during one or more Phanerozoic orogenies. They range from blueschist or greenschist facies up to and including gneiss. Their relationship is not always certain; at least some may be allochthonous (accreted).

Intrusive igneous rocks

Intrusive rocks ranging in age from Paleozoic to Tertiary, and in composition from gabbro to granite and syenite, are widespread and abundant around the Pacific margin. Most of the major batholiths are of Mesozoic or Paleogene age and have an average composition of granodiorite. In detail, however, they are composite and resulted from repeated magmatic events over extended periods of time. For example, intrusions in the Sierra Nevada occurred from Triassic to Late Cretaceous (Evernden and Kistler, 1970). Intrusive rocks are less abundant and individual plutons generally are much smaller east of the main batholithic belt.

Volcanic rocks

This map unit essentially shows only the extensive plateau basalts and other volcanic cover where the nature of the underlying rocks is unknown. The Volcanic rocks around the Pacific range in age from Proterozoic to Cenozoic, and in composition from rhyolite to basalt.

Sedimentary basins and platform deposits

Sedimentary basins are shown by sediment isopachs, colored to indicate the age of the oldest major sedimentary unit above basement. The age and lithology of the basement is generally indicated by the surrounding bedrock geology. Representative stratigraphic sections showing the generalized stratigraphy of many of the basins of the Circum-Pacific region are included in the notes (fig.17).

Ultramafic rocks

The ultramafic rocks are a distinctive class of magnesium- and iron-rich intrusive rocks that, in plate-tectonic theory, represent mantle rocks brought to the surface at accreting margins (or perhaps at primitive island arcs) and incorporated into land areas at convergent margins. They form the basal member of the typical ophiolite suite, below the gabbro, pillow basalts, possible massive sulfide deposits, and cherts, from which they may be separated by the shearing that accompanies the convergence. Ultramafic rocks are widely distributed in the orogenic belts around the Circum-Pacific region.

OCEAN AREAS

The basic background for oceanic regions is bathymetry printed in a light blue tint. Overprinted on this are sediment isopachs, colored to indicate the age of the underlying oceanic crust. The oceanic crustal age mapping from which the isopach coloration was derived was completed by Xenia Golovchenko, then of Lamont-Doherty Geological Observatory, as an unpublished part of the magnetic lineation compilation for the Plate-Tectonic Map of the Pacific Basin (Glovchenko and others, 1981). Also shown are the major active plate boundaries.

GEOLOGIC SETTING

NORTHEAST QUADRANT

The chief tectonic features within the Northeast Quadrant map area are: (1) parts of two shields (continental nuclei)- the Canadian and Guyana; (2) broad belts of essentially undeformed, younger sedimentary rocks that constitute platform cover over the shields; and (3) the Cordillera (sensu lato), a complex zone of sedimentary and extrusive and intrusive igneous rocks that extends along the entire margin of the continents facing the Pacific Ocean and even into the Atlantic along the Greater and Lesser Antilles. The Cordilleran zone has been involved in interactions between continental and oceanic plates at least since late Paleozoic time and possibly longer. Much of it is now interpreted as a collage of fragments that originated elsewhere and were accreted to the craton by plate motions.

SOUTHEAST QUADRANT

Following the guidelines of the Commission for the Geologic Map of the World for the Tectonic Map of South America (United Nations Educational, Scientific, and Cultural Organization (UNESCO), 1978), the area covered by the Southeast Quadrant can be divided into three tectonic regions that differ in origin, age, and structural evolution. The oldest, the South American Platform, constitutes the entire central area and most of the eastern part of the continent. It includes all of Brazil, Paraguay, Uruguay, Guiana, French Guiana, and Suriname, as well as the central and southern regions of Venezuela, eastern Colombia, Ecuador, Peru, Bolivia, and the northern part of Argentina. It is an old platform in which the basement was consolidated during the end of the Precambrian and the Cambrian. It contains the only Archean rocks of the continent. Deposition of the sedimentary cover and the associated volcanic rocks started in the Silurian. These rocks are found mainly in the four great downwarps of Paraná, Chaco, Amazon, and Parnaiba, as well as in the sedimentary prism flanking the Andes along the west margin of the platform. Smaller areas of sedimentation are found on the major shields where basement rocks of the platform crop out.

The Patagonian Platform is located entirely within Argentina and extends along the large continental-shelf margin. Younger in age, basement consolidation started in the middle part of the Paleozoic, but the platform was almost entirely masked by a volcanic-sedimentary cover developed from the Carboniferous onward.

These two platforms are bounded on the west by the large fold belt of the Andean Cordillera and the Caribbean Mountains, the latter developed on the northern edge of the South American Platform. These extensive belts show a persistent crustal mobility from at least late Precambrian until recent time. During the Phanerozoic, their polycyclic evolution occurred mostly over sialic crust.

The boundaries between these large tectonic regions are still poorly known partly due to insufficient geologic study but mainly owing to the Mesozoic and Cenozoic sedimentary cover. The Precambrian basement of the South American Platform is widely exposed in the Southeast Quadrant, both as large massifs and in smaller sporadic outcrops. The Patagonian Platform crops out in the North Patagonian, Deseado, and Malvinas (Falkland) Islands massifs, with extensions in the Dungeness Arch and even in the Eastern Patagonian Ridge, both extensions beneath the Argentine epicontinental sea. The Patagonian Platform basement is composed of metamorphic rocks and sediments of late Precambrian and early Paleozoic age, as well as Precambrian, Permian, and Triassic extrusive rocks and late Paleozoic granitic intrusive rocks. Several subsiding stages with resultant continental and marine sedimentation took place from the early Mesozoic until the tectonomagmatic reactivation in the Late Jurassic. Since then, large areas of the Patagonian Platform appear as molassic forebasins of relative tectonic stability that were modified only by epeirogenic movements and strong Cenozoic mafic volcanism.

The third great constituent of the continent is the Andean Cordillera and the Caribbean Mountains, where remnants of metasedimentary and metavolcanic rocks of polyphase evolution are assigned to the late Precambrian. The folded belt of the Andean Cordillera developed over a rifted continental margin during the final stages of the Precambrian (and into the Cambrian) with partial remobilization of the older terrain, including that of the Trans-Amazonian Cycle (2000 Ma). The elongated Andean Ranges show strong Paleozoic and Mesozoic structures with dominant Cenozoic tectonism accompanied by significant intrusive and volcanic episodes.

In the Caribbean Mountains, which developed during terrane accretion, extensive late Mesozoic and Cenozoic sedimentation took place between blocks of submarine ophiolitic volcanic rocks. Andean tectonism was the dominant feature during Neogene molassic deposition in the intermontane troughs. Terrane accretion and sedimentation were accompanied by emplacement of granitic plutons; mafic and ultramafic rocks, including serpentinitic peridotites, were brought to the surface.

The most outstanding features of the eastern Pacific Ocean are the large fracture zones trending east-west, which have been depicted on bathymetric maps. Recent magnetic and SEASAT gravity maps show these features with considerable detail. The major components are oceanic spreading axes, aseismic ridges, major trenches (interpreted as subduction zones), and large active transform strike-slip fault zones such as the Udintsev, Eltanin, Tula, Menard, Taitao, Guafo, Valdivia, Challenger, Mendana, Wilkes, Quebrada, Galápagos, Siqueiros, and Clipperton. Initial formation of southeastern Pacific marginal basins occurred in the final stages of the Middle and Late Jurassic orogeny. Most of these basins developed along the juncture of continental and oceanic crusts within a convergent tectonic framework characterized by volcanism and plutonism with associated underthrusting and strike-slip transcurrent movements (Drummond, 1986).

NORTHWEST QUADRANT

The continental part of the Northwest Quadrant Map area is an assemblage of continental blocks surrounded by Phanerozoic fold belts. The major continental blocks are parts of two Archean shields (Siberian Platform and North China Platform) and four major Proterozoic blocks (Yangtze Platform, Kontum Platform, Bureya Massif, and Kolyma Massif). The continental blocks are covered by essentially undeformed, younger sedimentary rocks. Phanerozoic fold belts are ancient accretionary complexes, including oceanic materials, microcontinents, and remnant island arcs. The fold belts contain the extrusive and intrusive rocks which are related to subduction. Subduction, collision, and accretion are the main cause of the geologic features in the Northwest Quadrant Map area.

SOUTHWEST QUADRANT

The geological background has been generalized from the Geologic Map of the Circum-Pacific Region, Southwest Quadrant (Palfreyman, 1988). Significant tectonic and lithological units have been combined to form seven major groups:

Major sedimentary basins, platform deposits, and surficial deposits. These are generally thick deposits of sediment that show little to no deformation. They range in age from Proterozoic to Cenozoic. This area contains the vast majority of the coal, oil, gas, and oil shale deposits in the Southwest Quadrant region.

Volcanic rocks. These range in age from Proterozoic to Cenozoic and are found throughout the Australian continent. They are especially concentrated along the convergent plate boundaries to the north and east of Australia. Areas of undivided igneous rocks, mixed volcanic and intrusive igneous rocks, confined to the Indonesian island of Sumatra are included in this category.

Phanerozoic fold belts and deformed basinal deposits. These consist of belts of deformed and metamorphosed sedimentary and igneous rocks and are concentrated in the east and south of the Australian continent, in the eastern part of the Papua New Guinea mainland, and in the South Island of New Zealand.

Precambrian mobile zones and deformed platform cover deposits. These consist of belts of rocks similar to those of Phanerozoic age. They are found in the western and central parts of the Australian continent.

Metamorphic complexes. Mostly Precambrian. These are areas of moderate- to high-grade metamorphic rocks that are located in central and western Australia.

Intrusive igneous rocks. These range in age from Precambrian to Cenozoic and in composition from felsic to ultramafic. They are distributed widely throughout the map sheet area.

TECTONIC SETTING

The plate-tectonic framework of the Pacific basin is shown in figure 1. The major plates include the North America, South America, Antarctica, Australia-India, and the Eurasia continental plates, the main Pacific Plate and the minor oceanic plates, Phillipine, Nazca, Cocos, Scotia, Caribbean, and Juan de Fuca. A major feature of the Pacific Plate are the long linear east-west fracture zones, which segment the Pacific Basin. Superimposed on the overall tectonic grain are chains of volcanic islands, including the Hawaiian, Welker-Kodiak, Marquises, and the Line Islands. The boundaries of the major lithospheric plates for the Pacific Basin are printed in red on the Energy Resources Map. They are delineated by spreading axes, major trenches that are interpreted to be the sites of subduction zones, and large strike-slip faults (active transforms).

The basic framework for the marginal basins of the Pacific began with the waning stages of Middle to late Jurassic orogenies. Most of the sedimentary basins of the Pacific margin developed along the junction of continental and oceanic crust, within a convergent regime, characterized by volcanism and plutonism, with associated underthrusting and strike-slip movements. Pacific margin trough basins developed in general over a thick and complex sequence of Mesozoic sedimentary, metamorphic, and intrusive and extrusive rocks possibly representative of an older arc-trench system. Structurally complex late Mesozoic deep-water graywacke, argillite, and radiolarian chert, with associated pillow basalt, gabbro, and ultramafic rocks, occur all along the Pacific margin.

The Pacific basin is highlighted by the Ring-of-Fire, a belt of volcanic and igneous intrusive rocks circling the Pacific Ocean. Sedimentary basins are developed marginal to the oceanic basins, within the magmatic belts, and within the cratonic interior.

NORTHEAST QUADRANT

The major plates of the northeast Pacific region are: the North America and South America continental plates, the main oceanic plate - the Pacific - and minor oceanic plates - the Caribbean, Cocos, Nazca, and Juan de Fuca. Major features of the northeast Pacific Ocean are the long linear east-west fracture zones, which have been recognized for some time on bathymetric maps. More recently they have been delineated on magnetic and SEASAT gravity maps. The boundaries of the major lithospheric plates in the Northeast Quadrant are printed in red on the Energy Resources Map. They are delineated by spreading axes, major trenches that are interpreted to be the sites of subduction zones, and large strike-slip faults (active transforms). The basic framework for the marginal basins of the northeast Pacific began with the waning stages of Middle to Late Jurassic orogenies. Most of the sedimentary basins of the Pacific margin developed along the junction of continental and oceanic crust, within a convergent regime, characterized by volcanism and plutonism, with associated underthrusting and strike-slip movements.

Pacific-margin trough basins developed in general over a thick and complex sequence of Mesozoic sedimentary, metamorphic, and intrusive and extrusive rocks possibly representative of an older arc-trench system. Structurally complex late Mesozoic deep-water graywacke, argillite, and radiolarian chert, with associated pillow basalt, gabbro, and ultramafic rocks, occur all along the Pacific margin. They extend for a distance of about 12,800 km from Ecuador to Alaska. This deepwater complex can be traced from the Santa Elena Peninsula, Ecuador, to western Colombia, thence to Costa Rica, and on to the Viscaino Peninsula, Mexico; then it continues through the California Coast Ranges and southwestern Oregon to the San Juan Islands and the west coast of Vancouver Island; and finally it includes Baranof and Chicagof Islands of southeast Alaska, the Chugach Range of southern Alaska, and Kodiak and Shumagin Islands.

SOUTHEAST QUADRANT

The plate-tectonic framework of the Southeast Quadrant comprises the large South American continental plate and the Pacific and Antarctica oceanic plates. Smaller oceanic plates include the Caribbean, Cocos, Nazca, and Scotia Plates (Corvalán, 1981). The limits of the largest lithospheric plates of the Southeast Quadrant are shown in red. The most outstanding features of the eastern Pacific Ocean are the large fracture zones trending east-west, which have been depicted on bathymetric maps. Recent magnetic and SEASAT gravity maps show these features with considerable detail. The major components are oceanic spreading axes, aseismic redges,- major trenches (interpreted as subduction zones), and large active transform strike-slip fault zones such as the Udintsev, Eltanin, Tula, Menard, Taitao, Guafo, Valdivia, Challenger, Mendana, Wilkes, Quebrada, Galapagos, Siqueiros, and Clipperton. Initial formation of southeastern Pacific marginal basins occurred in the final stages of the Middle and Late Jurassic orogeny. Most of these basins developed along the juncture of continental and oceanic crusts within a convergent tectonic framework characterized by volcanism and plutonism with associated underthrusting and strike-slip transcurrent movements (Drummond, 1986).

NORTHWEST QUADRANT

The major plates of the northwest Pacific region are the North America Plate, the Eurasia Plate, the Philippine Plate, the Pacific Plate, and the Australia-India Plate. In addition, some minor plates are subdivided and identified. Several models have been proposed for the plate boundary between the North America Plate and the Eurasia Plate, but none have been fully accepted.

Along the east margin of the Asian continent and adjacent to the Philippine Sea, lie a series of trench-island arc-marginal sea systems. The Himalaya Orogenic Belt and Sunda Arc constitute the convergent belt between the Eurasia Plate and the Australia-India Plate. Around the Banda Sea, three major plates converge: the southeast tip of the Eurasia Plate, the south tip of the Philippine Plate, and the Australia-India Plate. The interaction between these three plates has created the complicated island-arc systems in this region.

The Pacific Plate converges onto the Australia-India

Plate along the New Guinea Fold Belt and Bismark Archipelago, and along the Solomon Islands.

The Eurasia continent is composed of several continental blocks made up of platforms and massifs amalgamated along suture zones or fold belts. These suture zones are interpreted as the ancient plate boundaries. The development of sedimentary basins in this region is controlled by the interaction of these continental blocks.

SOUTHWEST QUADRANT

The Pacific Plate, Australia-India Plate, Eurasia Plate, Philippine Plate, and the Antarctica Plate are the major structural features of the Southwest Quadrant. Smaller structures such as the Burma, Mariana, Bismarck, and Solomon Plates lie between the main plates.

The Pacific Plate is moving in a general northwesterly direction from spreading axes in the eastern and southern Pacific at a rate of between 8 and 11 cm per year. It dips beneath the Philippine Plate in the north of the sheet area along the Mariana Thrust and beneath the Australia-India Plate along a complex series of thrusts and shears between New Guinea in the north and New Zealand in the southwest. Similarly, the Philippine Plate is dipping beneath the Eurasia Plate along the Mindanao Thrust. The Australia-India Plate is moving northwards away from spreading axes in the Southern Ocean at a rate of 8 cm per year and dips beneath the Eurasia Plate along the line of the Sunda and Timor Thrusts. The interaction between the Eurasia, Pacific, and Australia-India Plates has created a complex series of thrusts, shears, and minor plates in the Andaman, Banda, Bismarck, and Solomon Sea regions.

The Pacific Plate is composed almost entirely of oceanic crust overlain by Mesozoic to Cenozoic sediments, whereas the other major plates have substantial areas of continental crust (for example, the Eurasian continent, Australia and parts of New Zealand, and Antarctica). These continental masses consist of blocks of generally Precambrian age separated by younger fold belts and overlain by sedimentary basins of varying types.

ENERGY RESOURCES

OIL AND NATURAL GAS

The main oil and gas fields of the Pacific Basin are plotted as close to real scale and location as possible. Some of the smaller fields, of necessity, have been enlarged slightly, and in some areas several small fields in close proximity have been grouped as one. Oil fields are shown with a solid green color, and gas fields are shown in solid red. Note that a significant portion of the known oil and gas resources of the Pacific Basin area occur within the interior of the continental plates. Estimated reserves of oil and gas for countries of the Pacific Basin are shown in table 1. The 1998 oil and gas production for countries of the Circum-Pacific region is shown in table 2.

Index maps showing sedimentary basins and location of selected oil and gas fields are taken from the explanatory notes of the four quadrants and are included as figures 2 through 16. The data on the giant and selected major oil and gas fields for the Pacific Basin Map area is available in the tables of the various quadrants. These tables are included herein, and have been updated, where information is available, to a more recent date. Included in the tables 4 through 16 are the year of discovery, reservoir age and lithology, average producing depth, cumulative production (various dates), and the estimated ultimate recovery for many of the fields.

Northeast Quadrant

For the Northeast Quadrant giant fields contain approximately 43 percent of the total initial established reserves. The major portion of the reserves are in the continental interior basins where there are a total of 13 basins, which contain fields with greater than 500 million barrels of oil or 3 trillion cubic feet of natural gas.

Sedimentary Basins of the Northeast Quadrant

The basin index map (fig. 2) shows the names of the major basins in the Northeast Quadrant. The sedimentary basins can be classified as interior basins (cratonal and foreland), intramontane or fold-belt basins, and marginal basins (either directly or indirectly related to oceanic areas). The interior platforms of North and South America comprise a westward-thickening wedge of sediments ranging from a wedge edge where they onlap the shields to thicknesses of 7 to 11 km along the front of the Cordillera. The basin areas are formed by a series of large asymmetric depressions between the Cordillera and the shields, separated by basement arches, some of which are related to basement uplift.

The westward-thickening wedge of platform sediments is episodically deformed and uplifted in the Cordillera. Sediments are derived from Cordilleran uplifts, so as to increase basin subsidence, and further accentuate the basins along the mountain fronts. These basins are often referred to as foreland basins. One area with extensive uplift and foreland deformation is the Rocky Mountain region in the United States. The region could be considered as an unstable platform basin area.

The intramontane basins are sedimentary basins that occur within the major Cordilleran uplifts. Sediments were deposited in basins that developed within the Cordillera by localized subsidence, both during and after the major deformation. These basins developed from the mid-Jurassic to the late Tertiary.

Basins of the continental margin include all basin areas bordering the North and South American continents. These include the circum-Pacific basins, circum-Arctic Ocean basins, Bering Sea basins, Gulf of Mexico basins, and the circum-Caribbean basins. Only the circum-Pacific basins of the Northeast Quadrant will be considered in the following discussion. Figure 3 is a series of generalized sections illustrating the structural setting of selected Pacific margin basins.

Thick post-orogenic sequences are deposited in basins along the northeast Pacific continental margin. Both continental and shallow-marine sedimentary facies are present. Age of sediments range from middle Mesozoic to late Cenozoic.

Among the most characteristic expressions of the circum-Pacific region are the trenches that mark subduction zones and associated volcanic chains. Along the northeast Pacific margin, continuous accretionary subduction has been underway since about mid-Cenozoic. The shelves are typically narrow, commonly with steep slopes. Deltaic complexes are relatively small, and turbidite assemblages are widespread.

The continental-margin basins of the Northeast Quadrant extend some 12,800 km from northeast Peru to the Alaska Peninsula. The presently productive basins that are mainly offshore include: Cook Inlet, Sacramento, San Joaquin, Santa Maria, Salinas, Ventura, Los Angeles, Daule, Progreso, and Talara. Other basins with minor production include western Washington, Eel River, and Santa Cruz.

Examples of basins at the northeast continental margin are Cook Inlet basin, basins of the Gulf of Alaska, western Canada offshore basins, offshore western United States, and the Middle America marginal-trough basin.

Cook Inlet Basin

Cook Inlet Basin is a fault-bounded basin, 320 km long by 100 km wide. The basin is located in an arc-trench-gap setting between the volcanic arc represented by the volcanic and intrusive igneous rocks of the southern Alaska Range and a deformed Upper Cretaceous wedge of sediments to the southeast. Basin fill comprises rocks of Middle and Late Jurassic, Late Cretaceous, and Tertiary ages. The Lower Cretaceous section has been removed by mid-Cretaceous erosion. Upper Cretaceous rocks are mainly marine shale with only minor sandstone. The main basin fill is composed of thick Tertiary alluvial clastics of the Kenai Group.

The major oil and gas fields are located on north-trending anticlines.

Basins of the Gulf of Alaska

The continental margin of the central and eastern part of the Gulf of Alaska contains up to 10 km of Cenozoic sediments compressionally deformed by the subducting Pacific plate. The western Gulf of Alaska contains several basins with 2 to 6 km of Neogene sediments overlying older, more deformed Tertiary and Mesozoic rocks. The basins include Sanak, Shumagin, Tugidak, Albatross, and Stevenson. Sanak and Shumagin are small uplifted continental-slope basins containing late Miocene and younger rocks. Maximum thickness of sediment is possibly 2 to 3 km in Sanak and Shumagin basins.

The Kodiak Shelf offshore from Kodiak Island includes three basins - Tigidak, Albatross, and Stevenson - separated by structural highs. The north flank of the basins is marked by a wide zone of faults bounding the uplifted block of Kodiak Island. The seaward side is an asymmetric arch at the edge of the shelf about 115 km long and covered by as little as 16 m of water. Pliocene sediments comprise the main basin fill and may be as old as middle Miocene. The Pliocene is generally 3 to 3.5 km thick and possibly up to 7 km in Stevenson basin.

Western Canada Offshore Basins

The British Columbia offshore basins stretch 1,000 km from Dixon Entrance (between the Queen Charlotte Islands and southeast Alaska) in the north to the Strait of Juan de Fuca in the south. The major basins include Queen Charlotte, Tofino, and Winona.

Queen Charlotte Basin

The Queen Charlotte basin contains up to 4.5 km of Miocene to Pleistocene terrigenous clastics, predominantly nonmarine. The basin is probably floored by Jurassic and older intrusive and volcanic rocks with minor sediments, typical of the insular volcanic belt. Basement along the east is composed of plutonic and metamorphic rocks of the Coast Mountains. Along the west, the margin is formed by the tectonically emplaced "Pacific Rim" sequence. Development of the basin began in earliest Cretaceous time with the deposition of continental-shelf deposits of graywacke, argillite, and conglomerate. Northeastward tilting of the shelf was followed by the deposition of shallow-marine sediments during the Late Cretaceous. At the end of the Cretaceous or early Tertiary the Pacific Rim sequence of Upper Jurassic to Lower Cretaceous deep-water sediments was tectonically emplaced. Eocene and Oligocene sediments may have been deposited on the shelf; these are overlain by volcanics. Major Tertiary sedimentation began during the Miocene, interrupted by perhaps two periods of uplift and erosion, and continued through the Pliocene into the Pleistocene. Volcanics encountered in wells in the Queen Charlotte basin possibly were erupted during or immediately following the change in plate motion, convergence to translation, that took place about 10 m.y. ago, related to the widespread middle to late Miocene unconformity along the Pacific margin of western North America.

Tofino Basin

The Tofino basin contains a thick sequence of late Eocene to Pliocene rocks, primarily distal-facies mudstone and siltstone. The pre-Tertiary consists of a thick complexly-deformed sequence of Mesozoic sedimentary, metamorphic, intrusive, and extrusive rocks. A widespread submarine-volcanic event occurred in the early part of the middle Eocene. Initial subsidence occurred in the late Eocene, with major transgression in the Oligocene and early Miocene. Major uplift and regression occurred in the middle Miocene. Another major transgression of the sea occurred in the late Miocene, lessening in the early Pliocene. A major regressive phase followed in the late Pliocene to Pleistocene. Eocene to Oligocene rocks occur in a belt along the inner shelf, with Miocene and Pliocene rocks occurring mainly seaward.

Winona Basin

The Winona basin, with 3 to 5 km of Plio-Pleistocene sediments, lies at the base of the continental slope. The sedimentary succession is gently and broadly folded at the north, but deformed into prominent ridges at the south. The oldest sediments of the west flank, on the Paul Revere Ridge, are Pliocene, as indicated by Deep Sea Drilling Project (DSDP) hole 177A. The deepwater Winona basin most likely received a high proportion of second-cycle clastic deposits from the uplifted older Tertiary belt to the east.

Offshore Pacific Coast of United States

The basins of the Pacific offshore of the United States developed over a pre-middle Miocene unconformity. In general these basins developed on a surface consisting of a deformed sequence of Mesozoic sedimentary, metamorphic, and intrusive and extrusive igneous rocks.

Offshore Oregon and Washington

In northwestern Washington, oceanic basalt of Eocene age has been thrust onto the continental crust. This suggests a maximum age for the sedimentary section of offshore Washington. Western Oregon and Washington were the sites of thick sedimentation during early Cenozoic time with the accumulation of up to 8 km of sediment. Intense tectonism occurred during the late Eocene. The Coast Range was uplifted in the late Oligocene, and deposition shifted westward into the structural basins of the present continental shelf.

Offshore from Oregon and Washington a sedimentary basin occurs as an elongate trough, extending along the margin from Cape Blanco north to merge with the south end of the Tofino basin off Vancouver Island. Depocenters occur northwest of Coos Bay, off the mouth of the Columbia River, and off the southwestern part of the Olympic Peninsula. Within this elongate trough there is a sedimentary section of marine sandstone and siltstone of Eocene to Pliocene age as much as 8 km thick.

About 560 wells have been drilled in western Oregon and Washington with only about 70 drilled deeper than 1,500 m. Only 13 wells have been drilled offshore.

Northern and Central California

The continental shelf off northern and central California is characteristically narrow at Point Arguello (lat 34°30'N.) north. A deformed blanket of late Cenozoic sediments underlies the continental shelf and crops out in patches along the coast. Outcrops at Eureka (lat 45°45'N.) record a late Miocene transgression and marine deposition during the Pliocene. Regression occurred in the late Pliocene, with deposition of coarse nonmarine clastics in the early Pleistocene.

There are five sedimentary basins along the Pacific margin of central and northern California from Point Arguello north to the California-Oregon border. The basins from north to south are Eel River (including onshore), Point Arena, Bodega, Ano Nuevo, and offshore Santa Maria. The onshore portion of the Eel River basin has recorded minor gas production from Miocene beds, and minor oil production has been obtained from the onshore extension of the Ano Nuevo basin.

California Borderland

The California continental borderland, a subsea geomorphic province, is an elongate region lying shoreward of the 3 km isobath that extends from point Conception (lat 34°30'N.) to Isla Cedros (lat 28°N.). The region is characterized by a highly irregular submarine topography of basins and ridges. There are about 19 major topographic basins (35 to 135 km long by 8 to 35 km wide) with water depths ranging from 200 to 3,000 m. The seaward boundary of the borderland is marked by a steep continental slope known as the Patton Escarpment in its northern part.

The borderland owes its origin to a position on the Pacific plate near the northern termination of the East

Pacific Rise where motion of the Pacific plate changes to extension along major strike-slip faults. The dominant structural control in the borderland is a wrench-fault system. The origin and history of the southern California basins has been ably discussed by Crowell (1974).

Middle Miocene sedimentary and volcanic rocks occur in most of the area and at one time may have covered it entirely, with deposition over a broad shelf with volcanic centers. This shelf subsided uniformly with the accumulation of 2.5 km or more of middle Miocene sediments and volcanics. Near the end of the middle Miocene the shelf was folded, faulted, and broken up into basins in which siliceous and phosphatic shales were deposited in seaward areas. Sandstone, shale, and breccia were deposited in landward areas. Offshore basinal deposition began early in late Miocene time.

Clastic material was derived for the most part from the mainland and was distributed by turbidity currents. These depositional processes have continued to the present.

California offshore basins, once part of a regional Pacific basin, became separated as a result of the Neogene transform movements and are now elongate deep basins separated by uplifts of Mesozoic and older rocks. The four Tertiary basin areas include the San Diego trough, offshore Los Angeles, the Outer Banks, and the Ventura-Santa Barbara Channel.

The San Diego trough is a broad basin filled with up to 3 km of Tertiary sediments derived from Mesozoic metasediments and granitic intrusions.

The Outer Banks basins contain mainly Upper Cretaceous and Eocene-Oligocene clastics 2 to 3 km thick. Miocene-Pliocene sediments are absent or thin on the crests of major structural highs and up to 1.5 km thick in the basin deeps.

Onshore Southern California Basins

The most significant productive basins of the Northeast Pacific Margin occur in California. The onshore basins include Sacramento, San Joaquin, Salinas, Santa Maria, Ventura, and Los Angeles. Production for the Santa Maria, Ventura, and Los Angeles basins extends into the offshore area.

The Sacramento and San Joaquin basins occupy the Great Valley of California, bounded on the east by the Sierra Nevada and on the west by the western margin. The basins are an asymmetric structural trough with the axis near and parallel to the western margin. The two basins are separated by the Stockton arch fault zone in the subsurface. The Sacramento basin, 450 km long by 100 km wide, contains Upper Cretaceous and Tertiary sediments, which thicken from north to south to about 7 km. The basin is essentially a dry-gas producing area with production from Upper Cretaceous and Tertiary sands.

The San Joaquin basin, 410 km long by about 100 km wide, contains a thick Upper Cretaceous and Tertiary section, which reaches a thickness of at least 12 km in the southwest part. Production from the basin is primarily oil with significant associated gas. Productive sands occur from the Upper Cretaceous to the Pliocene with most of the production from Miocene and younger formations.

The Salinas-Cuyama basin is a coast-parallel basin, 250 km long by 45 km wide, lying to the west of the San Joaquin basin. The basin is bounded to the northeast and southwest by major strike-slip faults. The area is underlain by granitic basement and contains a relatively thin section of about 2 km of lower Miocene to lower Pliocene clastic rocks. The largest field is San Ardo, producing from Miocene sandstone.

The Santa Maria basin is a triangular-shaped area in the California coastal belt. It is bounded by mountain ranges to the northeast and the south and extends into the offshore to the west. The basin contains up to 2 km of Tertiary clastics. Principal production is from the fractured shale of the Monterey Formation with some production from Miocene and Pliocene sands.

The Ventura basin is a west-trending transverse basin containing a very thick Upper Cretaceous to Tertiary section, possibly as much as 12 to 15 km thick. The basin extends into the offshore and is in structural contact with the Santa Barbara Channel. All epochs from the Late Cretaceous to the Pleistocene are productive, with principal production from the Miocene and Pliocene.

The Los Angeles basin is a small, very deep basin of about 4,150 km^2 with more than 10 km of Tertiary sediments. The late Miocene and early Pliocene sediments form the main productive horizons.

Middle America Marginal-Trough Basin

The Middle America marginal-trough basin is a large sediment trough on the Pacific continental shelf extending approximately 1,100 km from Costa Rica to southern Mexico. Oldest sediments are believed to be Upper Cretaceous with a maximum sedimentary section of about 8 km. The main sedimentary fill is post-early Miocene.

The tectonic setting of the basin from the late Tertiary to the present is a forearc basin in an arc-trench gap. The outer shelf and slope is believed to be an accretionary prism, uplifted by imbricate thrusting involving oceanic crust and overlying sediments. Gravity and seismic data suggest a marginal ridge paralleling the trench. This is most likely an offshore extension of basement of the Nicoya complex, an uplifted belt of Mesozoic and Paleogene basic volcanic, ultramafic, and associated pelagic and turbidite sediments.

The tectonic history of the Pacific marginal zone (Coast Ranges, coastal plain, shelf, slope, and trench) is relatively young, probably late Tertiary and younger. The major tectonic features of the late Tertiary are superimposed on early Tertiary and older tectonic trends. The main orogeny occurred during latest Cretaceous and early Tertiary (Laramide) with deformation and upwarping of the older arc-trench Nicoya complex. This was followed by subsidence and transgression in the early Paleogene, especially during middle Eocene with basaltic volcanism and volcaniclastic deposition. In early to middle Miocene time, folding occurred followed by marine transgression with formation of the offshore ridge and marginal-trough basin. This was accompanied by calc-alkaline plutonic activity in Costa Rica.

Southeast Quadrant

Within the Southeast Quadrant, the presence of producible hydrocarbons was detected by settlers shortly after America was discovered. In 1532, the Spanish Emperor Charles V officially authorized the settlers to produce "mineral oil" from the Caribbean island of Cubagua to be used for healing purposes. This first documented reference could be interpreted as the start of a significant oil industry in the region that was producing 3,076,000 bbl of oil and 5,562 million ft^3 of natural gas per day by the end of 1987 (489,053 m^3/day of oil and 157.5 million m^3/day of gas). Brazil is not included in these figures.

The abundant oil and gas resources in the Southeast Quadrant are distributed mainly in eight countries. These are ranked based on cumulative production and remaining reserves as follows: (1) Venezuela; (2) Argentina; (3) Colombia; (4) Ecuador; (5) Trinidad-Tobago; (6) Peru; (7) Bolivia; and (8) Chile.

Orinoco Oil Belt and Oriental Basin (Venezuela)

The Venezuelan Orinoco Oil Belt, has an estimated volume of in-place heavy crude oil of 187.8 billion m^3 (1,181 billion bbl). At year-end 1986, proved reserves in the belt were 4.16 billion m^3 (26.17 billion bbl) and unproved reserves 14.82 billion m^3 (93.23 billion bbl) according to Martinez (1987).

Located on the south flank of the backarc Oriental Basin, the Orinoco Oil Belt covers an area of 54,000 km^2 and consists of a prism of Tertiary sediments wedging to the south, which unconformably overlies the Cretaceous, the Paleozoic, or the Precambrian basement of the Guiana Shield. Ninety percent of the crude oil is contained in the Miocene Oficina Formation, which consists of fluvial and marine clastic rocks, and the rest is in Late Cretaceous reservoirs.

As many as 11 giant oil fields (with estimated ultimate recovery of more than 500 million bbl and 3 trillion ft^3 of gas) have been discovered in the Orinoco Oil Belt. In the rest of the Oriental Basin, five other giant oil fields and two giant gas fields (El Furrial and El Placer) are presently being produced and developed.

Maracaibo Basin (Venezuela)

The sedimentary basin with the largest estimated ultimate recovery of oil and gas in the Southeast Quadrant is by far the Maracaibo Basin, Venezuela, with a total estimated ultimate recovery of 80,000 million bbl of crude oil and some 73 trillion ft^3 of gas. In the Maracaibo Basin there are twelve giant oil fields with a total estimated ultimate recovery of 44,000 million bbl and a cumulative oil production of 27,000 million bbl by the end of 1987.

San Jorge Basin (Argentina)

The second most important oil producing country in the Southeast Quadrant is Argentina, both for its oil reserves and present daily production. Argentina contains four giant oil fields and one giant gas field. Two of the giant oil fields are in the San Jorge Basin, where the first commercial oil field of Argentina, the Comodoro Rivadavia field, was discovered on December 13, 1907, when the government was exploring for ground water for the small port and settlement there.

Neuquen Basin (Argentina)

Another giant field for both oil and gas reserves is Loma de la Lata in the Neuquen Basin of Argentina, a predominantly Jurassic and Cretaceous depositional basin filled with marine and nonmarine clastic sediment, subordinate carbonate rocks, and evaporites.

Cuyo Basin (Argentina)

The last giant oil field of Argentina is Punta de Bardas-Vacas Muertas, within the Triassic Cuyo Basin. Cuyo is a typical pericratonic land-locked intermontane basin of a transtensional taphrogenic tectonic style.

Middle Magdalena and Llanos Basins (Colombia)

Colombia is the third greatest oil-producing country in the Southeast Quadrant. A large part of Colombian production comes from basins where two giant oil fields have been discovered to date. One is the Middle Magdalena Basin, an intra-arc basin that lies between the two eastern branches of the Colombian Andes, as an elongated half graben with more than 12 km of Cretaceous to Holocene sedimentary fill. The other is the Llanos Basin, a vast grassy lowland stretching from the Andean foothills eastward to the Guiana Shield.

The main oil field in the Middle Magdalena Basin is La Cira-Infantas, a faulted anticline where producing Eocene sand unconformably overlies a deeply truncated Cretaceous sequence. Productive zones in the Eocene La Paz Formation and in the Oligocene Mugrosa and Colorado Formations held more than 520 million bbl of oil of which some 459 million bbl had been produced by 1987.

Los Llanos Basin is a Paleozoic through Tertiary clastic sedimentary basin in the sub-Andean pericratonic trend. Very asymmetric, the main pronounced structural development is in the foothills belt, where compressional stresses associated with the Andean Orogeny created a series of large folds and westward-dipping thrust faults.

Exploration of the Llanos Basin has been cyclic. The first well drilled in 1944 resulted in a subcommercial discovery. Increased exploration efforts took place in 1958, 1969, and finally in 1980, when the Arauca field was discovered. Exploration was resumed in 1983 and is continuing at a good pace after discovery of the Cano Limon X-2, which tested oil from the late Eocene Mirador Formation at a rate of 10,690 bbl/day of low-sulfur, 31 degrees American Petroleum Institute (API) gravity oil. Subsequent drilling has established the discovery as a giant oil field, with an estimated ultimate oil recovery of over one billion bbls. Present oil production of the Cano Limon area is 209,000 bbl per day.

Oriente Basin (Ecuador)

The most prolific basin in Ecuador is the Oriente Basin, extending from the foothills of the Andes eastward over an area of over more than 100,000 km^2. Oil accumulations are structurally controlled mainly in north-trending faulted anticlines, but stratigraphic trapping is also evident in certain areas.

Two giant oil fields were discovered in the Oriente Basin in 1969: Shushufindi and Sacha. The anticlinal features are of very low structural relief, with lengths of 35 km and 28 km, respectively. Commercial production is from the U and T sands of the Napo Formation in the Shushufindi field (estimated ultimate recovery of 1.35 billion bbl and from the Hollin Formation (69 percent) and the U sands of the Napo Formation (21 percent) in the Sacha field (estimated ultimate recovery of 753 million bbl).

Progreso Basin (Equador)

This marginal basin, which extends from the Gulf of Guayaquil to the northwestern part of Peru, contains as much as 8 km of post-Oligocene shale, siltstone, and sandstone. The sedimentary section is mostly Miocene, with some Pliocene and Pleistocene marine deposits. In 1970 the giant Amistad gas field was discovered in the Gulf of Guayaquil. The estimated ultimate recovery of the Amistad undeveloped field is 3 trillion ft^3 of natural gas.

Talara Basin (Peru)

The Talara or Northwestern Peruvian Basin lies on the Pacific coast west of the Andes. Only a part of the basin is preserved on land, but it extends well into the offshore area where it may connect with other Tertiary basins along the Pacific coast of South America (Progreso, Daule, and Sechura). The basin contains more than 8 km of Campanian (83-73 Ma) to late Eocene marine to fluvial-transitional clastic sediment. The main producing horizon is the early Eocene Parinas Formation consisting of deltaic, fluvial, and turbidite deposits. Production is also obtained in descending order of importance from the Paleocene Salina-Mogollon Formation and from the middle and late Eocene Talara and Verdum Formations. Finally, oil was produced from the Oligocene and Miocene in the depleted Zorritos oil field in the Progreso Basin, close to the Ecuadorian border.

A giant field, the La Brea-Parinas field discovered in 1869, has produced for more than a century with a cumulative production of 539 million bbl of oil. As of December 31, 1987, the estimated ultimate recovery is 592 million bbl. For the entire Talara region the estimated ultimate recovery is 1,339 million bbl of crude oil.

Ucayali Basin (Peru)

The lower Ucayali Basin, of the pericratonic domain, extends into the central part of Peru, near the Urubamba River valley. In this basin a sedimentary fill as thick as 5.5 km composed of Paleozoic, Jurassic, Cretaceous, and

Tertiary deposits overlies the Precambrian Andean basement. Two giant gas fields, San Martin and Cashiriari, have estimated ultimate recoveries of 3 trillion and 8 trillion ft^3 of natural gas, respectively. Production from these huge anticlines is from Cretaceous sandstone reservoirs at depths between 3,900 m (12,800 ft) in the San Martin field and 2,440 m (8,000 ft) in the Cashiriari field.

Trinidad-Tobago Basins

The main structural elements of the Trinidad-Tobago Basins in the easternmost part of the Venezuelan mobile belt are lateral extensions of tectonic features farther west. These elements from north to south are the Northern Range (Coastal Range of Venezuela), El Pilar fault, Northern Basin, Central Range, Naparima thrust belt, the prolific Southern Basin, and the Southern Range.

Several giant and major oil and gas fields were discovered in the Trinidad-Tobago Basins, starting in 1913 with the Fyzabad Group (estimated ultimate recovery of 850 million bbl) on land, followed by Soldado field (estimated ultimate recovery of 600 million bbl) offshore in the Gulf of Paria. Many other oil fields lie on the island, such as Point Fortin, Erin, Palo Seco, Penal, Oropuche, Trinity, Catshill, Moruga, Balata, Morne Diablo, Navette, and others. The Miocene Cruse and Forest-Moruga Sandstones are the main oil reservoirs. The most common trapping mechanisms are up-dip permeability pinchouts over or on the flanks of contemporaneous mud diapirs. Oils have an average gravity of 23 degrees API.

At present active exploration is confined to the offshore area, both in the West Tobago Basin in the north and in the Columbus-Galeota Basin in the south and east. Significant discoveries have been made, mainly natural gas, like the giant North Coast Group (estimated ultimate recovery of 3 trillion ft^3) and the Galeota Group (7 trillion ft^3 of recoverable natural gas). Productive intervals are mainly of Pliocene age (Gros Morne and Saint Hilaire Formations), and even Pleistocene, such as the Queen's Beach and East Manzanilla gas fields, in the tropical Atlantic Ocean.

Northwest Quadrant

Sedimentary Basins in the Northwest Quadrant

Figure 12 shows about 197 sedimentary basins in this map area (listed in table 8). Stratigraphic columnar sections are shown for the representative 47 sedimentary basins and 1 oceanic rise (fig. 17). In this map, a sedimentary province, which has the undeformed sediments with thickness of more than 1000 m, is identified as 'a sedimentary basin'. Almost all sedimentary basin boundaries coincide with the 1000-m isopach line, or main tectonic lines, which control the tectonic development of the basins. Most oil and gas fields are located within sedimentary basins. Many coal fields, however, tend to be located outside of the sedimentary basins.

The 197 main sedimentary basins of the Northwest Quadrant can be classified as 12 types according to their geographic distribution and geologic characteristics, as follows:

1. Arctic Sea, northern area of the North American Continent and Asian Continents
2. Pacific coast of the North American Continent
3. Along the Aleutian Islands arc, between the Pacific and North American Plates
4. Over the cratons of Asian Continent
5. Along the suture zone between the cratonic blocks within the Asian Continent
6. Along the eastern margin of the East Asian Continent
7. In and along the trench-island arc-marginal sea systems of the Northwest Pacific Ocean
8. Along the continental margin of the Southeast Asian Continent including the Sunda Shelf
9. Inside the Sunda Shelf-Indochina region tectonically controlled by Cenozoic wrench tectonics related to the collision of the Australia-India Plate to the Eurasia Plate
10. Along the islands around the Banda Sea
11. In and around New Guinea
12. Along the Solomon islands arc

Each basin within a geographic group has common geologic characteristics, such as initiation age, lithofacies variation, and tectonic development. This implies that the generation and evolution of sedimentary basins has been strongly affected by the regional geologic evolution or by the movement of the multiple plates. From the view point of petroleum geology, these geological characteristics effect the basic characteristics of the oil and gas fields, source rock, reservoir facies, thermal and diagenetic histories, and oil and gas potential.

The sedimentary basins of type 4 distributed over the cratons of the Asian Continent, for example, Eerdosi Basin (074, fig. 13 and table 8) and Shichuan Basin (085, fig. 13 and table 8), have the following general characteristics:

1. Developed in a non-marine environment
2. Basin initiation in the Precambrian or early Paleozoic
3. Basins with round or square shapes, and diameter of several hundred kilometers
4. Giant oil and gas fields present

The sedimentary basins of type 6, distributed along the east margin of the east Asian Continent, Songliao Basin (065, figure 13 and table 8) and East China Sea Basin (081, fig. 13 and table 8), for example, have the following general characteristics:

1. Initiated in a nonmarine environment, and developed in a non-marine environment or shallow marine environment
2. Basin initiation in the Mesozoic
3. Basins elongated in a direction parallel to the trench system
4. Development of these basins affected by rift tectonism related to the Pacific Plate subduction beneath the Eurasia Plate
5. Giant oil and gas fields present

The sedimentary basins of type 7 can be divided from their geographic position in the trench-island arc-marginal sea systems into forearc basins, backarc basins, and intra-arc basins and are distributed in and along the trench-island arc-marginal sea systems of the northwest Pacific Ocean. Niigata-Akita Basin (048, fig. 13 and table 8), Shimajiri Basin (061, fig.12 and table 8), and Visayan Sea Basin (126, fig. 12 and table 8), for example, have the following general characteristics:

1. Initiated in a nonmarine environment; almost all initiated and developed in a marine environment
2. Significant variations of lithofacies and depositional environments in the lateral and vertical dimension
3. Basin initiation in the Cenozoic
4. Basins elongated in a direction parallel to the island arc
5. Giant oil and gas fields not present

Oil and Natural Gas

Index maps and data of selected oil and gas fields for the Northwest Quadrant are shown in figs. 13 and 14. Data such as the year of discovery, reservoir age, lithology for each field, and cumulative production are included in table 9.

Southwest Quadrant

The major oil and gas fields of the map sheet area have been plotted on the main map and are shown in fig. 15 and are detailed in table 11. The estimated proven reserves of oil and gas (1992 figures) of producing countries within the map sheet area are shown in table 12. Economic oil and gas deposits in the non-overlap region of the map are confined to Papua New Guinea, Australia, and New Zealand. The estimated proven reserves of these three countries are: oil-1,893,930 (1,000 bbl) and gas-26,506 (bcf) (table 13).

OIL SAND

Oil sand is defined as those oil-impregnated sands from which the oil cannot be recovered by conventional borehole methods. The gravity of the oil is generally about 10 degrees API or less. Significant oil-sand deposits are shown by a green stippled pattern on the map. Major deposits of oil sand occur in Canada and Venezuela; minor deposits occur in Trinidad, Columbia, and the United States (Utah, California, and New Mexico).

Northeast Quadrant

Four major oil-sand deposits covering an area of approximately 49,500 km2 occur in central Alberta, Canada: Athabasca, Wabasca, Peace River, and Cold Lake. The deposits occur in a wedge of Cretaceous sediment that onlaps the Canadian Shield. The depth ranges from the surface down to 600 m. About 2000 km^2 of these deposits are covered with 50 m or less of overburden. Oil-in-place in the four deposits is estimated to be 1,080 billion barrels, of which 35 billion barrels are considered economically recoverable by current methods of open-pit mining. Currently the only in situ production of synthetic crude oil from oil sands is from the central Alberta deposits (fig.16).

Southeast Quadrant

Giant deposits of oil sand occur in Venezuela, and minor deposits are found in Colombia, Trinidad, Ecuador, and Peru.

The largest accumulation in the Southeast Quadrant is the Miocene oil sand of the formerly named Orinoco Tar Belt. Oil-sand deposits are base-wedge and wedge-edge occurrences where Tertiary deposits onlap the Precambrian basement of the Guiana Shield.

Smaller but important oil-sand deposits have been reported in Colombia and Ecuador; the main one is located west of the Sacha giant oil field, close to the Andean foothills. Another significant oil-sand deposit is in southern Peru, in the mountainous area close to the headwaters of the Indio Muerto and Yauca Rivers.

The two major oil-sand areas of Canada and Venezuela are shown in fig. 16 with generalized structure sections that show the similar tectonic setting of the two deposits.

OIL SHALE

Oil shales are fine-grained sedimentary rocks which when heated in a closed retort, yield substantial amounts of oil (40 liters of oil per tonne of shale is considered the minimum yield for a true oil shale). The organic matter contained in oil shales is usually derived from algal remains and from spores and pollen that have been deposited in swamps, lakes, and shallow seas. Oil shale is depicted on the map by a green outlined pattern.

The most significant oil-shale resources of the Pacific Basin occur in the Northeast Quadrant in Colorado, Utah, and Wyoming, of the western United States.

In the Southeast Quadrant only a few minor oil-shale deposits have been reported in Chile and Argentina.

In the Northwest Quadrant large marine oil-shale deposits of Early and Middle Cambrian age occur on the northeastern Siberian Platform around Anabar, Olenek, and the Lena Rivers. Oil-shale deposits of Jurassic and Cretaceous age in northern China and Mongolia are mostly associated with coal-bearing rocks. Oil-shale deposits of Tertiary age in China, Thailand, and Myanmar (Burma) are associated with coal-bearing rocks and occur in marginal regions where major orogenic movements produced folded and faulted mountains (Duncan and Swanson, 1965; Duncan, 1976).

In the Southwest Quadrant oil shales are found in all states of Australia and in New Zealand. Most of Australia's demonstrated oil-shale resources are situated in narrow deep Tertiary basins along the central coast of Queensland. However, far larger are the inferred deposits in a thin but extensive marine Cretaceous formation underlying much of northwestern Queensland, which is estimated to contain 3,838,000 million tonnes of shale containing 230,000 million cubic meters of oil (tables 18 and 19). At present Australia's oil-shale resources are classed as subeconomic.

COAL

Coal deposits of the Pacific Basin are shown in brown patterns indicating rank and general areal extent of the deposits.

The classification of coals by rank is based on the percentage of fixed carbon and calorific value (expressed in BTUs per pound) calculated on a mineral-matter-free basis. Although there may be some differences between countries, in general the rank classification used is that established by the American Society for Testing and Materials (1966). This is summarized in appendix IV.

Major coal deposits occur throughout much of the Pacific Basin. Most of the significant deposits and production are associated with interior basins and bordering foreland-thrust belts.

Coal production for the countries of the Circum-Pacific region for 1996 is shown in table 3.

Northeast Quadrant

Major coal deposits occur throughout much of the Northeast Quadrant (fig 18; table 14). Most of the significant deposits and production are associated with interior basins and bordering foreland-thrust belts. Significant coal deposits of the Pacific margin, with only minor production at present, occur in the Cook Inlet and Susitna basin areas of Alaska, the Queen Charlotte Islands, and Vancouver Island of the Canadian margin, Washington, Oregon, California, Mexico, and Costa Rica.

The major producible coal deposits of western Canada occur in the synorogenic clastic wedge of eastern British Columbia and Alberta. The coal ranges in age from latest Jurassic to Paleocene. The Energy Resources Conservation Board (1985) estimates remaining in-place resources of all types of coal in Alberta at 59 gigatonnes (109) as of December 31, 1984, of which 22 gigatonnes are considered recoverable.

The only producing coal field in central Alaska is in the Nenana basin. Production from this area totalled 800 million short tons in 1984. The major coal-producing areas of the western United States are the Great Plains and Rocky Mountain province. Production from these two areas in 1984 totalled 248.9 million short tons.

Coal deposits of Mexico occur in three basins: (1) in the state of Coahuila (north-central Mexico) with six coal districts, (a) Rio Escondido, (b) Sabinas, (c) Esperanza, (d) Saltillito, (e) San Patricicio, and (f) Monclova; (2) east of Hermosillo, Sonora; and (3) in the state of Oaxaca, southeast Mexico.

One of the more important deposits in Central America is the Rio Uscari district in Costa Rica.

Southeast Quadrant

Commercial coal deposits ranging in rank from anthracite to lignite and peat occur within the area covered by the Southeast Quadrant (fig. 19, 20; table 15). Commercial deposits are of late Paleozoic, Triassic, Jurassic, Cretaceous, and Tertiary age. Peat deposits are mainly of Quaternary age.

Rough estimates for principal coal deposits in the Southeast Quadrant total 46.6 billion metric tons of proved and additional reserves. The reported commercial peat deposits are on the order of 208 million metric tons.

The largest coal resources, about 20 billion metric tons, are found in Colombia, followed by Venezuela and Chile, with 9.2 and 8.7 billion metric tons, respectively. Colombia is by far the largest coal producer with an output of close to 15 million metric tons per year (table 15). Coal is found in early Tertiary basins in intermontane valleys along the flanks and foothills of the Andean and Caribbean Ranges and along their northern and eastern extensions. Eighty percent of these coal reserves are in the Cundinamarca and Boyaca Provinces, El Cerrejon being one of the most important deposits with estimated reserves of over 1,600 million metric tons. The area of this Paleocene deposit is 38,000 hectares at 200 m below the surface. The present El Cerrejon project, at a cost of 3 billion dollars, will have a production rate of 15 million metric tons per year.

Early Tertiary Colombian and Venezuelan coal is mainly bituminous. Early Cretaceous coal of Peru is anthracitic, and Tertiary coal of Chile and Argentina is subbituminous and lignitic. Quaternary peat deposits are reported in Argentina, Bolivia, and Ecuador.

Northwest Quadrant

The economically workable coal seams occur in intracratonic basins and platforms, and orogenic regions, of Upper Carboniferous-Permian, Upper Triassic-Jurassic, and Upper Cretaceous-Middle Tertiary age (fig. 21; table 16).

In the orogenic regions like collisional suture, island arc, and so on, coal-bearing basins may have been exposed to rapid differential uplift and subsidence, and as a result, the basins tend to be limited both in extent and coal property. Coal-bearing formations are likely to be deeply buried, often in areas of high geothermal gradient due to regional and local volcanic activity. This causes relatively high but variable character in the rank of coal.

In the stable cratonic regions, relatively extensive deltaic coal-bearing basins are usually formed. Usually transgression and regression extend over wide areas and then laterally persistent coal seams are formed in coastal environments. Such areas seldom suffer intense deformation. Therefore, range in the rank of coal is often relatively narrow, and there is no definite structural control on coal-bearing basins.

This quadrant area is basically composed of the Angaraian paleoplate, Cathaysian paleoplate, and fragments of Gondowanaland from north to south. The Cathaysian paleoplate contains the Bureya, Tarim, Sino-Korean and Yangtze cratons.

The suture between the Siberia and Tarim-Breya cratons was the main ocean separating the Angaraian paleoplate and the Cathaysian paleoplate during Paleozoic and Early Mesozoic time. The collisional suture separating the Bureya and Sino-Korean cratons is of Permo-Triassic age. The collisional suture separating the Sino-Korean and South Yangtze craton is of Late Triassic-Early Jurassic age. The next collisional suture to the south, separating the Yangtze craton from North Tibet-Malaysia, and from Indonesia, is of Jurassic age. The continuous area from Northern Tibet through Malaysia and Indonesia is considered as a separate plate further extending under the Gulf of Thailand to southwest Borneo.

By Late Triassic, the core of Southeast Asia was largely consolidated. Thereafter, the additional Gondowanaland fragments of South Tibet and of Burma-Northwest Sumatra were accreted during Cretaceous time. Finally, India arrived and during Eocene time, collided and drove into the pre-existing mosaic of plates in southern Asia.

In Angararian paleoplate, there are developed extensive deltaic coal-bearing strata of Carboniferous, Permian, Lower and Middle Jurassic, Upper Cretaceous and Neogene age. In the Sino-Korean and Yangtze cratons, extensive deltaic coal-bearing strata from Middle Carboniferous to Lower Permian in age and Jurassic coals are well developed in Korea. In the collisional suture separating the Tarim-Sino-Korean cratons and Yangtze craton, Jurassic and Cretaceous coals are well developed.

In Vietnam, the Permian to Triassic basins that occupy a collisional suture zone are interpreted as basins that have subsequently opened as a result of wrench faulting. They are commonly characterized by rhyolitic volcanism and by the presence of important coal deposits. A major orogenic event in the Late Cretaceous was the collision of the Burma microplate with the Sinoburmalaya margin of Eurasia, and this collision was the major cause of formation of coal-bearing basins. In early Tertiary, the Burma microplate was moving northwards and important transform motion began in Thailand, Malaya Peninsula, and Sumatra. Slight extension on strike-slip faults led to important Tertiary graben-like coal basins along and adjacent to the line of these faults. In eastern Kalimantan, extensive deltaic coal-bearing strata are developed in the continental marginal basins. In the Taiwan region and Japan, the Pacific Plate convergence caused strike-slip faulting or differential uplift and subsidence and the resulting formation of coal-bearing basins.

The collision between the Indian Plate and the Eurasian Plate and the subduction of the Pacific Plate under the Eurasian Plate in Eocene time led to the formation coal basins caused by intracratonic strike-slip fault movement in China, Burma, and Thailand, and also the volcanic inner-arc intramontane coal basins in Japan, Taiwan, and the Philippines (Tapponnier and Molnar, 1977; Tatsch,1980; Zhang and others, 1984; Parker and Gealey, 1985; Taira and Tashiro, 1987; Hutchson, 1989).

Southwest Quadrant

Irian Jaya

Coal seams up to 1 m in thickness occur in nonmarine fluviodeltaic sediments of Permian age in the center of the "Birds Head" region of western Irian Jaya. Rocks of similar age and provenance that crop out along the western end of the Central Range in eastern Irian Jaya also contain thin coal seams up to 1.5 m thick (table 17).

A number of minor deposits of lignite are known from the Salawati and Bintuni Basins in the "Birds Head" region and from the Akimegah, Iwur, and North Coast Basins of eastern Irian Jaya. These are of Neogene age. All of the coal occurrences located to date in Irian Jaya are either too small, too low grade, or too remote to be economic.

Papua New Guinea

Apart from coal bands found in Jurassic sediments in oil exploration wells in the Gulf of Papua, all Papua New Guinea coal is Neogene or Quaternary in age. Neogene coal deposits occur throughout the country; however, the major occurrences are:

1. A belt extending from around the Gulf of Papua through the Southern Highlands westward to the Star Mountains on the Irian Jaya border
2. The North Sepik region
3. The Huon Peninsula
4. The Gazelle Peninsula on the eastern tip of New Britain and southern New Ireland
5. Cape Vogel Basin.
6. Areas around Goroka and Gumini in the Highlands region.

Quaternary coals are found interspersed with those of Neogene age in the Gulf region, Southern and Western Highlands, and North Sepik area.

In general the coal seams tend to be thin, discontinuous, and are often dipping and located in inaccessible localities. Analyses show that (1) the rank of the coals varies between lignite and subbituminous; (2) there are wide variations in composition within individual deposits; (3) in general the coals have a high sulfur content; and (4) the Quaternary coal shows very high ash and low fixed-carbon content.

None of the coal deposits are considered economic.

New Caledonia

Small deposits of coal occur in a number of Jurassic to Cretaceous basins that are found along the western side of the island. In general the individual seams are discontinuous and vary greatly in thickness. Rank ranges from subbituminous to bituminous. The largest basin (Nondoue) lies between Noumea and St. Vincent to the northwest; here, however, the coal seams are extremely variable in extent and are not economic. The Moindou Basin farther to the northwest contains seams up to 2 m in thickness and small quantities of coal have been mined in the past (1881-1902, 1930-1933) to fire nickel furnaces near Noumea.

New Zealand

New Zealand coal ranges in age from Cretaceous to Tertiary and in rank from lignite to bituminous. Approximately 86 percent of the estimated total recoverable coal reserves of 6,500 million tonnes is lignite, 11 percent subbituminous, and 3 percent bituminous. The coal fields can be grouped into seven regions. They are (north to south): Northland, Waikato, Taranaki, Nelson-Westland, Canterbury, Otago, and Southland.

Australia

Australia has about six percent of the world's demonstrated resources of black coal and eight percent of the world's brown coal. It is the world's leading exporter of black coal. The bulk of the very large resources of Australian coal are Permian or Tertiary in age with lesser Triassic, Jurassic, and Cretaceous deposits. In contrast to Europe only minor occurrences of Carboniferous coal are known. Coal grades range from lignite to bituminous and minor amounts of anthracite. Coal is mined in all of the Australian States except the Northern Territory with the bulk of the estimated recoverable resources in Queensland and New South Wales (Permian, bituminous) and Victoria (Tertiary, lignite).

Antarctia

Laminae and lenses of coal occur in Permian sandstone at Horn Bluff in George V Land in East Antarctica. The quantity of coal is insignificant and is of no economic importance.

GEOTHERMAL RESOURCES

Three kinds of geothermal data are shown on the Energy-Resources Map of the Pacific Basin: geothermal fields that have been identified, those developed to generate electricity, and hot springs with surface temperatures >50 degrees C.

The classification scheme, showing type of hydrothermal-convection system (water-dominated or vapor-dominated) and estimated reservoir temperature, is from Muffler (1978). Hydrothermal-convection systems have been further divided to distinguish between systems that are generating power and those that are currently being developed.

Northeast Quadrant

The largest producer of electricity from geothermal energy in the Northeast Quadrant is The Geysers geothermal plant, located in the Coast Ranges in northern California. The system is vapor-dominated, one of three of this type in the United States. The plant currently has a generating capacity of 1,792 megawatts (MW) (DiPippo, 1985).

Several hydrothermal-convection systems have been identified throughout northern California, Oregon, and Washington in the volcanic Cascade Range, and in the volcanic area of central and southeastern Oregon. The hydrothermal-convection system at Mt. Lassen in northern California is a high-temperature, vapor-dominated system, but because of National Park status it has not been developed. None of the identified systems in the Cascades or southeastern Oregon have been developed to date, but in many of these areas geothermal water is being utilized for space heating.

Young volcanoes exist throughout the Snake River Plain of Idaho, and numerous hydrothermal-convection systems have been identified. The size of the reservoirs, however, is not known. Farther east, in northwestern Wyoming, a third vapor-dominated system occurs in the Mud Volcano area of Yellowstone National Park, but it is also withdrawn from commercial development because of National Park status.

In the region of the eastern Sierra Nevada range front in eastern California and western Nevada, the Long Valley caldera is related to the young volcanic features (DiPippo, 1985). The Coso 25 MW geothermal plant was constructed in 1985.

The occurrence of hot-water reservoirs in the Imperial Valley of southern California is attributed to active crustal spreading and Quaternary volcanism. Three geothermal plants have been built in this region and are generating electricity: Salton Sea (10 MW), Brawley (10 MW), and East Mesa (12.5 MW). A fourth plant, at Heber, has a generating capacity of 45 MW. In the southern part of this region, the Cerro Prieto geothermal plant in northern Baja California produces 400 MW (DiPippo, 1985).

In the Basin and Range geologic province, hydrothermal-convection systems in the northwest part of Nevada are the result of crustal extension. The Brady Hot Springs and Desert Peak geothermal fields in northwestern Nevada were being developed in 1985 (DiPippo, 1985).

A small cluster of hydrothermal-convection systems are found in southwestern New Mexico and southeastern Arizona and to the north near the Wasatch front in Utah. The Roosevelt (Utah) geothermal plant produces 20 MW, and the Fort Cove-Sulphurdale (Utah) geothermal plant produces 0.675 MW in each of its four units.

In the northern Rockies, hydrothermal-convection systems occur mainly in the region of the Idaho batholith in southwestern Montana. Other small systems occur in the Rocky Mountains, but they are scattered, and temperatures are lower than 90° C.

The easternmost extent of geothermal fields in the western United States is the Rio Grande rift, which extends from New Mexico northward into the southern Rockies of Colorado. The largest identified hot-water system of this geologic province occurs within the Valles caldera in New Mexico.

In Alaska, twenty-five hot-water hydrothermal-convection systems with temperatures from 90° to 150° C and three with temperatures >150° C, have been identified. They occur across central Alaska and in southeast Alaska. Because of the remoteness of these geothermal fields, none are being commercially developed at this time.

On Hawaii, the youngest of the Hawaiian Islands, a small geothermal power plant, Puna No. 1, was built on the rift zone of Kilauea volcano. The plant, built in 1982, generates 5 MW.

Canada's high-temperature geothermal areas are located along the volcanic belts of the Cordillera (Jessop, 1985). Two identified geothermal fields, Mt. Meager area at lat 52.5°N, long 123.5°W, and Mt. Cayley at lat 50° N, long 123.5°W. have reservoir temperatures that exceed 150° C. Because the need for electrical power in Canada has been declining, however, the pace of development of these geothermal fields has slowed. Some of the lower temperature (<90° C) geothermal areas of the sedimentary aquifers of the prairies in Canada are presently being utilized for direct-heat uses.

Mexico has developed two geothermal fields: Cerro Prieto in Baja California, and Los Azufres (lat 20°N, long 100.5°W); a third field is under development at Los Humeros (lat 19.5°N, long 97.5°W). Both Los Azufres and Los Humeros occur in areas of Holocene volcanics. The plant at Los Azufres currently generates 25 MW, and Los Humeros developed in 1985 was have a generating capacity of 15 MW. (DiPippo, 1985).

The chain of volcanoes in western Central America is an area of high potential for geothermal energy. El Salvador has developed the Ahuachapan geothermal field. The power plant currently produces 95 MW and is the first geothermal plant built in Central America. Guatemala is planning to install a 15 MW plant at

Zunil. Many areas in Guatemala look promising, but further exploration is needed. Nicaragua developed a 35 MW plant on the southern flank of Momotombo volcano at Lake Managua. Costa Rica was developing the Miravalles geothermal field in 1985 (Corrales, 1985 projected to be online in 1990 with a power potential of 32 MW, with a planned additional 50 MW plant (DiPippo, 1985). In Panama, in 1985 there were seven areas identified as geothermal localities, and regional assessments were under way (Ramirez, 1985).

Southeast Quadrant

Practically all of the geothermal areas considered are distributed in the calc-alkalic Pliocene to Quaternary volcanic rocks that stretch along the Andes.

The first geothermal power plant installed in South America is in the Copahue geothermal volcanic field in central-western Argentina, in the Andean foothills. This small 670-kilowatt plant began operating in early 1988. Also in Neuquen Province the Domuyo Volcano, with abundant hot springs, fumaroles, and geysers, is being studied because of its very high potential for geothermal energy. There are several other areas in Argentina where geothermal potential has been assessed including Taco-Ralo-Rio Hondo (Santiago del Estero Province) and Tuzgle Volcano (Salta Province). In Northern Chile, potential geothermal developments are being studied at El Tatio, Puchuldiza, and Suriri. The estimated power potential for the El Tatio site is 100 MW and for the Suriri site is 50 MW. In Colombia, the Ruiz and Chiles Volcanoes, Azufral de Tuquerres, and Paipa are areas of potential development. Five areas are being assessed in Ecuador: Cuenca-Azogues, Chimborazo, Chadupas, Imbabura-Cayambe, and Tufino-Chiles-Cerro Negro. Six regions of Peru may have potential of geothermal development: the Southern Volcanic Chain, the Puno region, the Huancavelica-Huancayo region, the Central region (Cajatambo-Cerro de Pasco), the Ancash region, and the Cajamarca region. In Venezuela two promising geothermal sites have been identified: Barcelona-Cumana and Pilar-Casanay. The hot springs of Pomarapa Volcano and the Pulacayo area in Bolivia indicate potential geothermal resources there, but further exploration is needed to evaluate the level of potential (table 20).

Northwest Quadrant

Hot-spring data for Japan are so numerous that only those springs with a surface temperature greater than 90° C are shown on the map, with each circle representing a group of hot springs. For areas outside of Japan, data were collected from various published sources. Data for Thailand is from the Geological Survey of Japan (1987), and data for the Philippines are based on Alcaraz (1974). Hot-spring data for other Southeast Asian countries are from Waring (1965) and Gupta (1980).

Japan

In Asia geothermal power generation was introduced earliest in Japan, but development in the 1970s and 1980s was very slow, mainly due to environmental concerns. As of 1990, the total installed capacity amounts to 283 MW, composed of eight large plants and two small plants for local use at hotels. Throughout Japan, exploration and resource assessment for newly surveyed high-temperature geothermal reservoirs have been and are now very active. By 1995 at least three more geothermal power plants will be on line in northeastern Japan and Kyushu. A great variety of opinion exists on the geologic control of the distribution of geothermal resources on the Japanese Islands, and it has been recently reviewed by Kimbara (1988).

The Philippines

The Philippines is the largest producer of geothermal power in Asia, and second largest in the world, with a total installed geothermal power generation capacity as high as 894 MW for four geothermal fields: Mak-Ban on Laguna; Tiwi on Luzon; Tongonan on Leyte; and Palimpinon on southern Negros. Besides these four sites, exploration is in progress in six prospective areas on Luzon, three on Visayan, and one on eastern Mindanao with total capacity 1554 MW (Datuin and Troncales, 1986). Geographically, these geothermal areas are associated with three major belts of Pliocene to Quaternary volcanoes of the Philippine Island Arc: the western volcanic belt faces the South China Sea and includes geothermal resource areas of northern and central Luzon and Mindoro Island; the eastern volcanic front facing the Pacific parallel to the Philippine Fault, including the very active geothermal fields of southern Luzon, Leyte, and Mindanao; and the volcanic belt aligned through Sulu Archipelago and toward its northeastern extension.

Thailand

On the basis of cooperative surveys by several national and international institutes, two geothermal resource areas have been selected for intensive assessment: the San Kampaeng area and the Fang area in the northwestern part of Thailand. A 300-kilowatt binary-cycle pilot plant is being built in the Fang area using geothermal fluids at 150-200° C. Geothermal fields of northern Thailand are located at the easternmost tip of the Himalayan Orogenic Belt.

Indonesia

According to a nationwide assessment of geothermal resources in Indonesia by Alzwar (1986), total resource potential is estimated to be 13,000-14,000 MW which comprises 3,550 MW for Java, 4,900 MW for Sumatra, 3,000 MW for Sulawesi, and other islands. However, installed capacity at present is only 140 MW at Kamojang and 2 MW at Dieng, on Java. The Darajat geothermal field, located 10 km southwest of Kamojang, and the Salak geothermal field, also in Java, are now under final tests for development at the 110 MW level. The Lagendong field in the northern part of Sulawesi is expected to produce 15 MW by 1993. The distribution of potential geothermal resource areas is clearly controlled by the prominent trend of volcanic zones that parallel active trenches, such as the volcanic zones of Sumatra, Sunda Strait, Java, Bali, and Nusatenggara, corresponding to the Sunda Trench and the volcanic region of Halmahera and Sulawesi, also caused by strong interaction between adjacent plates.

Southwest Quadrant

Geothermal activity is characteristic of the volcanic island-arc systems bordering Australia to the north and east; however, few of these resources have been utilized to date. Most numerous are water-driven systems that are usually associated with waning volcanic activity or deep-seated faulting. Surface expressions of these systems include warm to boiling springs and, in volcanic areas, solfataric activity. Some geothermal fields are vapor driven and are associated with active volcanism. Strong fumarolic activity is often the surface expression of these latter systems. Hot springs that are found away from active plate margins (for example, in the Australian continent) are formed by deeply circulated water in sedimentary basins.

New Zealand

The only area in the Southwest Pacific in which geothermal resources are utilized on a commercial basis is in and around the Taupo volcanic region of the North Island of New Zealand. Here, 12 geothermal fields are known. Both water and vapor systems occur. The total installed capacity of the generators is 284 MW.

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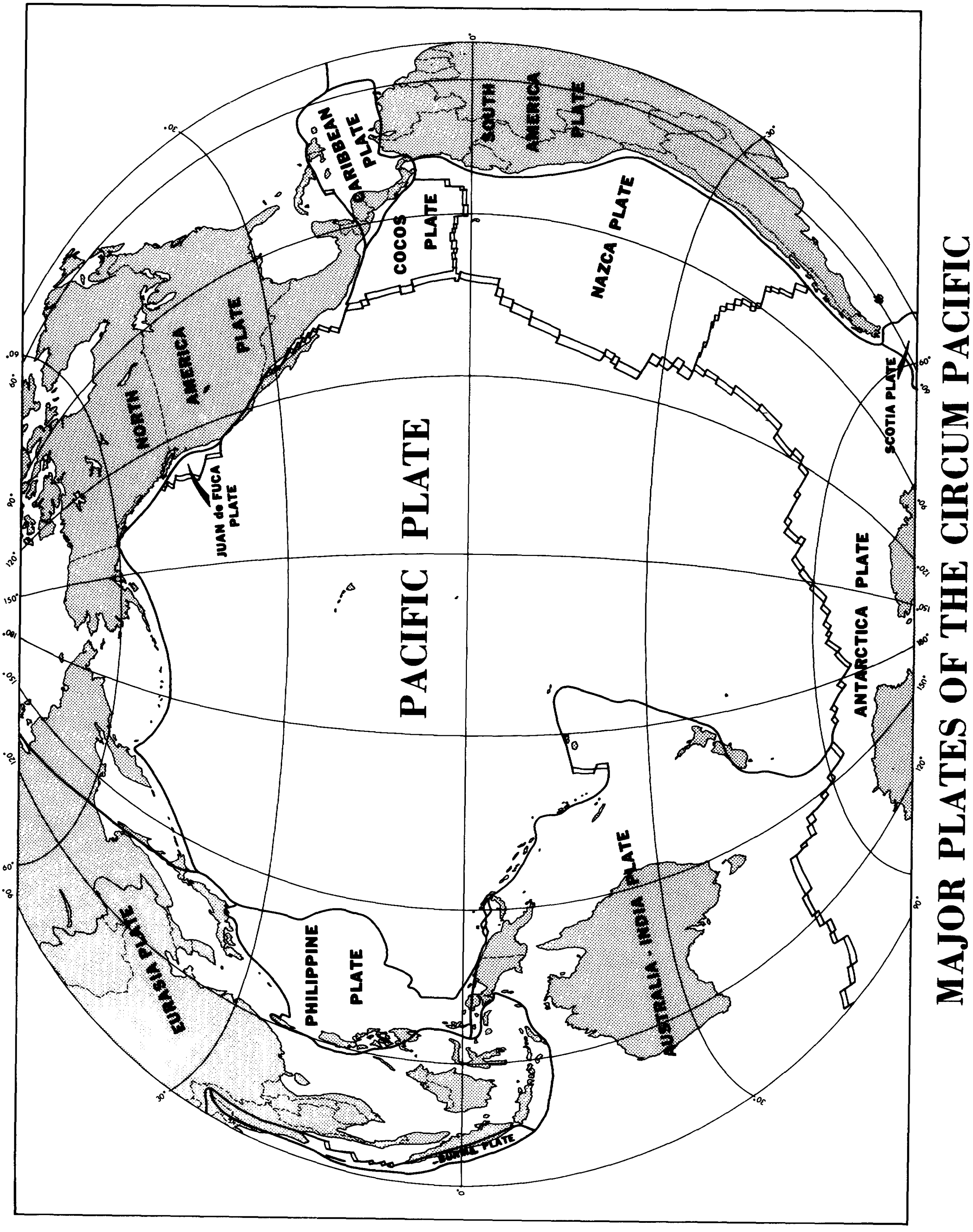


Figure 1. Plate-tectonic setting, Circum-Pacific Region.

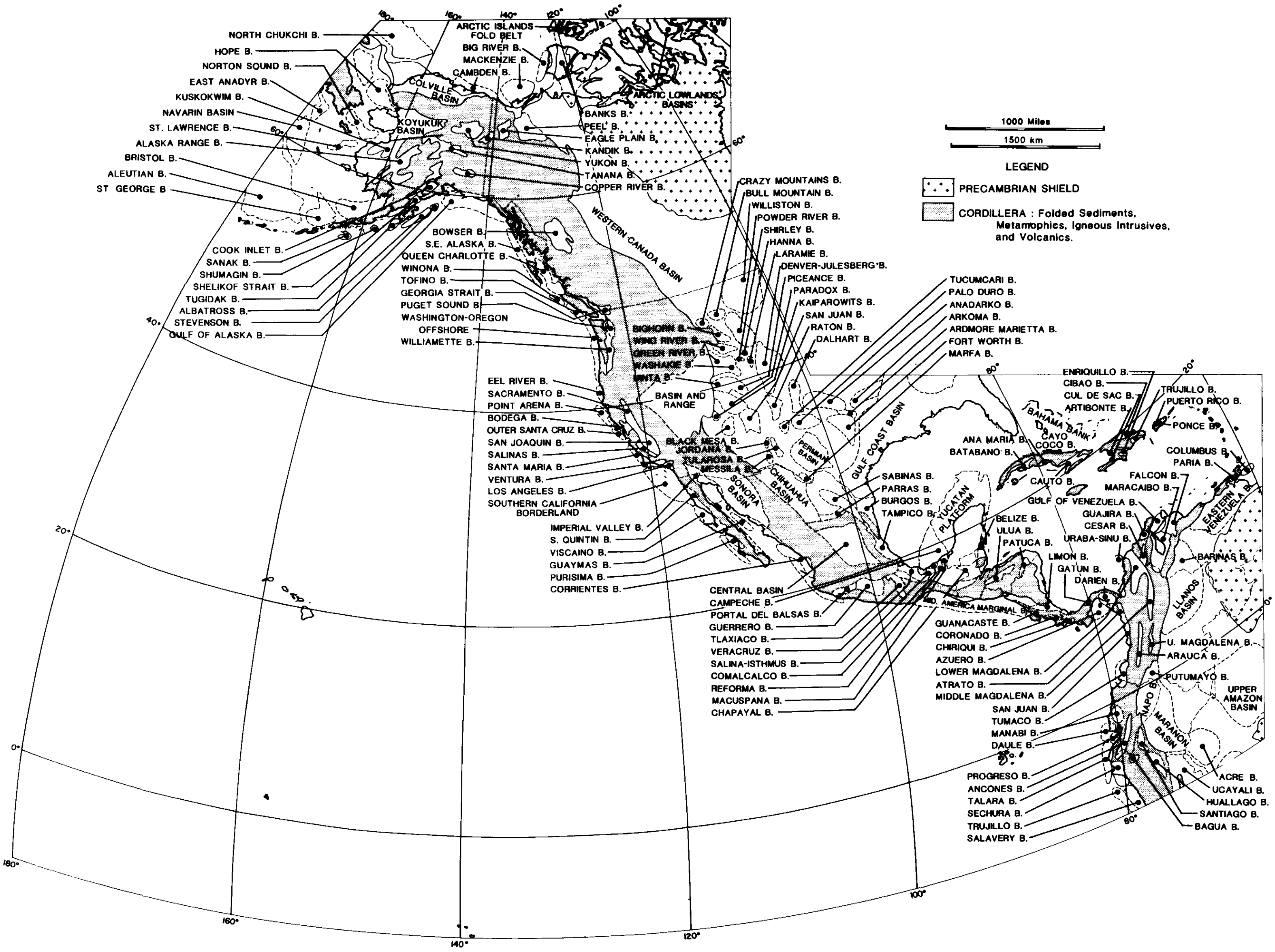


Figure 2. Index map showing location of sedimentary basins, Northeast Quadrant, Circum-Pacific region.

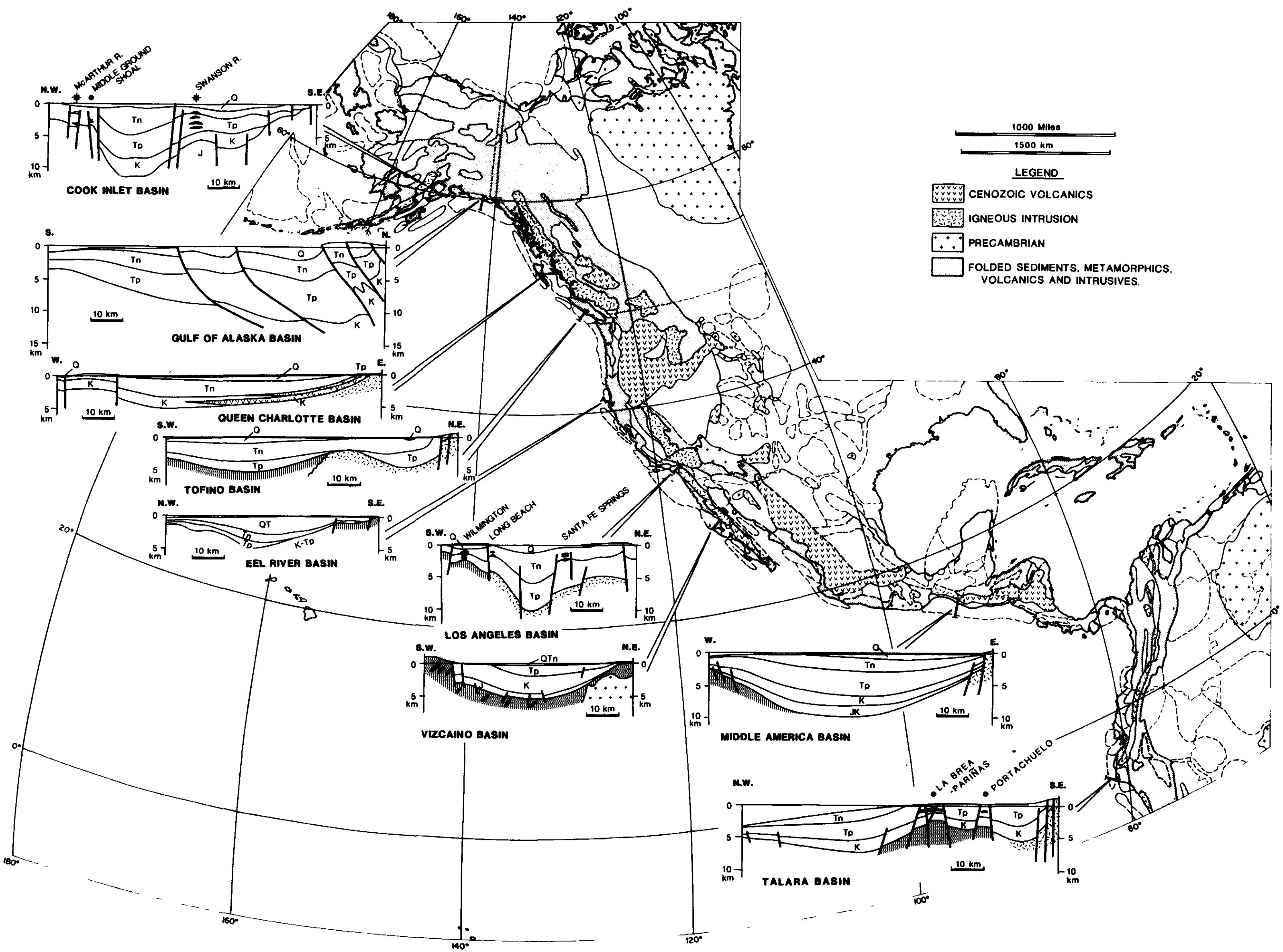


Figure 3. Generalized cross sections of selected major oil-producing basins, Pacific margin, Northeast Quadrant, Circum-Pacific region.

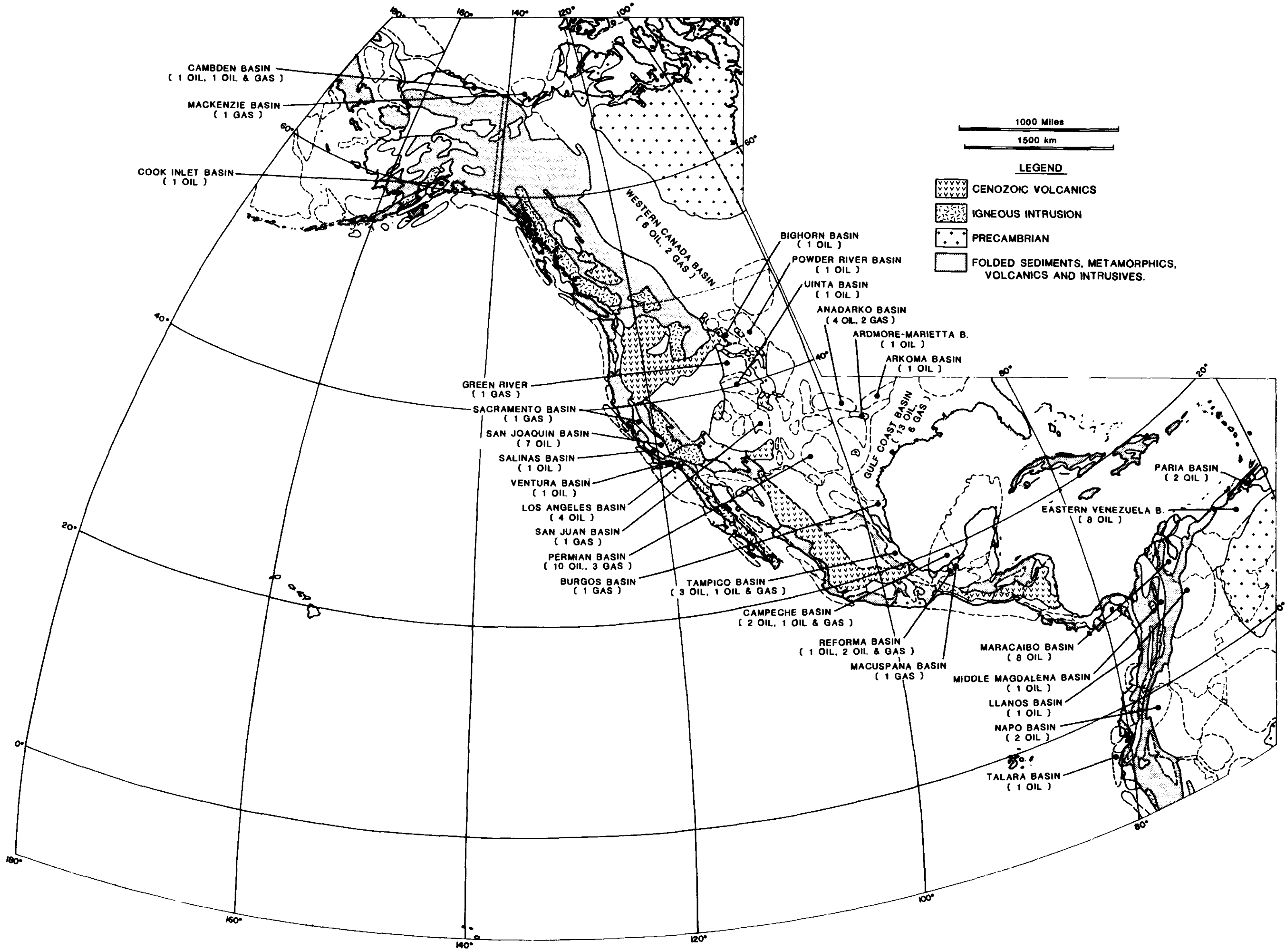


Figure 4. Index map showing basins containing fields with greater than 500 million barrels of oil or 3 trillion cubic feet of gas, Northeast Quadrant, Circum-Pacific region.

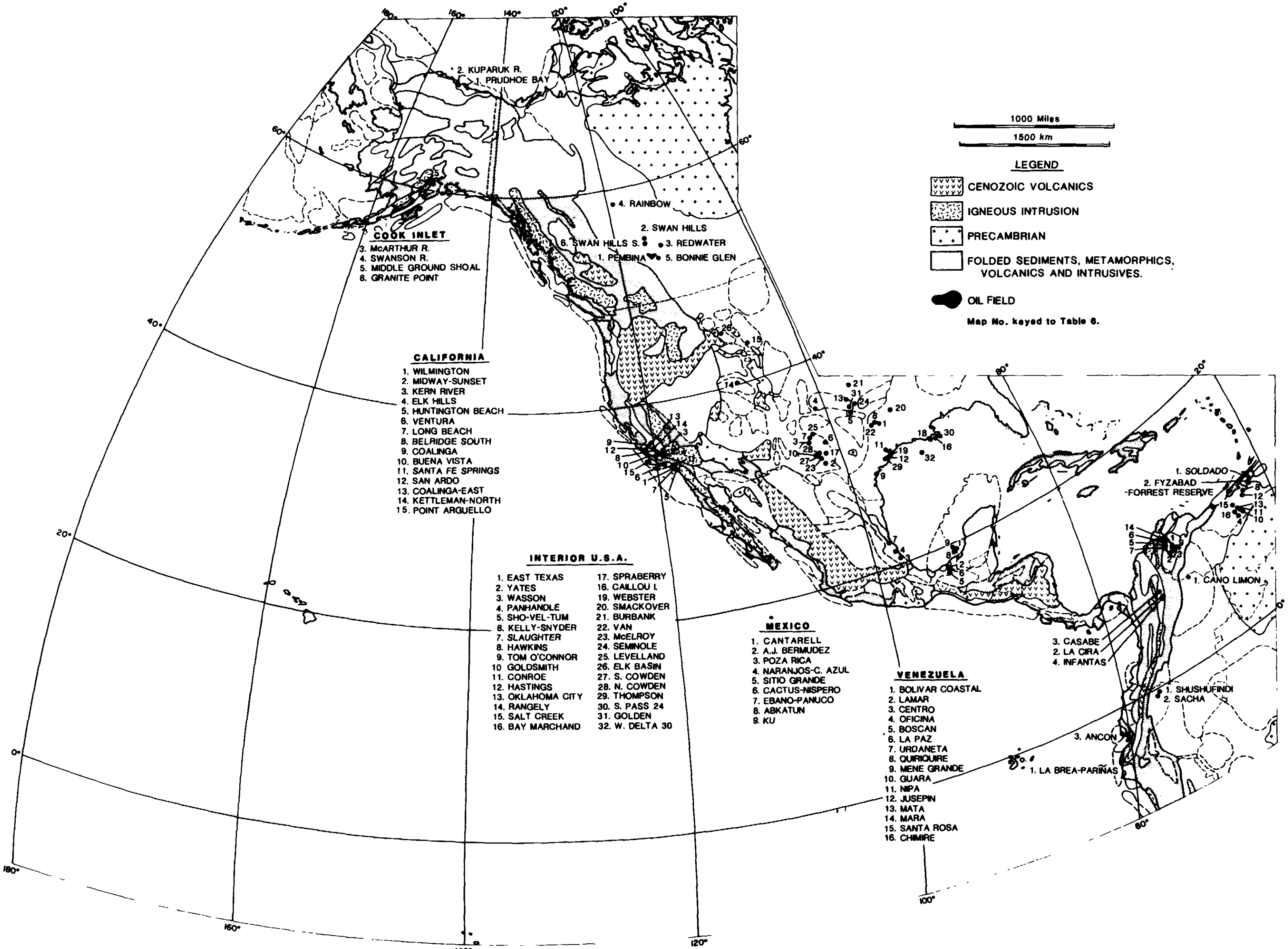


Figure 5. Index map showing locations of selected major oil fields, Northeast Quadrant, Circum-Pacific region.

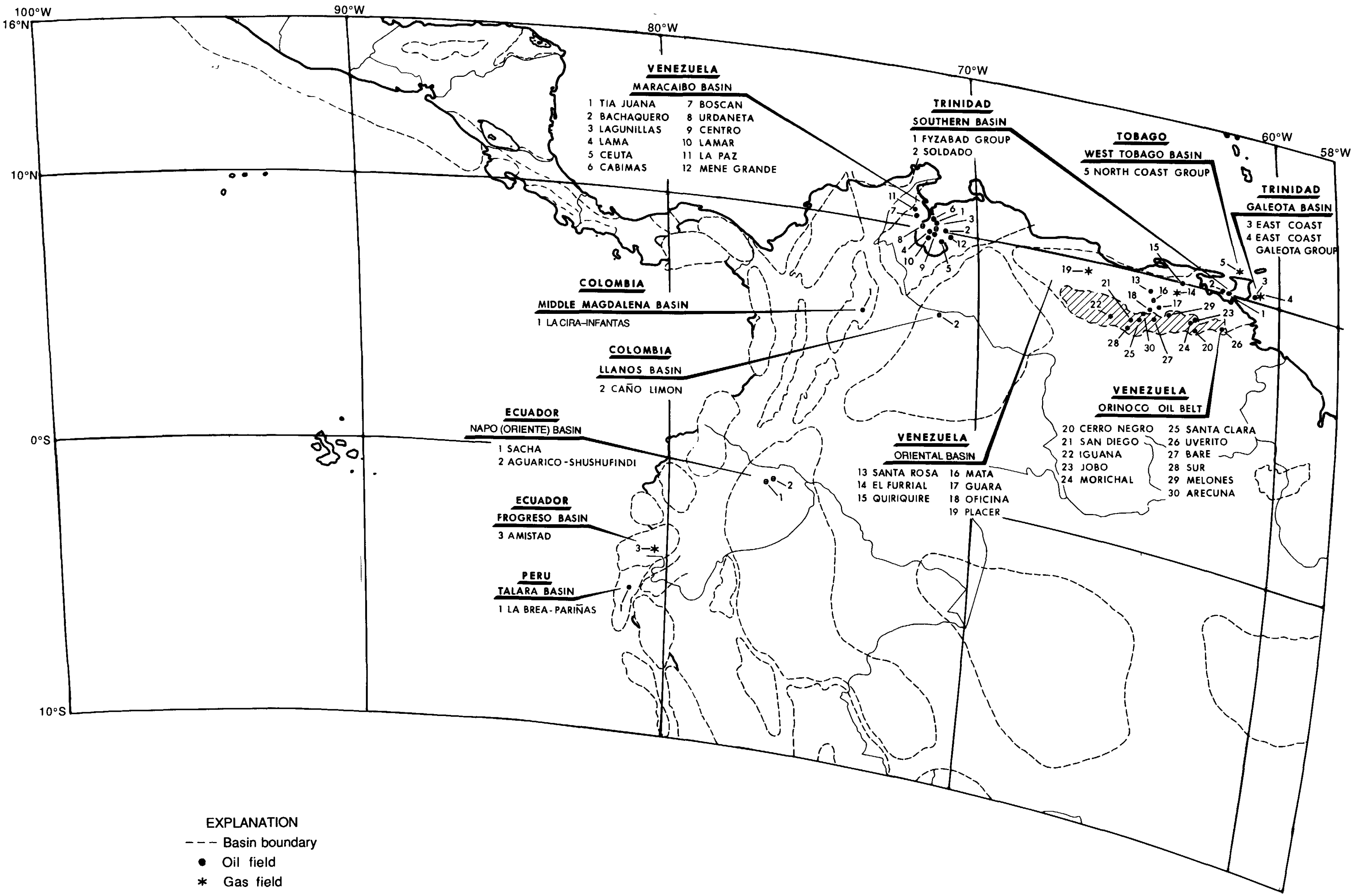


Figure 8. Index map showing basins with giant oil and gas fields containing estimated ultimate recoveries greater than 500 million barrels of oil or 3 trillion cubic feet of gas in nòrthern segment, Southeast Quadrant, Circum-Pacific region. See text for discussion of oil and gas fields (refer to table 6).

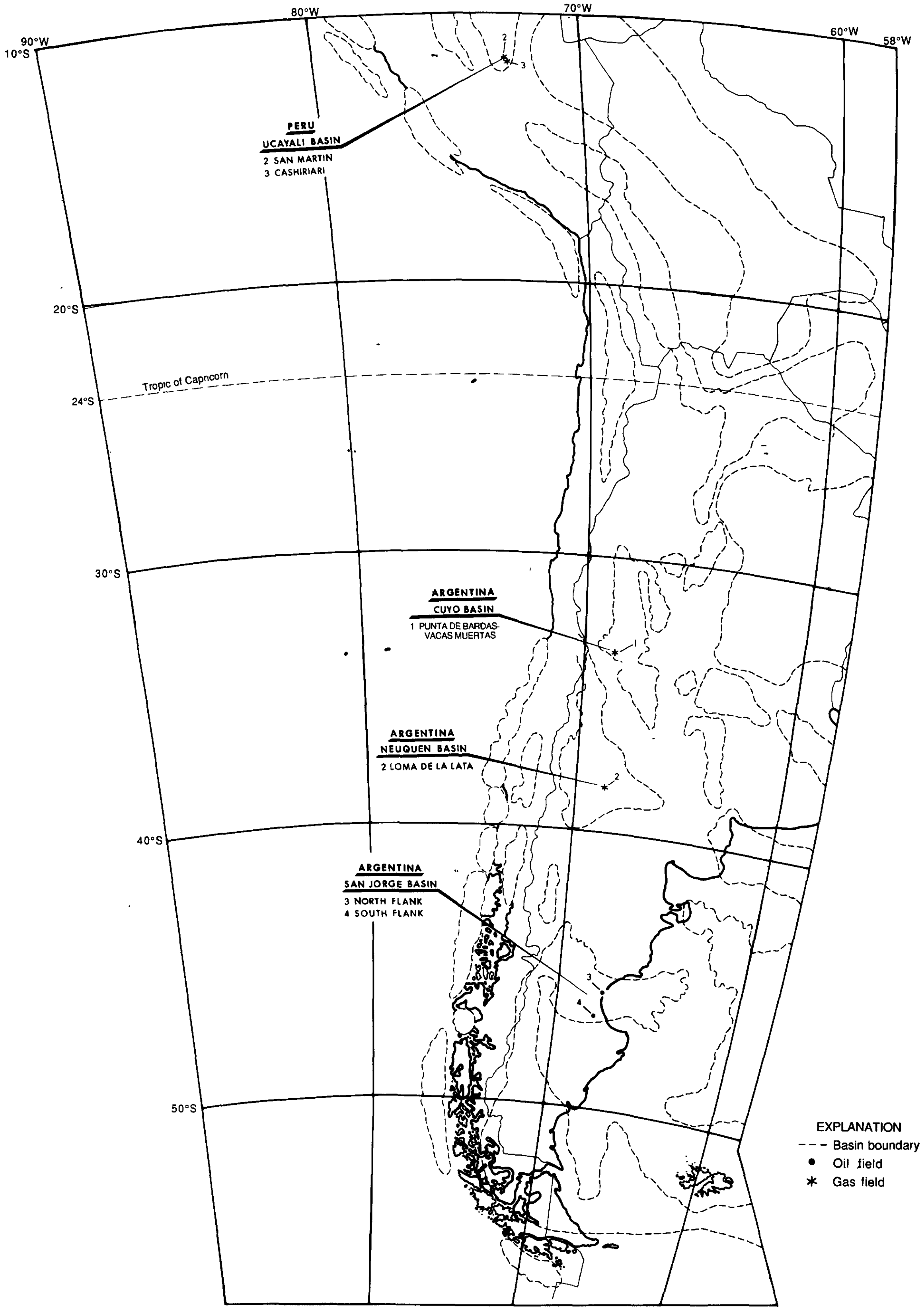


Figure 9. Index map showing basins with giant oil and gas fields containing estimated ultimate recoveries greater than 500 million barrels of oil or 3 trillion cubic feet of gas in southern segment, Southeast Quadrant, Circum-Pacific region (refer to table 6).

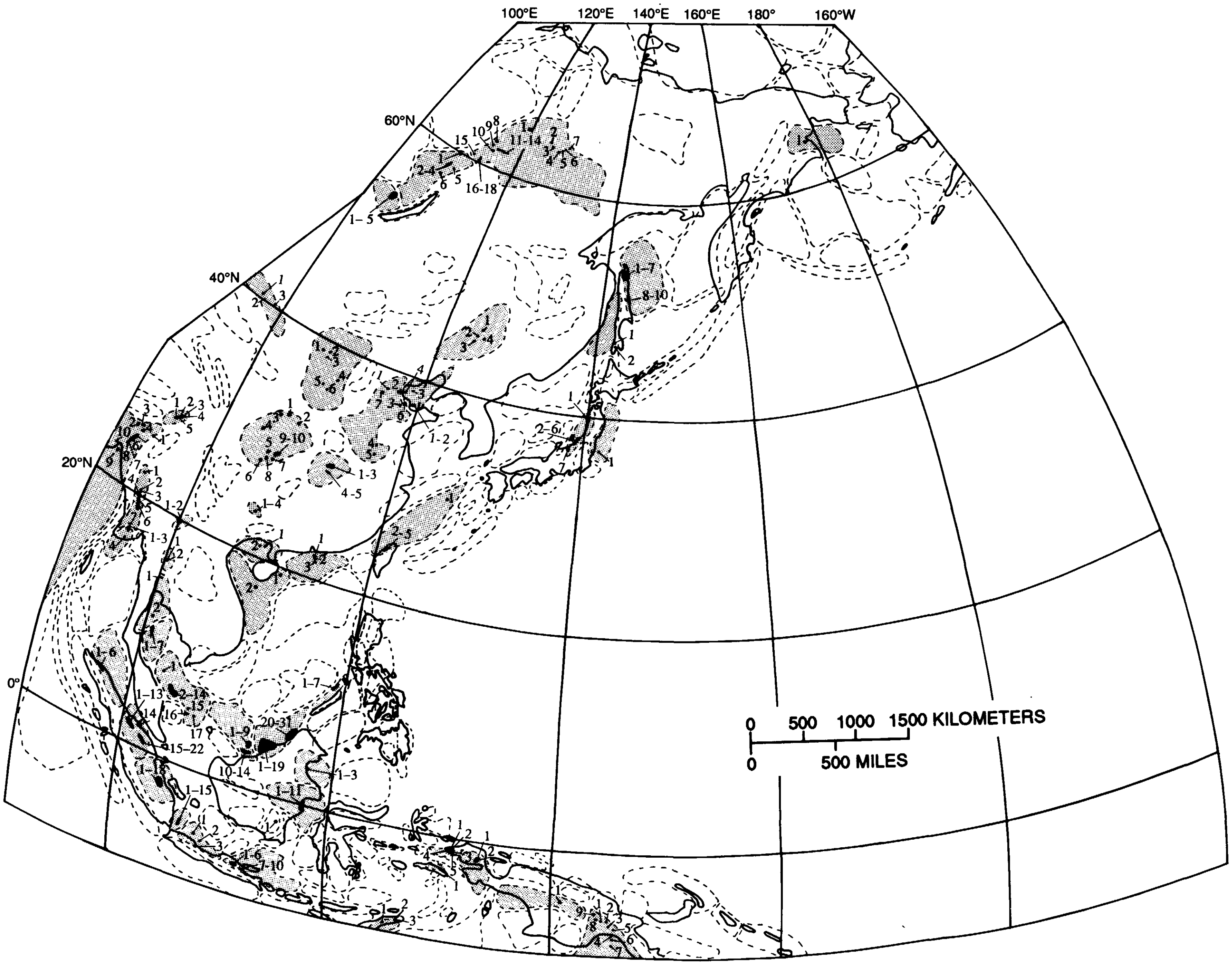


Figure 14. Index map showing location of selected oil and (or) gas fields, Northwest Quadrant, Circum-Pacific region (numbers refer to table 9; see figure 13 for basin numbers). Dashed lines show sedimentary basin boundaries, shaded areas show oil- and (or) gas-bearing sedimentary basins; blackened areas represent oil and gas fields.

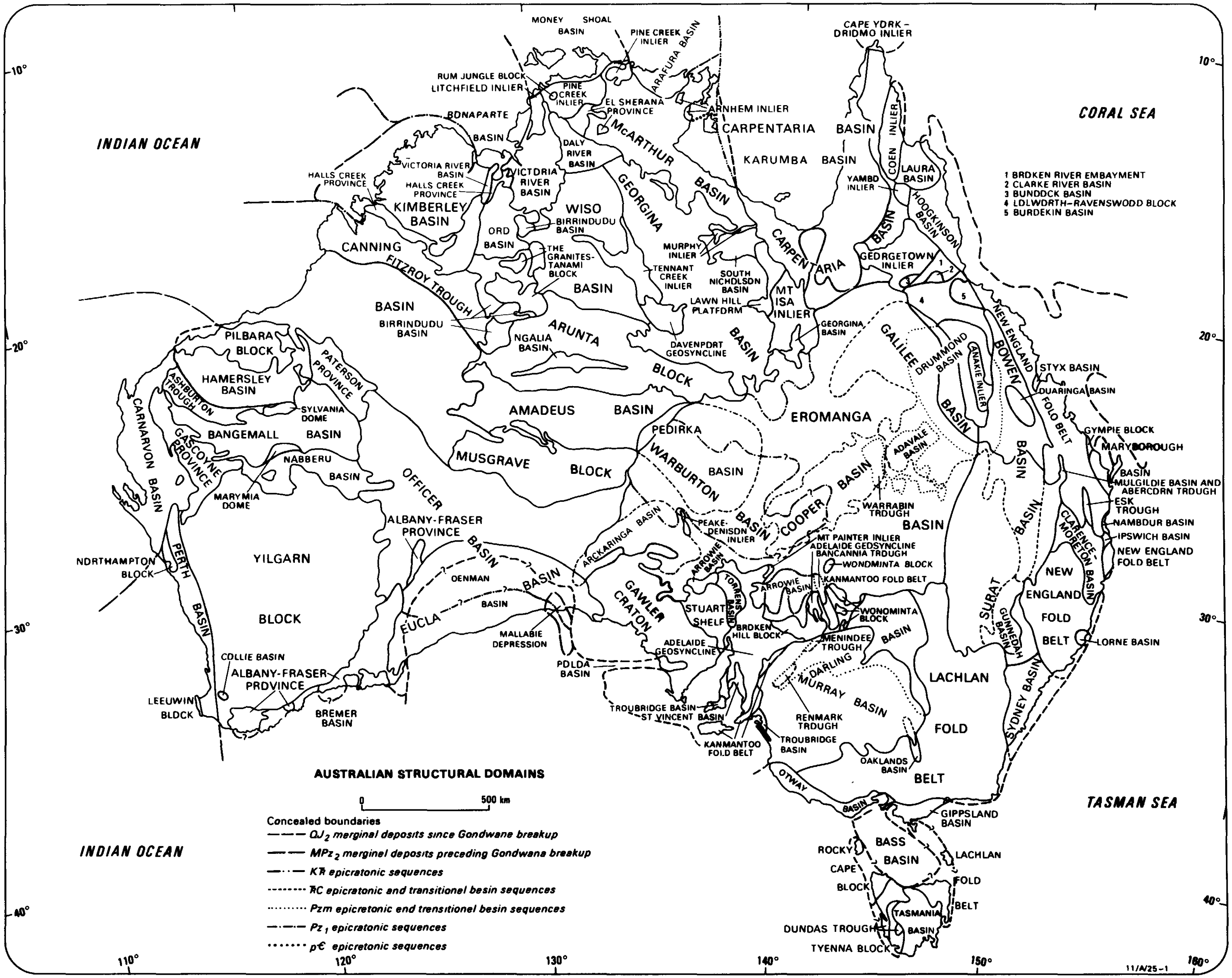


Figure 15. Principal morphostructural features of Australia.

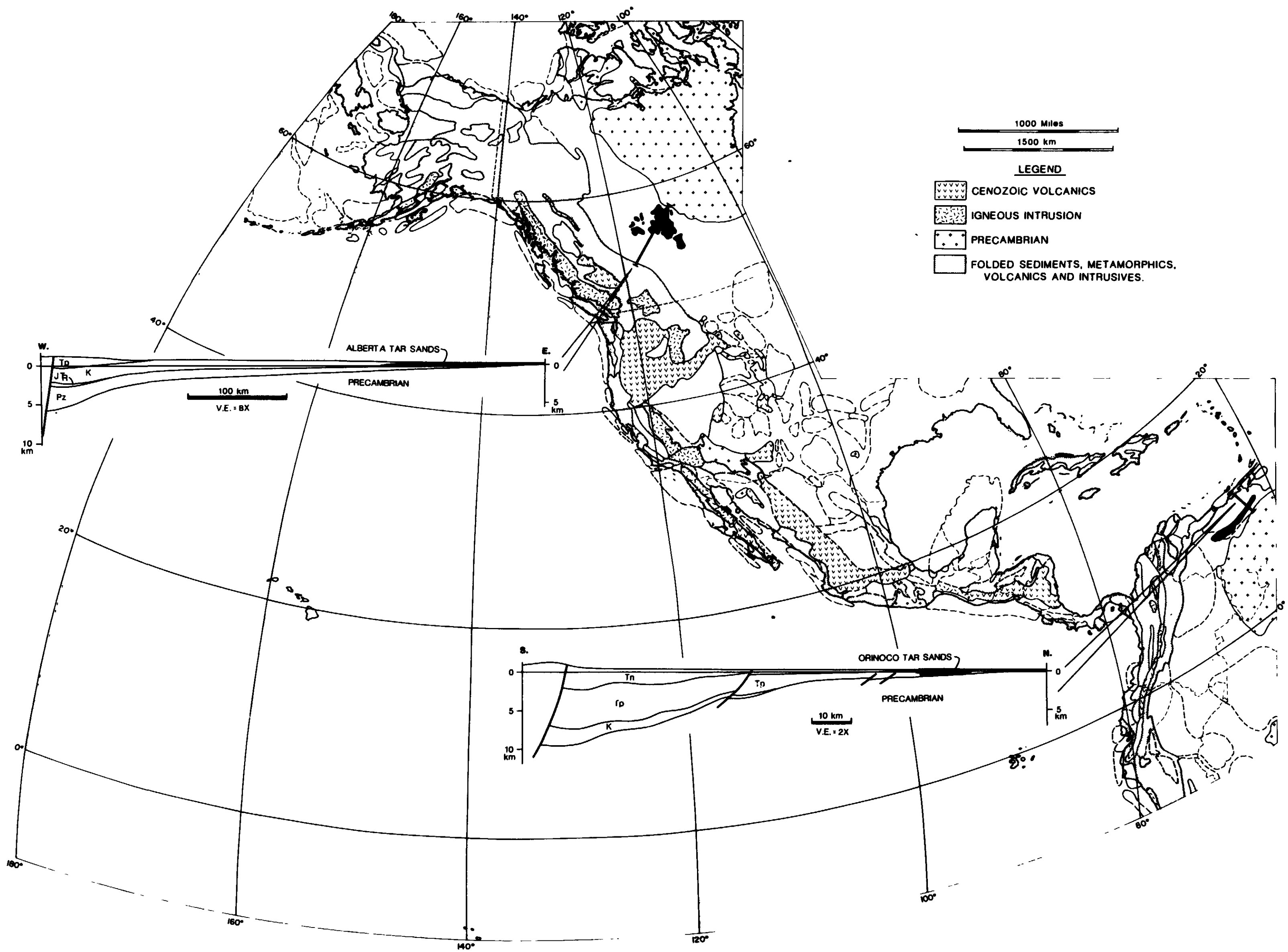


Figure 16. Index map showing location of major oil-sand deposits in central Alberta, Canada, and Venezuela.

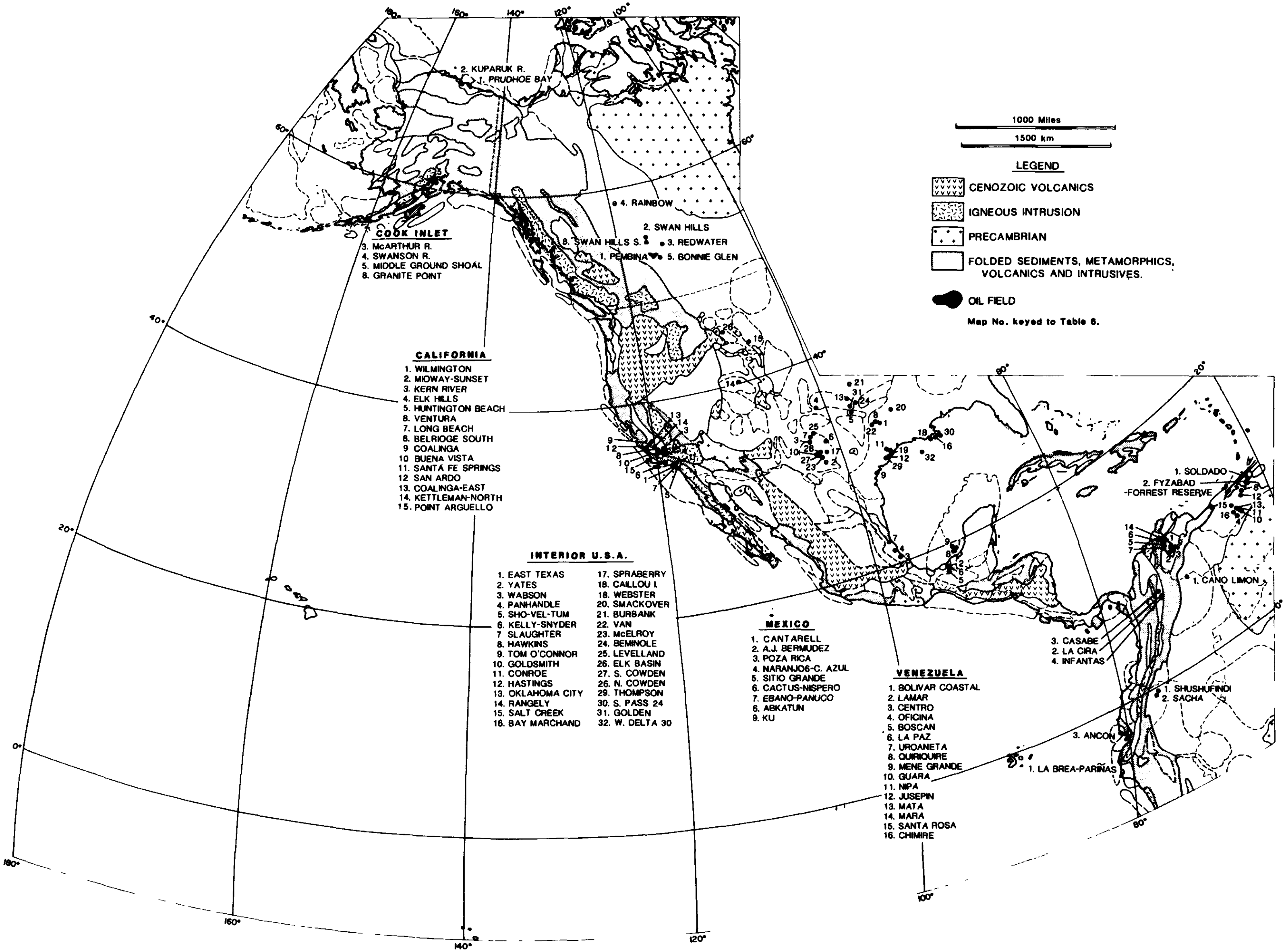


Figure 5. Index map showing locations of selected major oil fields, Northeast Quadrant, Circum-Pacific region.

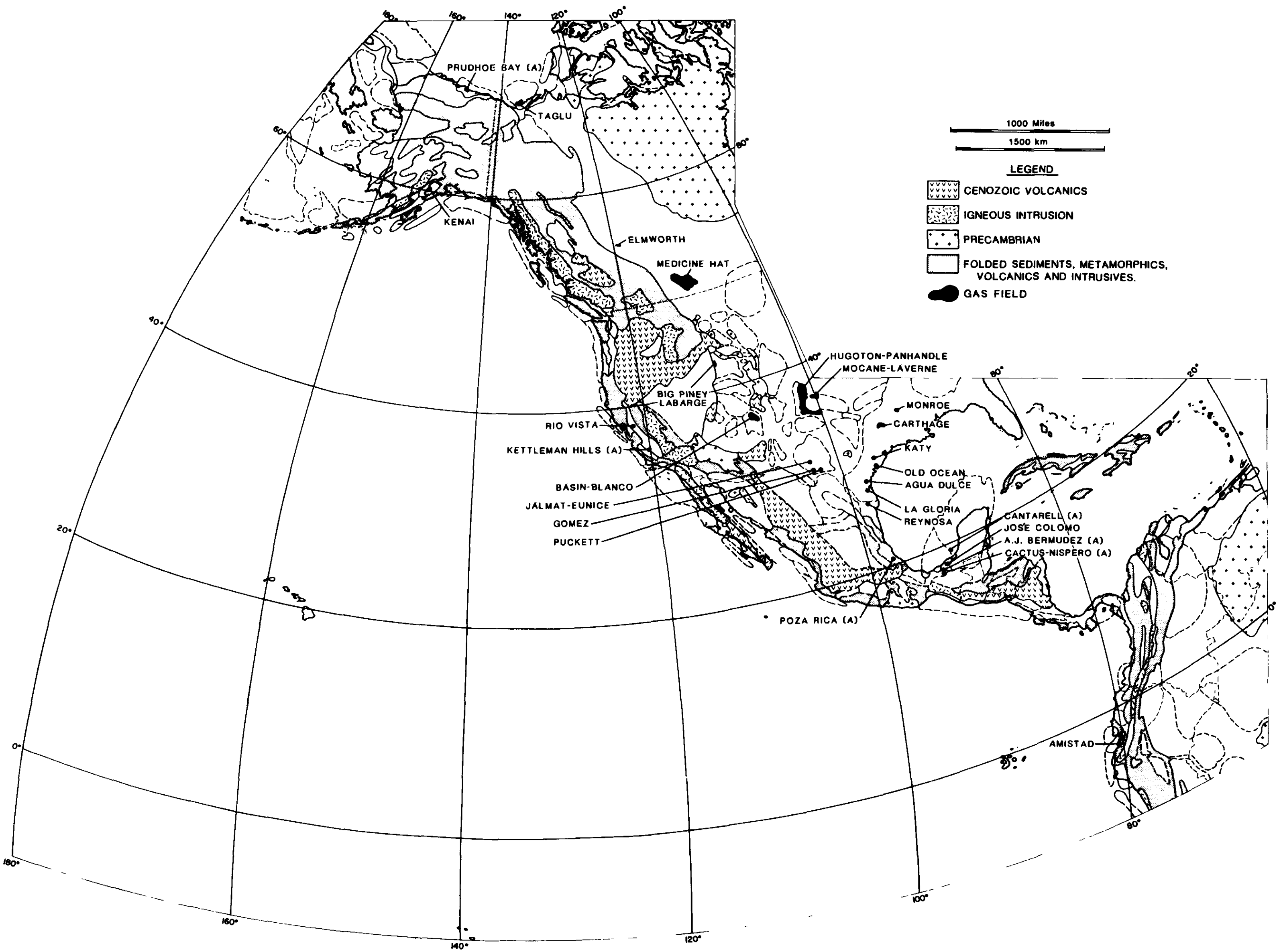


Figure 6. Index map showing locations of selected major gas fields, Northeast Quadrant, Circum-Pacific region.

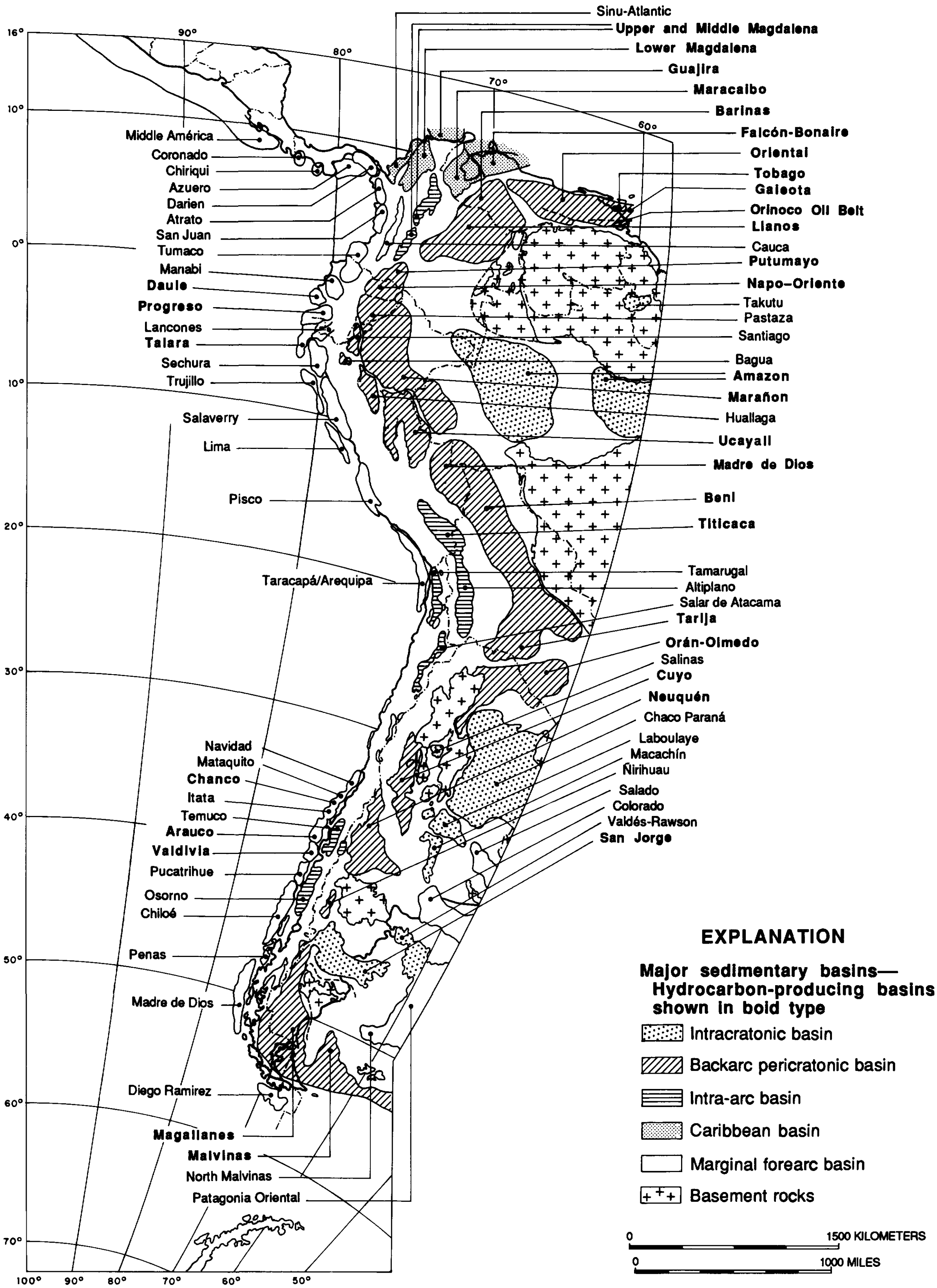


Figure 7. Index map showing location of major sedimentary basins, Southeast Quadrant, Circum-Pacific region. Basin boundary dashed where approximately located.

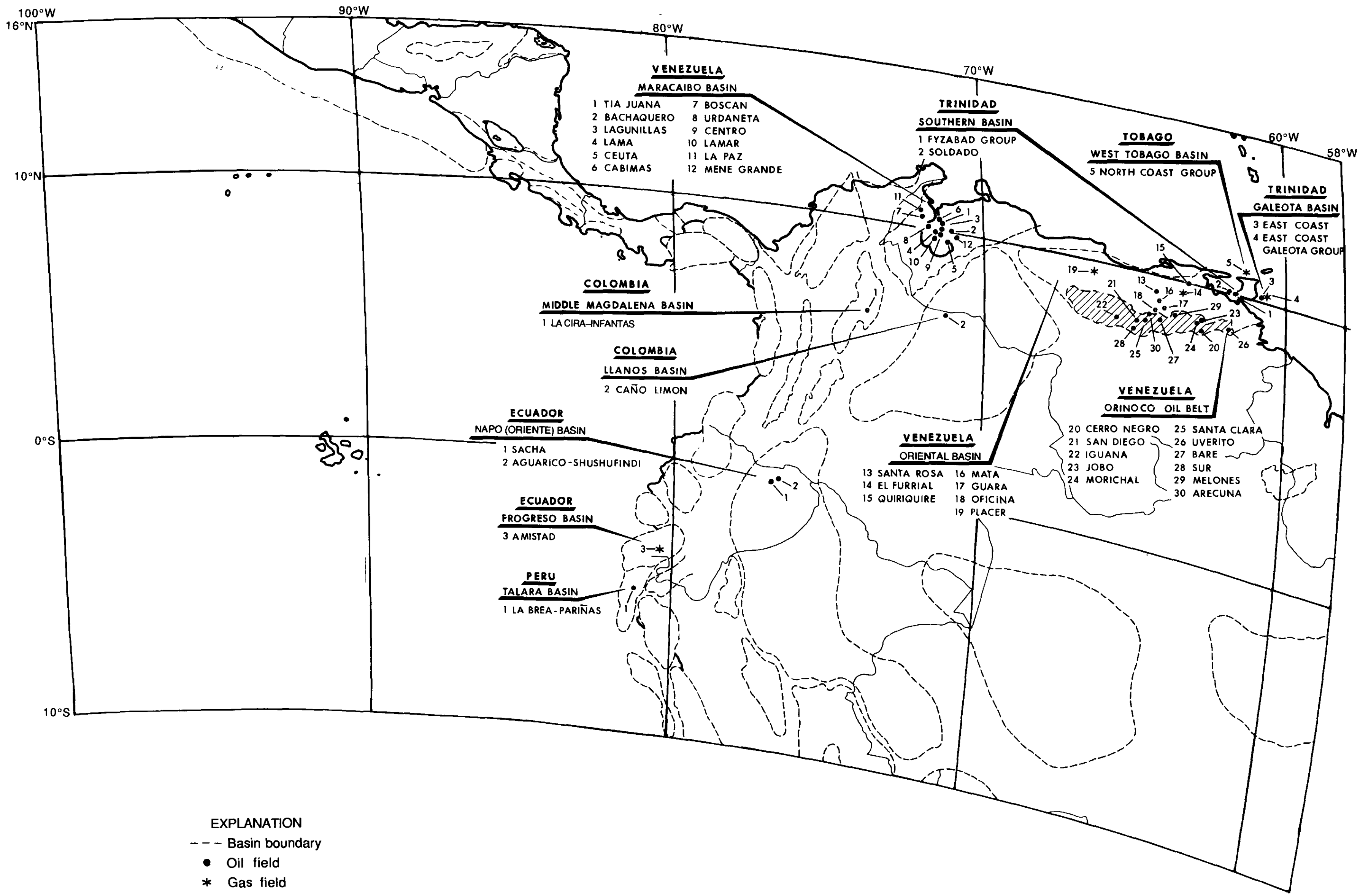


Figure 8. Index map showing basins with giant oil and gas fields containing estimated ultimate recoveries greater than 500 million barrels of oil or 3 trillion cubic feet of gas in northern segment, Southeast Quadrant, Circum-Pacific region. See text for discussion of oil and gas fields (refer to table 6).

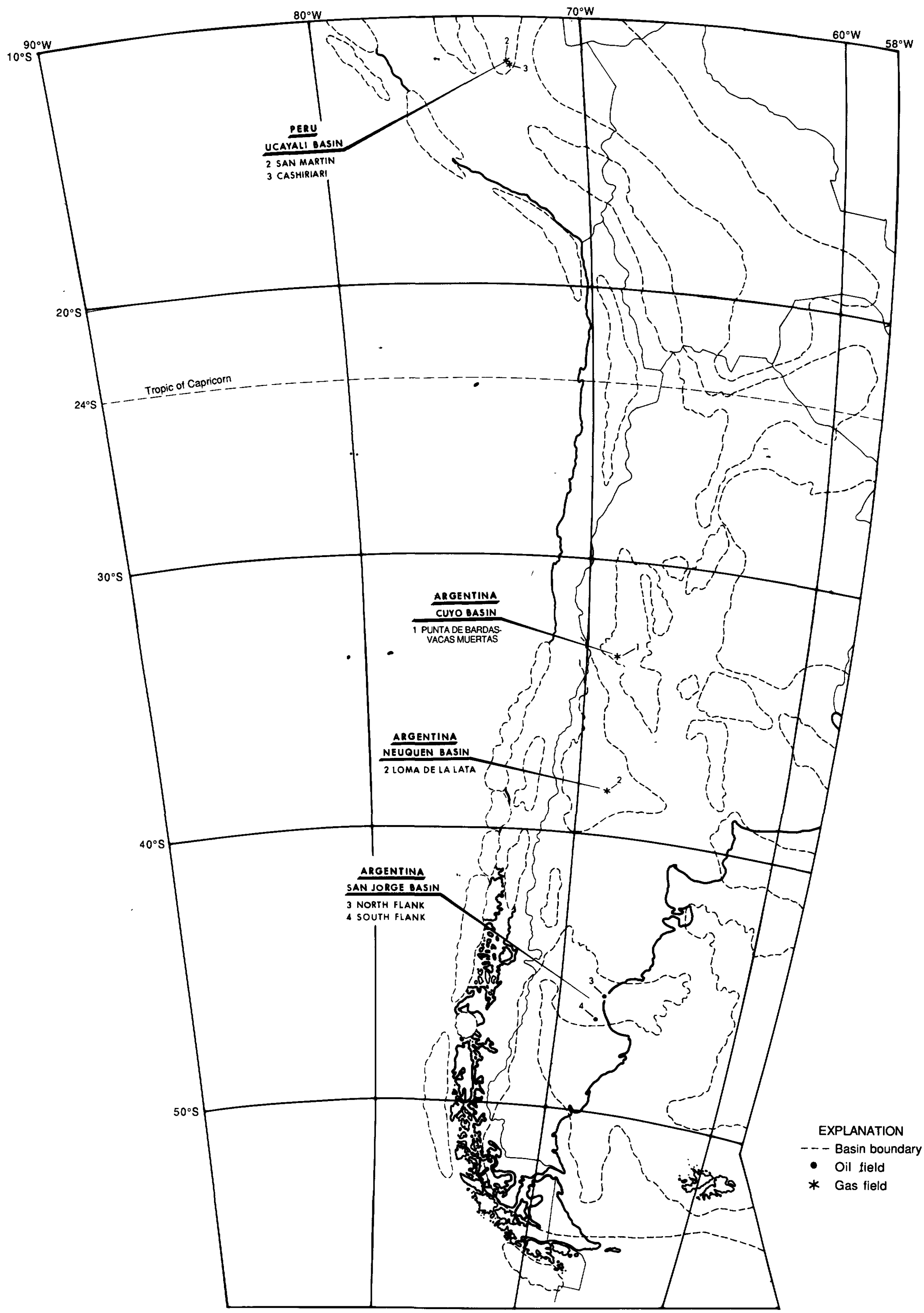


Figure 9. Index map showing basins with giant oil and gas fields containing estimated ultimate recoveries greater than 500 million barrels of oil or 3 trillion cubic feet of gas in southern segment, Southeast Quadrant, Circum-Pacific region (refer to table 6).

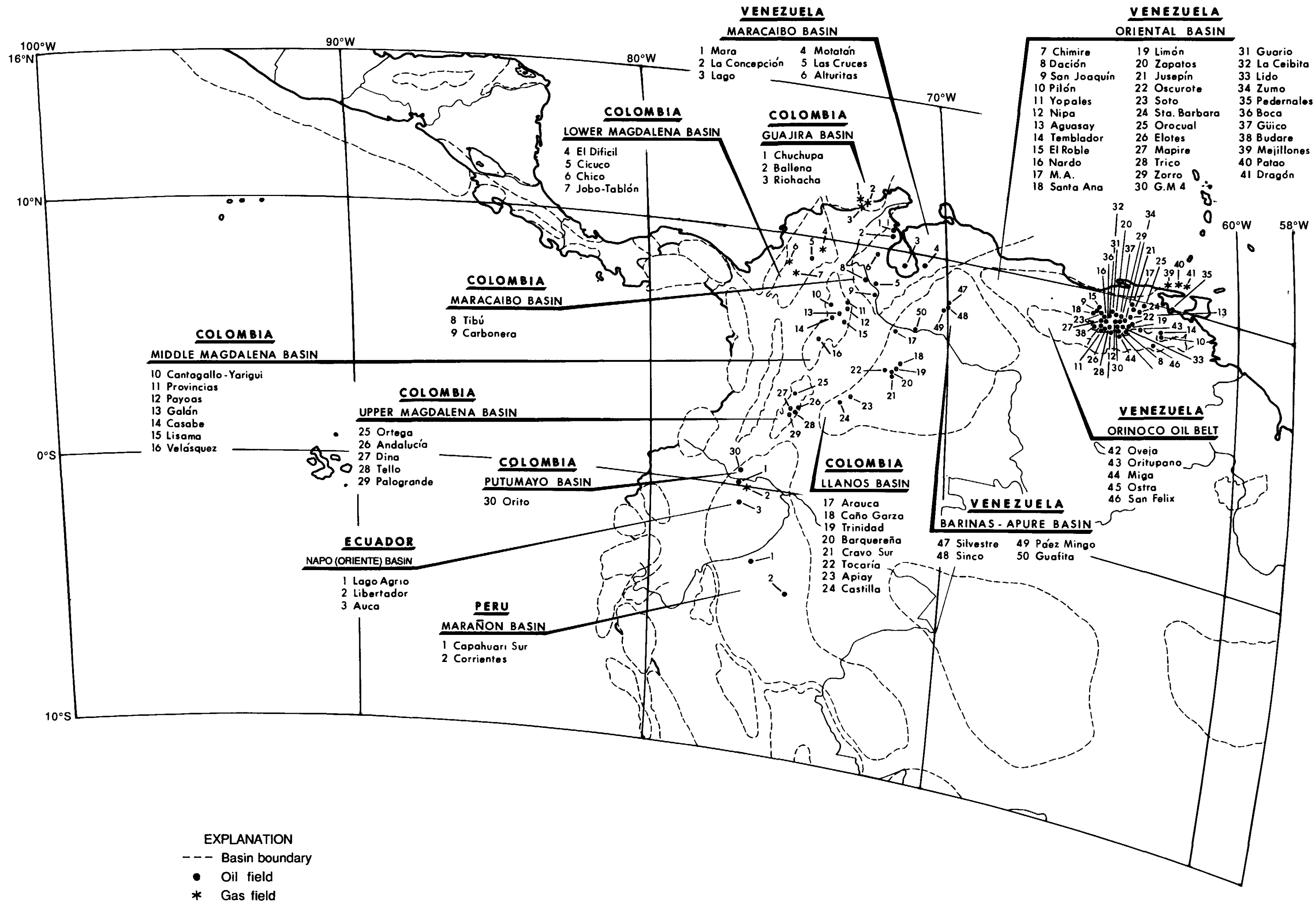


Figure 10. Index map showing basins with major oil and gas fields containing estimated ultimate recoveries between 500 and 100 million barrels of oil or 3 trillion cubic feet to 600 billion cubic feet of gas in northern segment, Southeast Quadrant, Circum-Pacific region (refer to table 7).

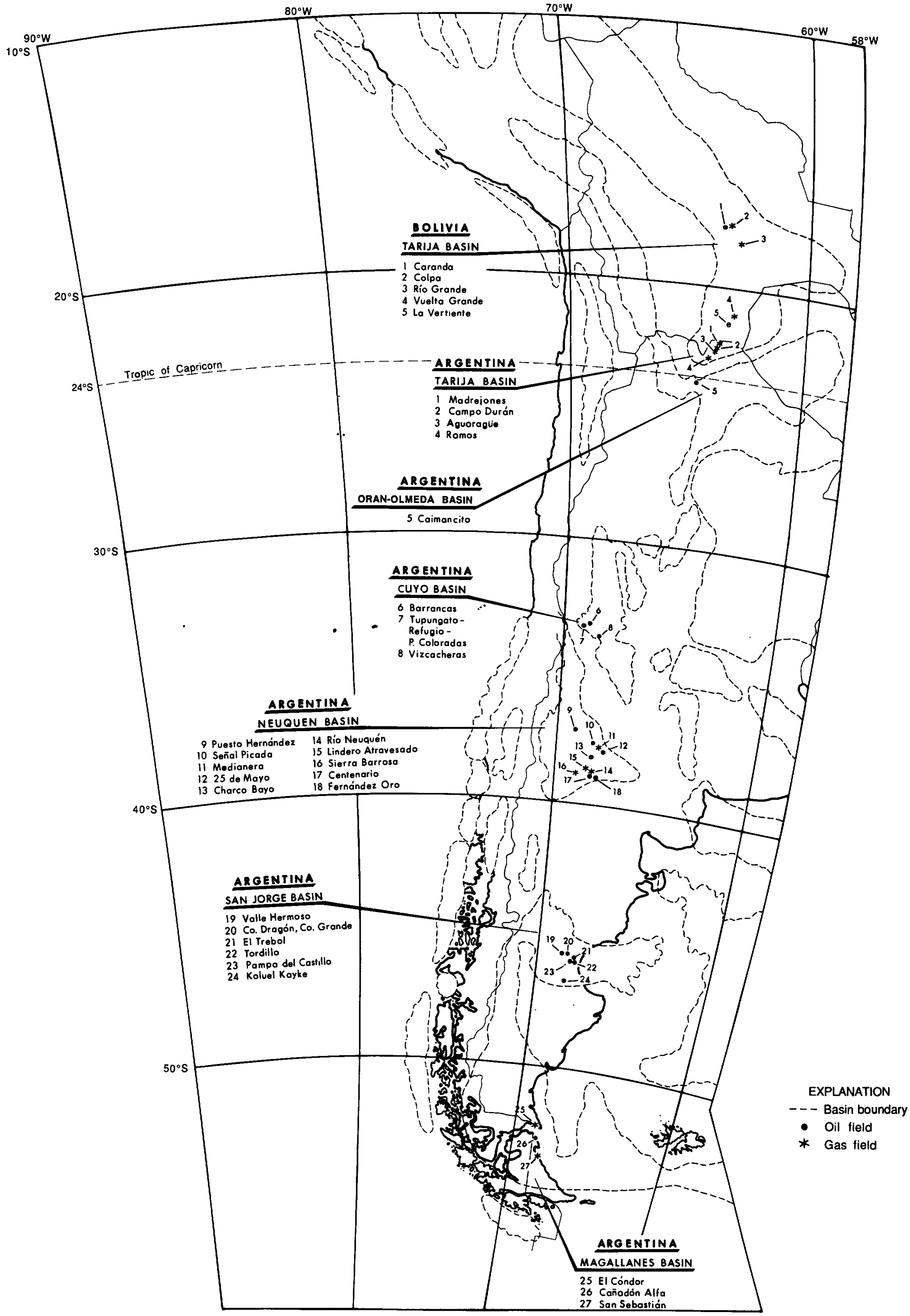


Figure 11. Index map showing basins with major oil and gas fields containing estimated ultimate recoveries between 500 and 100 million barrels of oil or 3 trillion cubic feet to 600 billion cubic feet of gas in southern segment, Southeast Quadrant, Circum-Pacific region (refer to table 7).

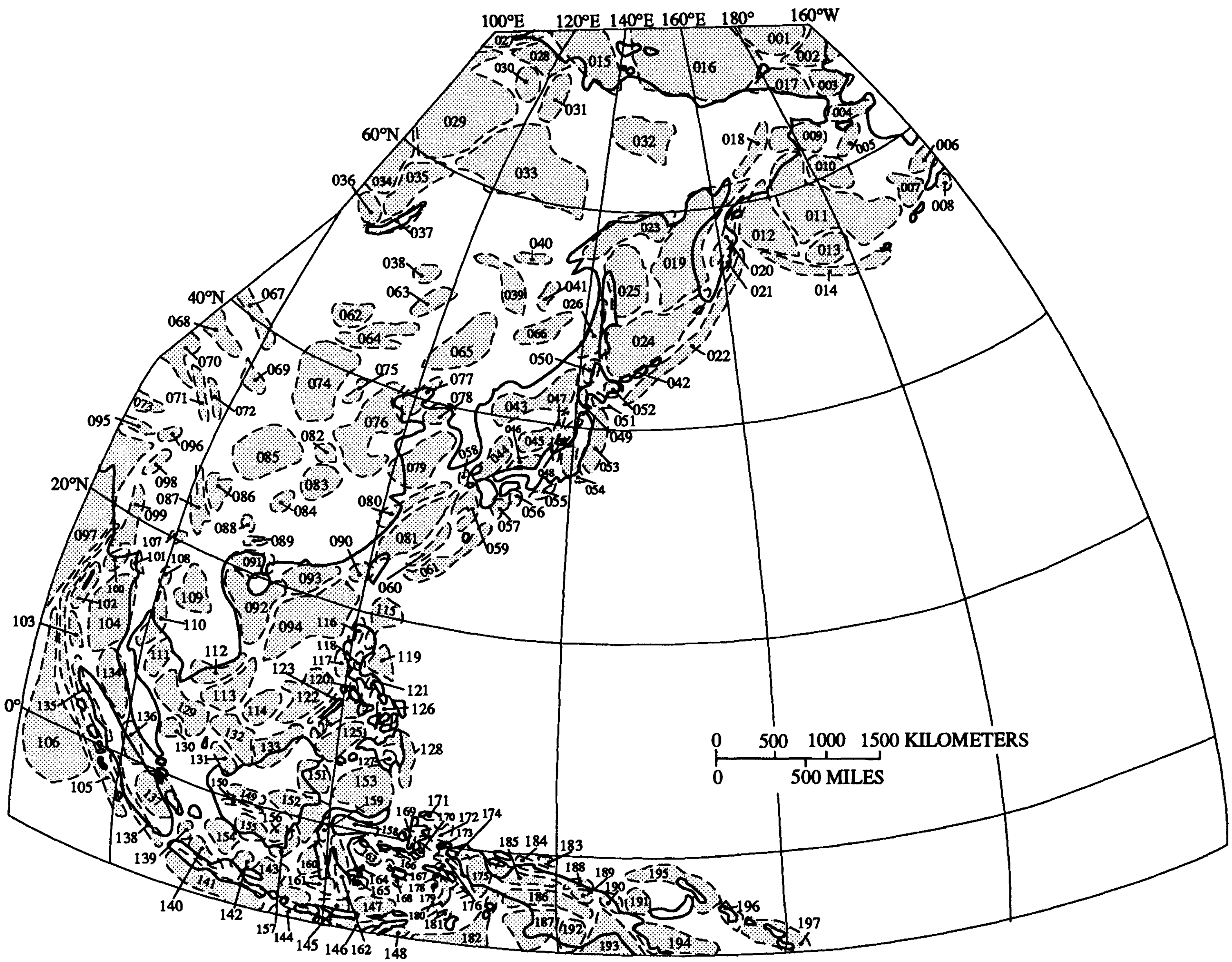


Figure 12. Index map showing location of sedimentary basins (shaded), Northwest Quadrant, Circum-Pacific region (numbers refer to table 8).

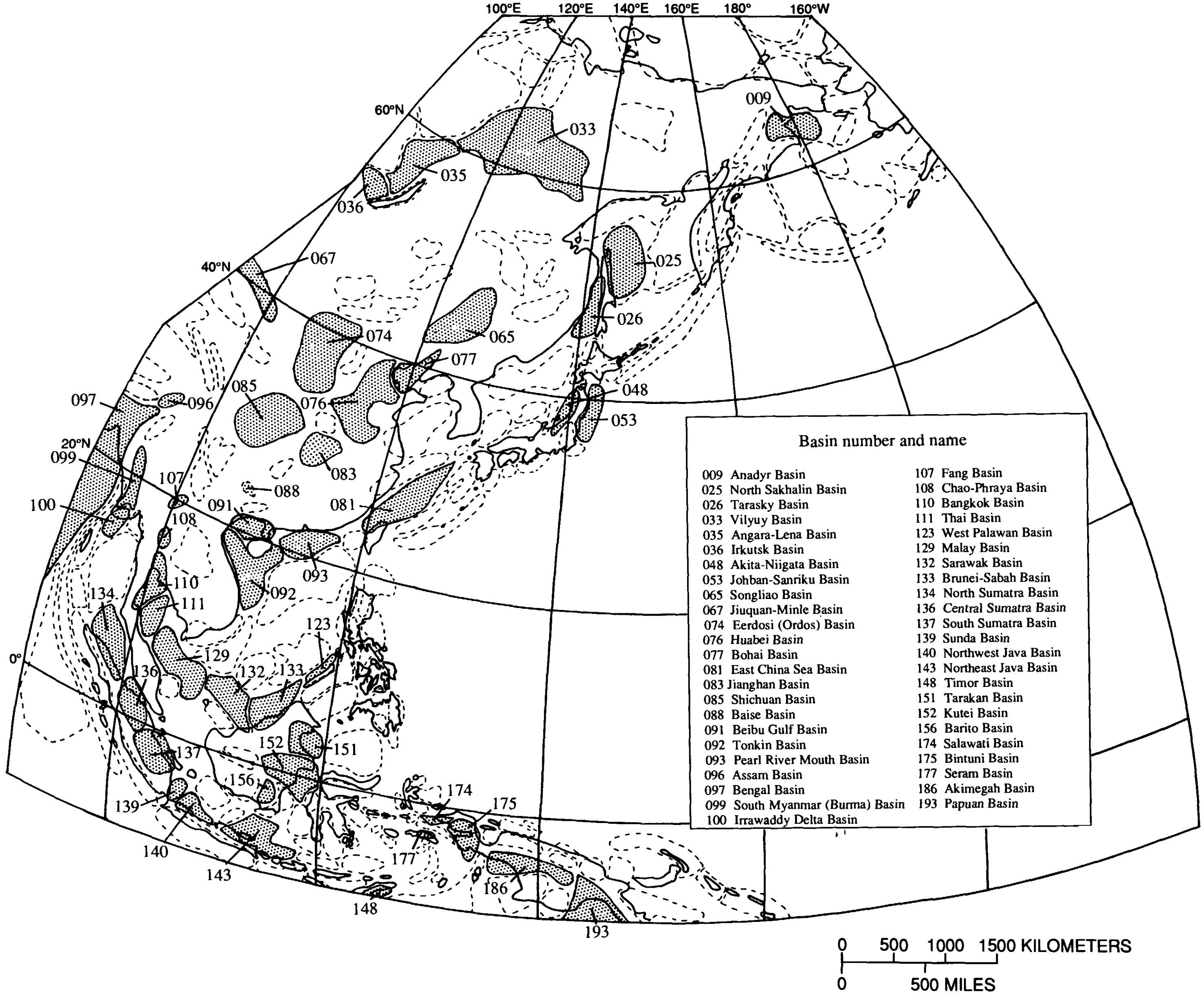


Figure 13. Index map showing location of sedimentary basins that contain selected oil and (or) gas fields, Northwest Quadrant, Circum-Pacific region (numbers refer to table 9). Dashed lines show sedimentary basin boundaries, shaded areas show oil- and (or) gas-bearing sedimentary basins.

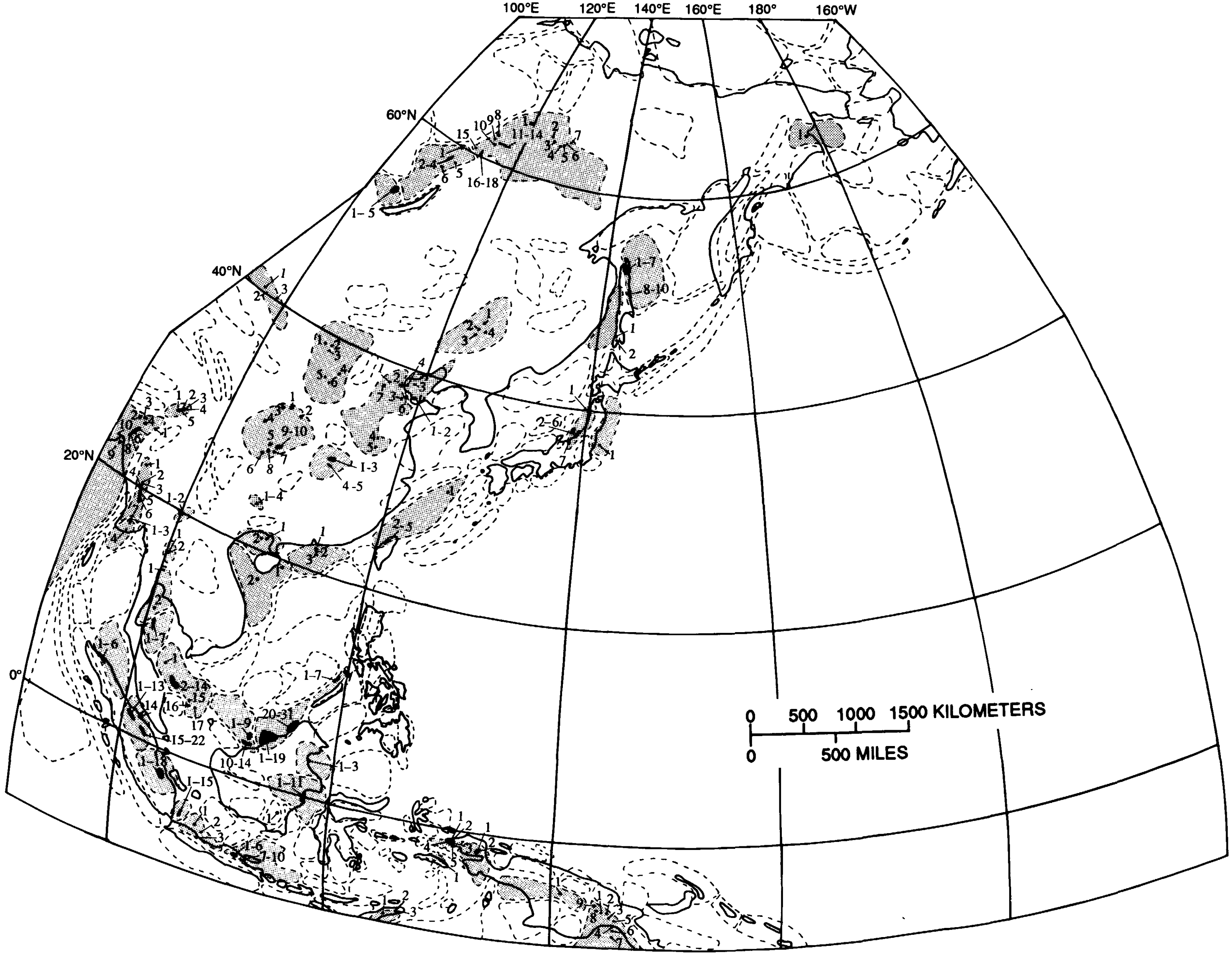
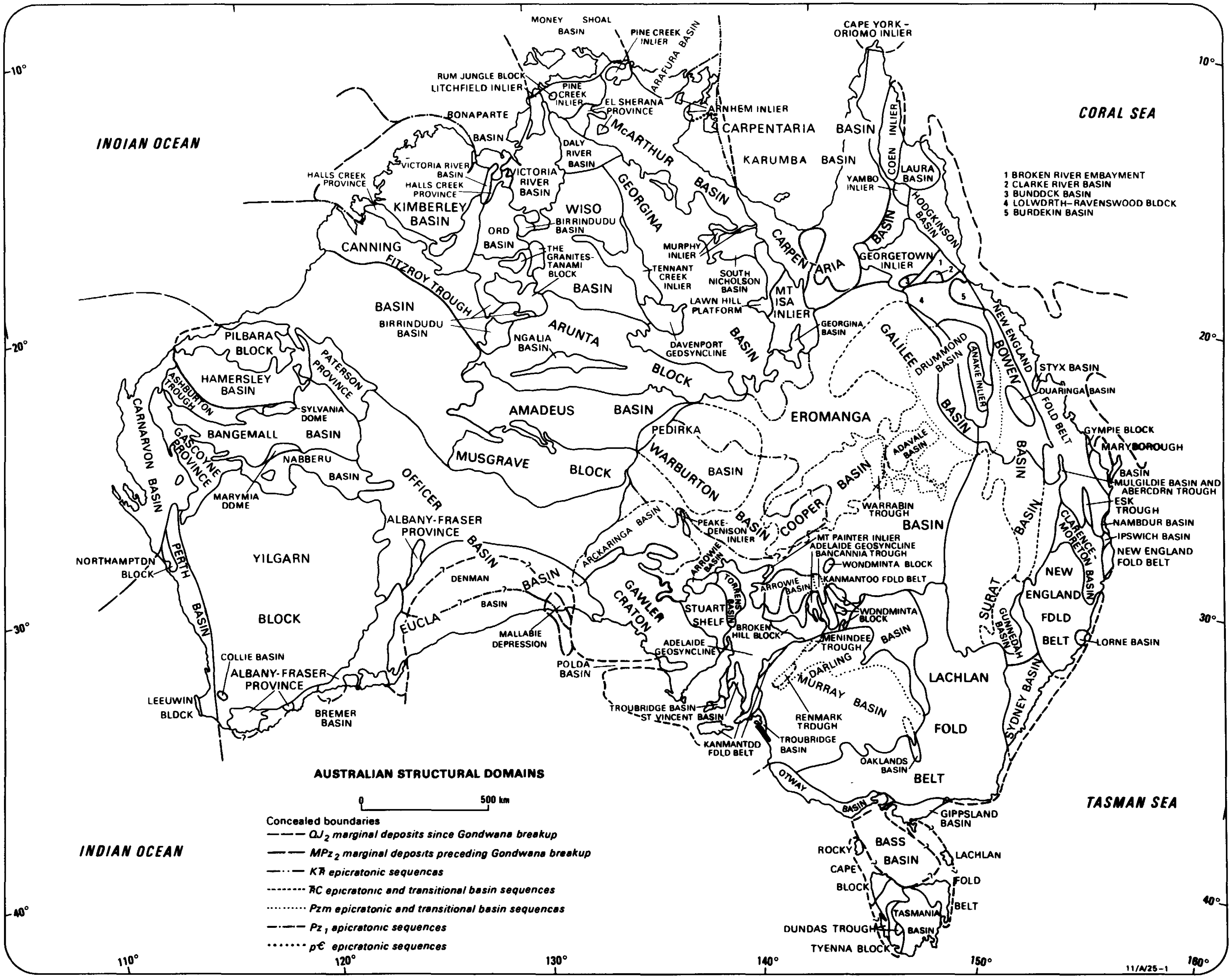


Figure 14. Index map showing location of selected oil and (or) gas fields, Northwest Quadrant, Circum-Pacific region (numbers refer to table 9; see figure 13 for basin numbers). Dashed lines show sedimentary basin boundaries, shaded areas show oil- and (or) gas-bearing sedimentary basins; blackened areas represent oil and gas fields.



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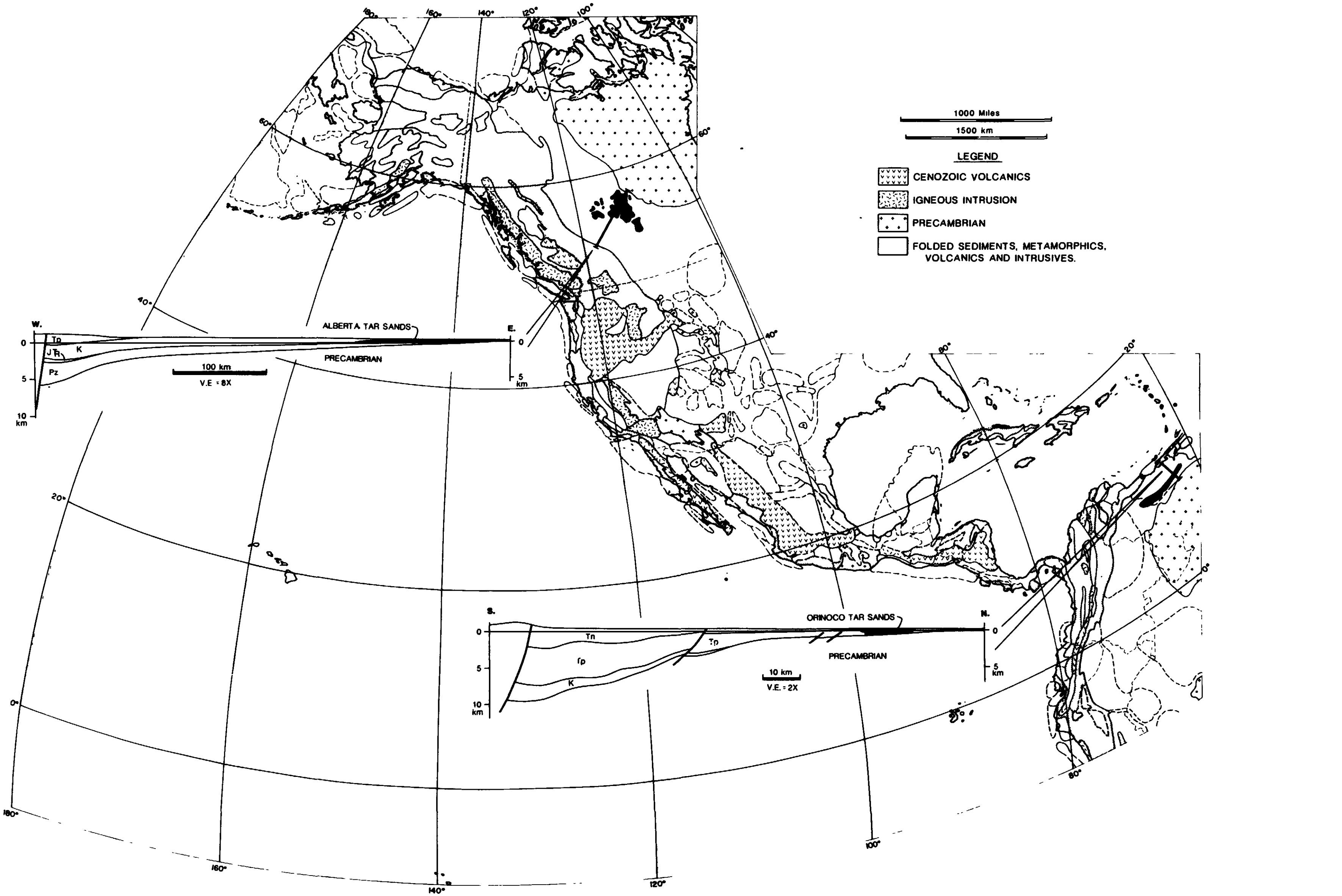

Figure 16. Index map showing location of major oil-sand deposits in central Alberta, Canada, and Venezuela.

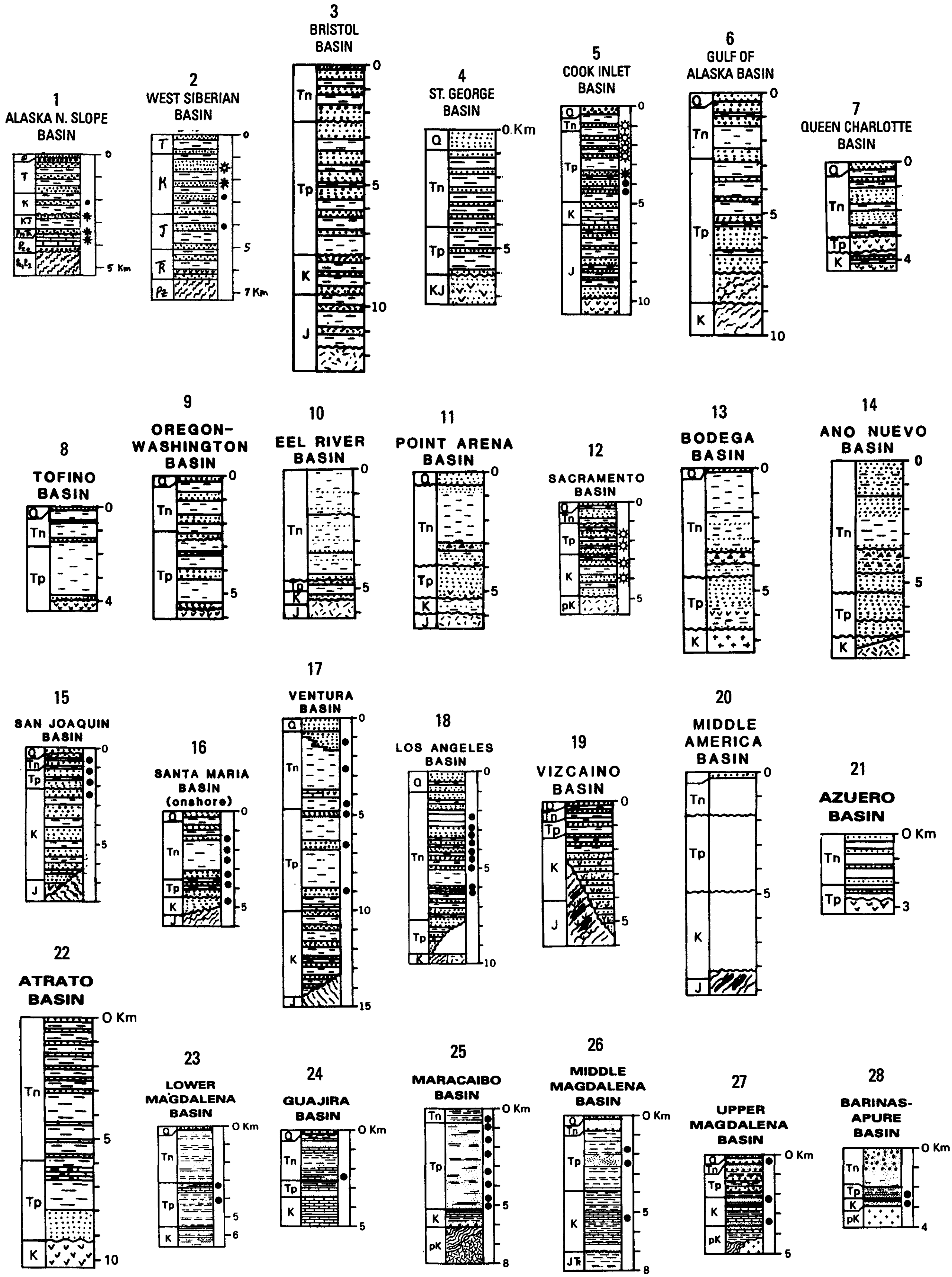

Figure 17. Stratigraphic columns of sedimentary basins, Circum-Pacific region.

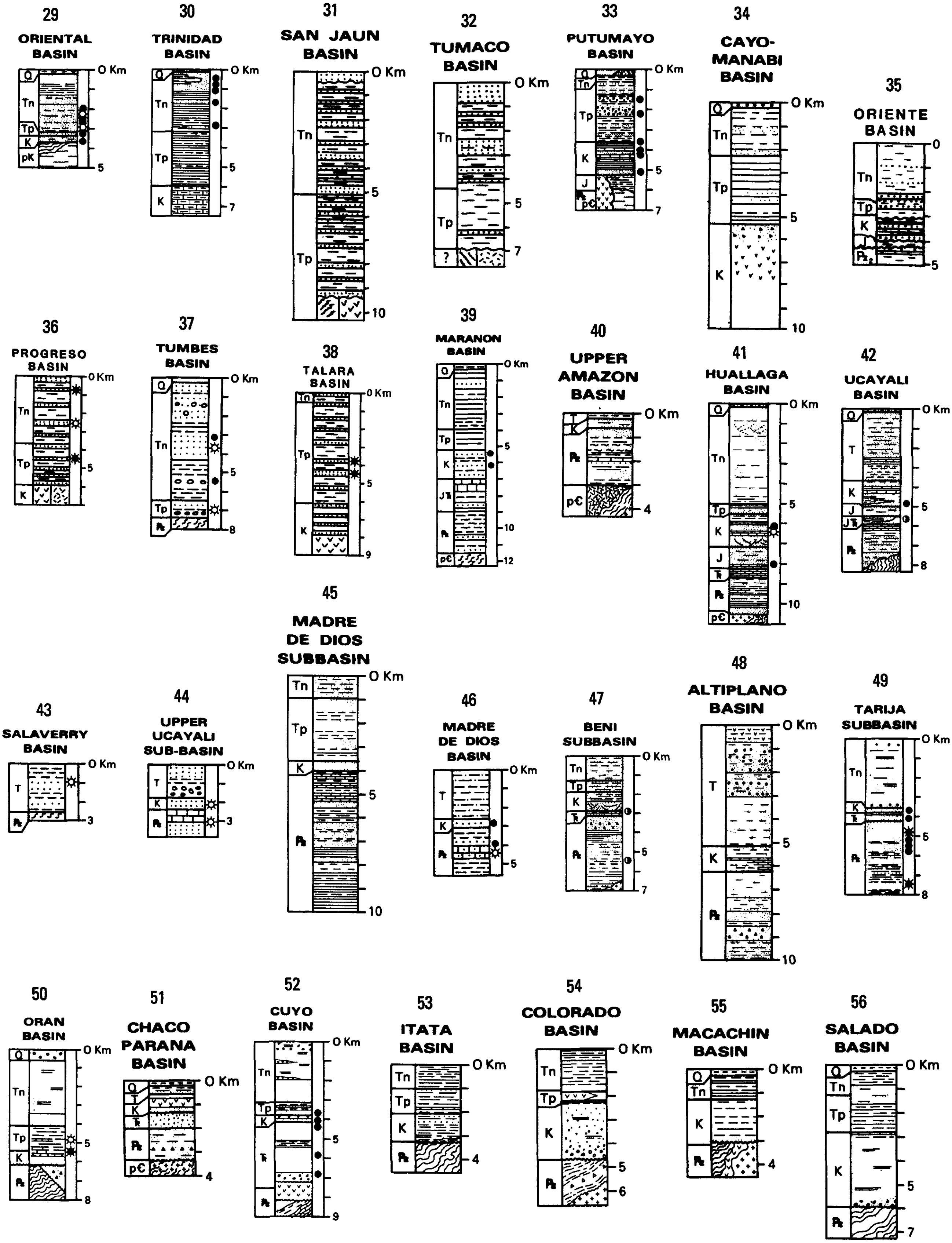

Figure 17.—continued Stratigraphic columns of sedimentary basins, Circum-Pacific region.

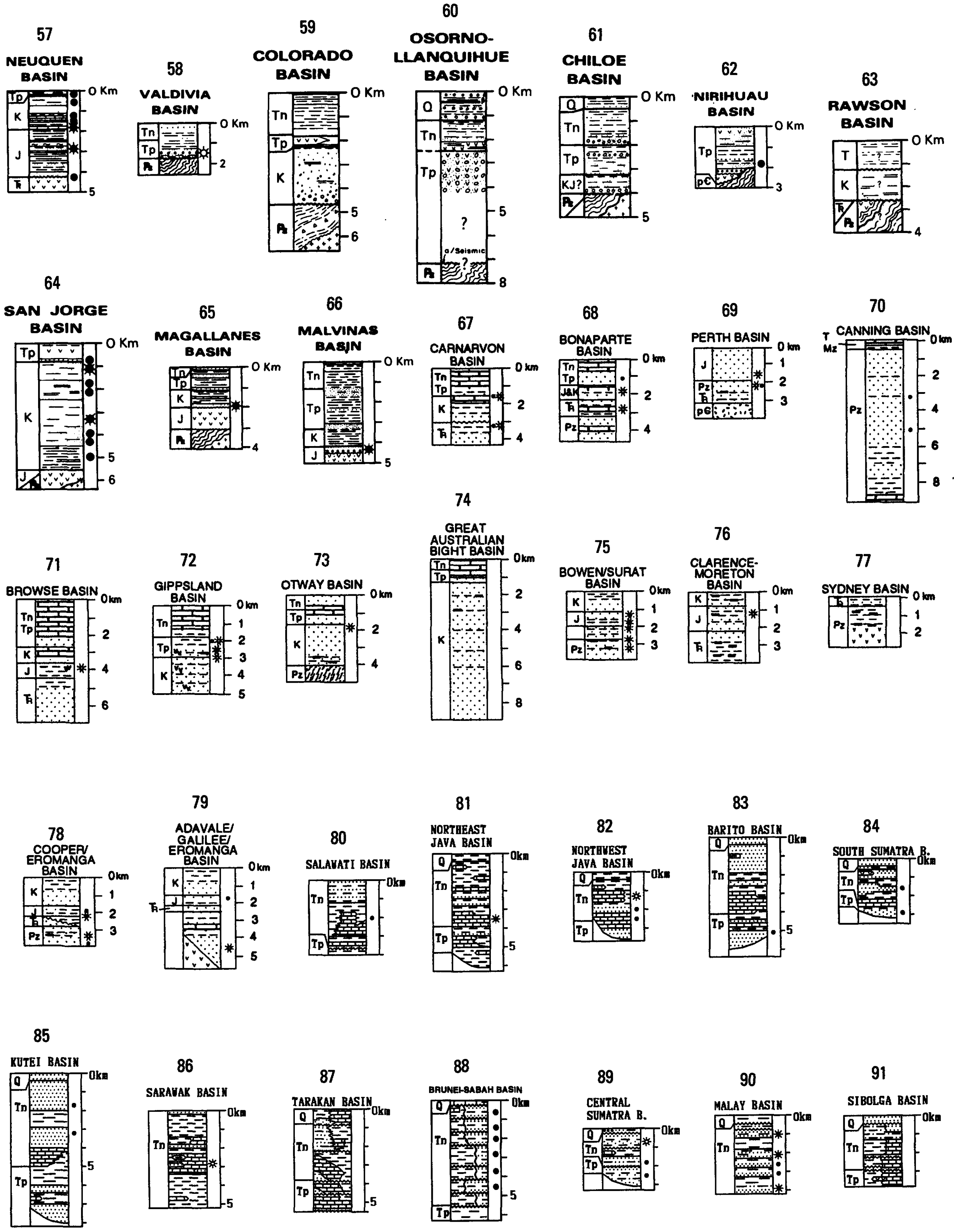

Figure 17.—continued Stratigraphic columns of sedimentary basins, Circum-Pacific region.

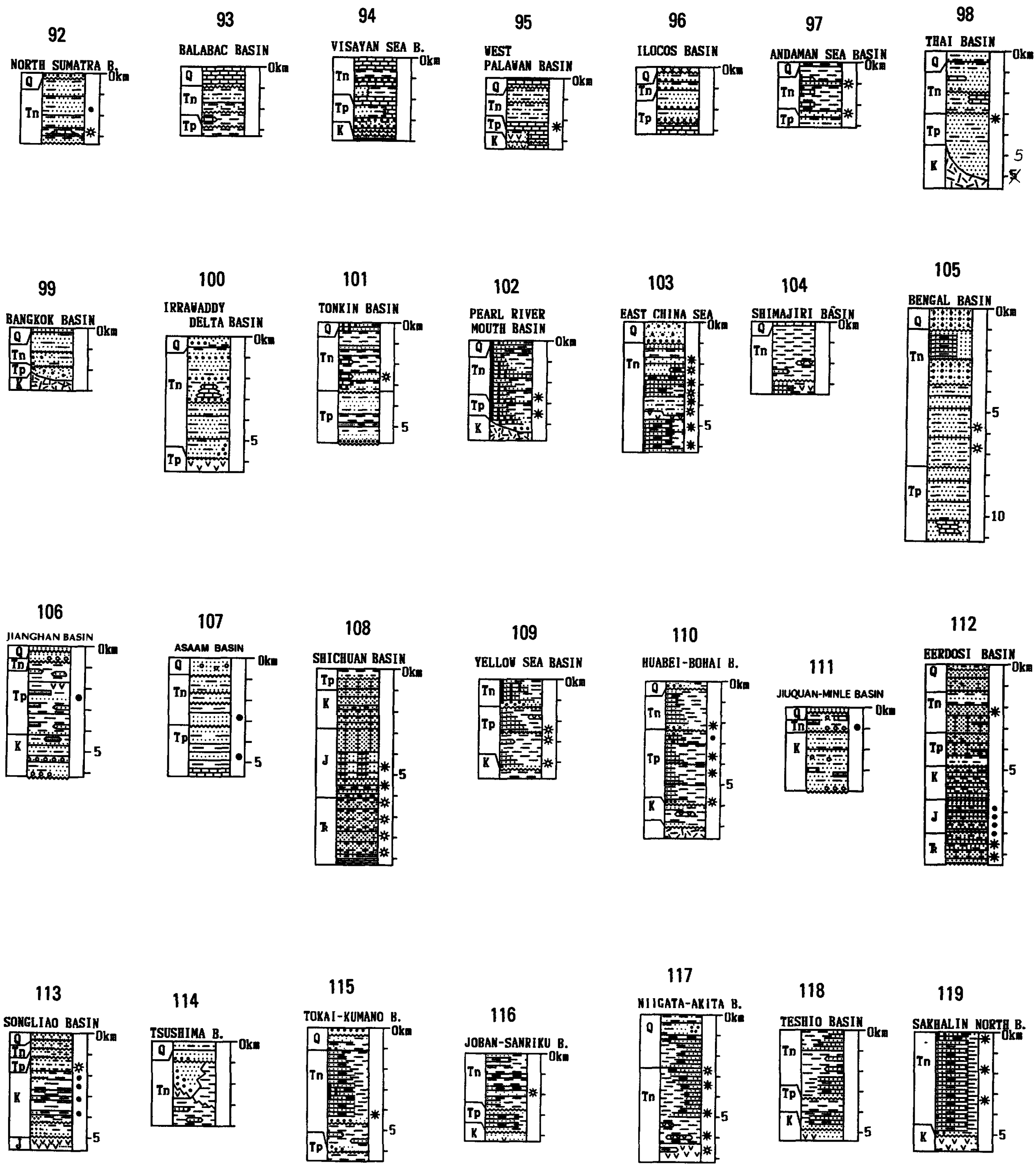

Figure 17.—continued Stratigraphic columns of sedimentary basins, Circum-Pacific region.

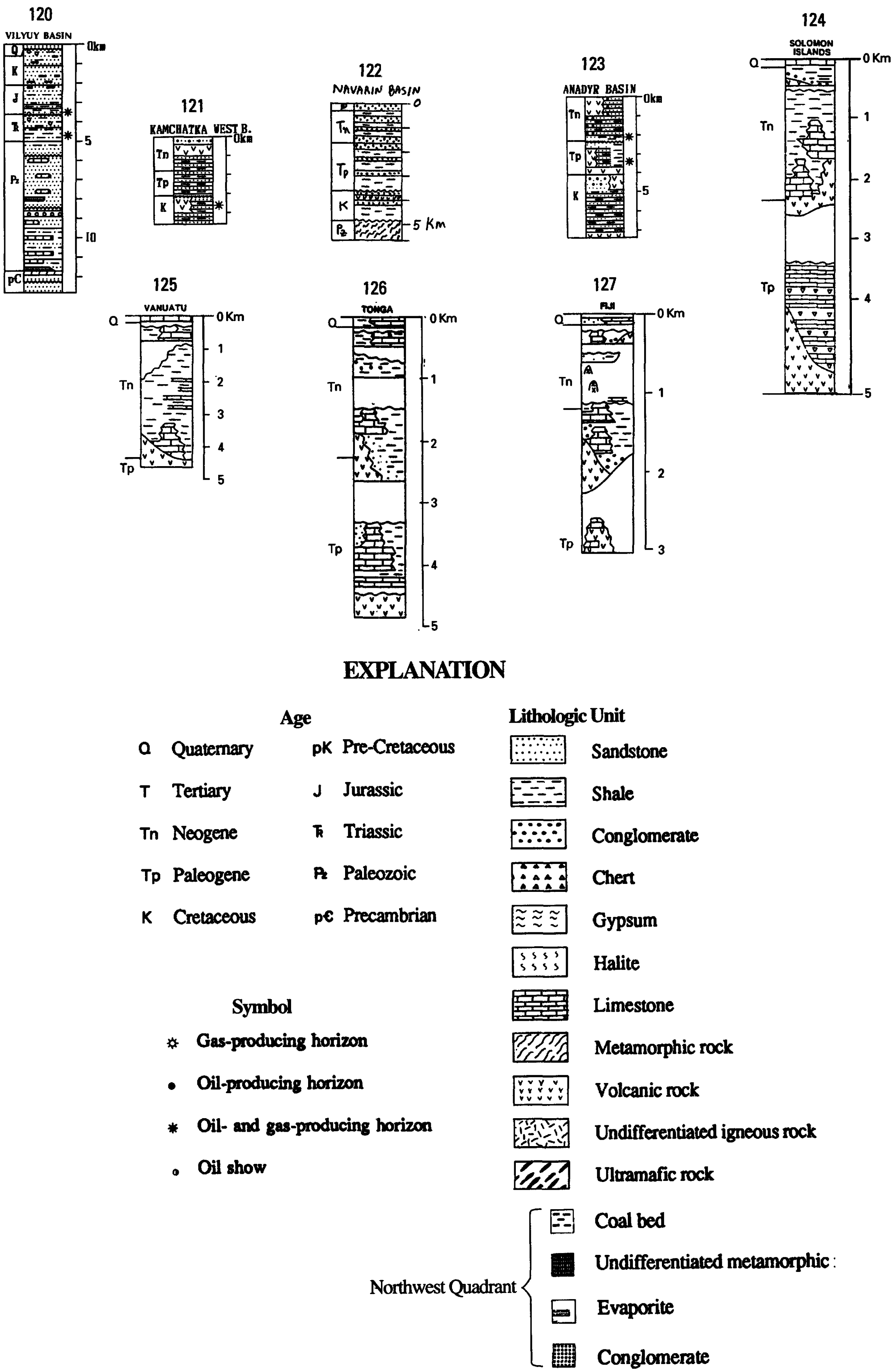

Figure 17.—continued Stratigraphic columns of sedimentary basins, Circum-Pacific region.

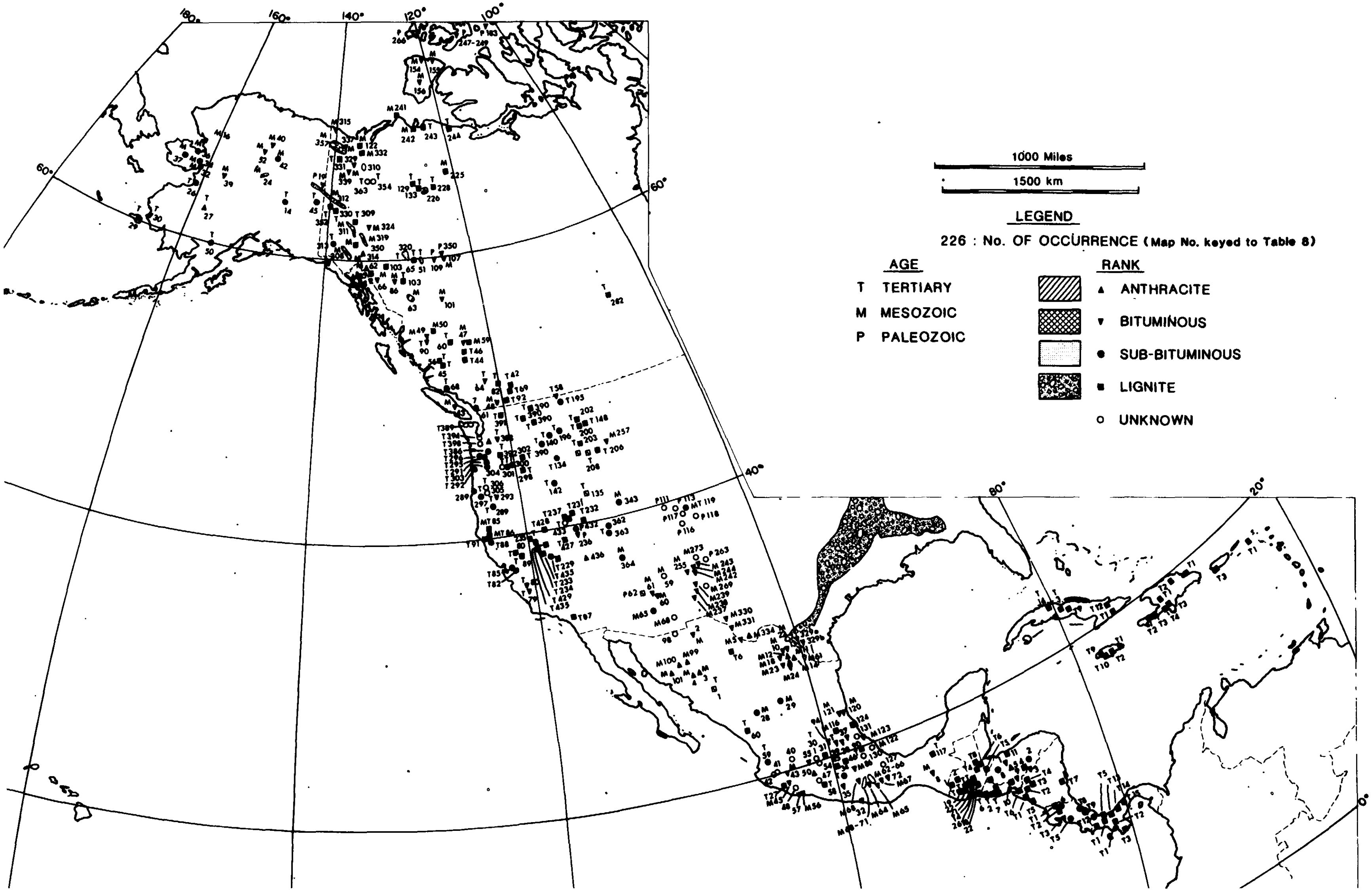

Figure 18. Coal supplement map showing small deposits on the 1:10,000,000-scale Energy-Resources Map, Northeast Quadrant, Circum-Pacific region.

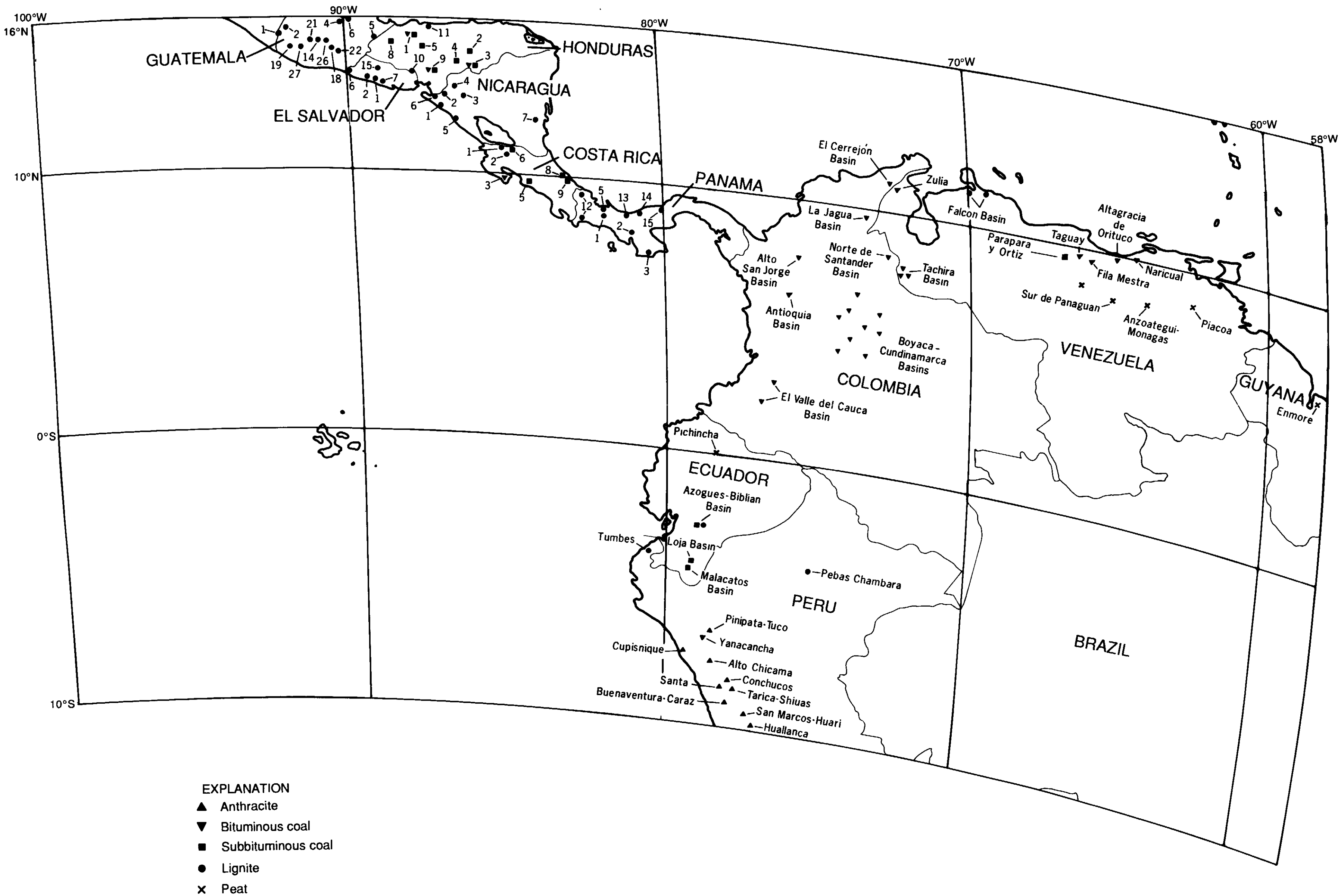

Figure 19. Selected coal deposits in northern segment, Southeast Quadrant, Circum-Pacific region (refer to table 15).

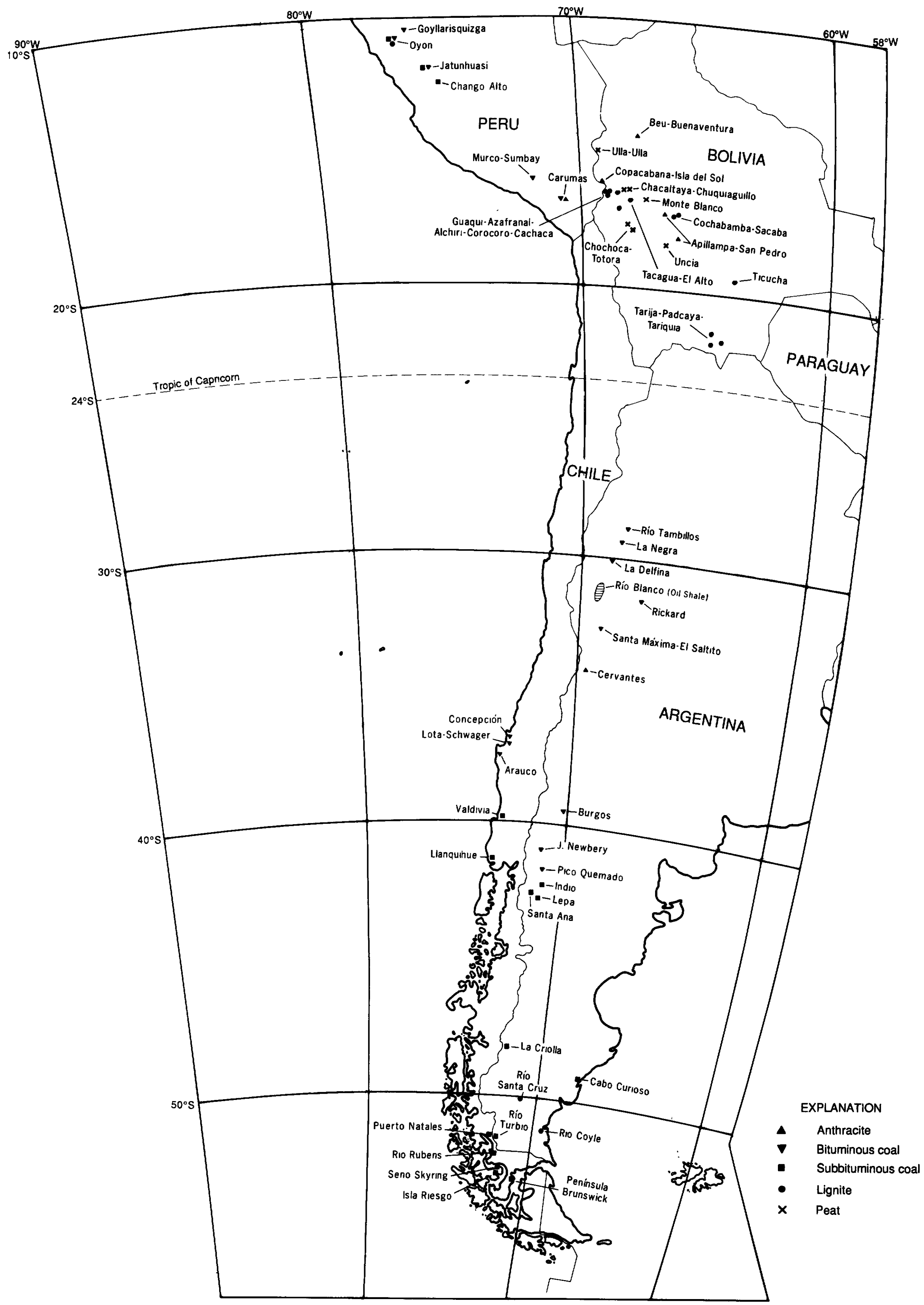

Figure 20. Selected coal deposits in southern segment, Southeast Quadrant, Circum-Pacific region (refer to table 15).

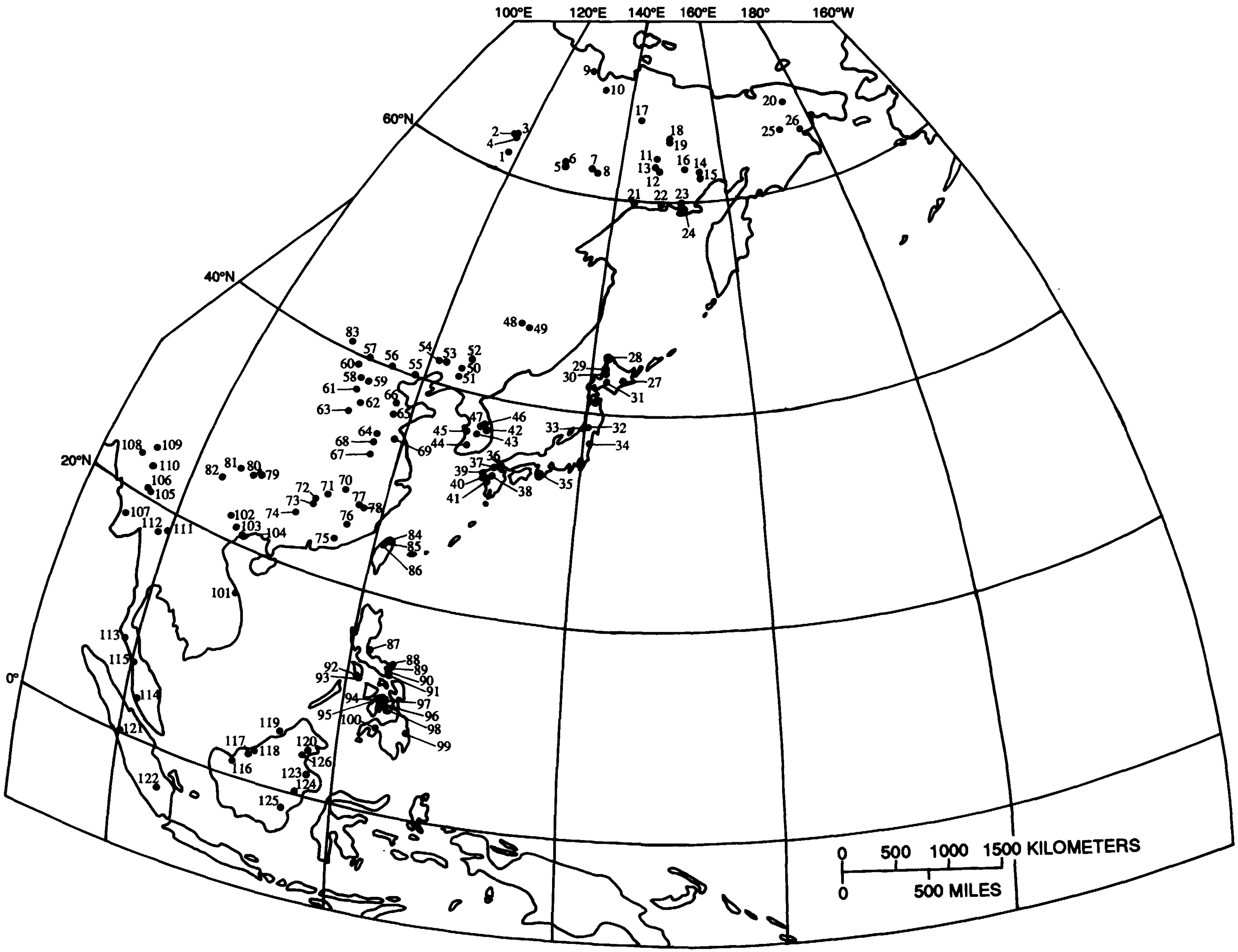

Figure 21. Index map showing location of major coal fields, Northwest Quadrant, Circum-Pacific region (numbers refer to table 16).

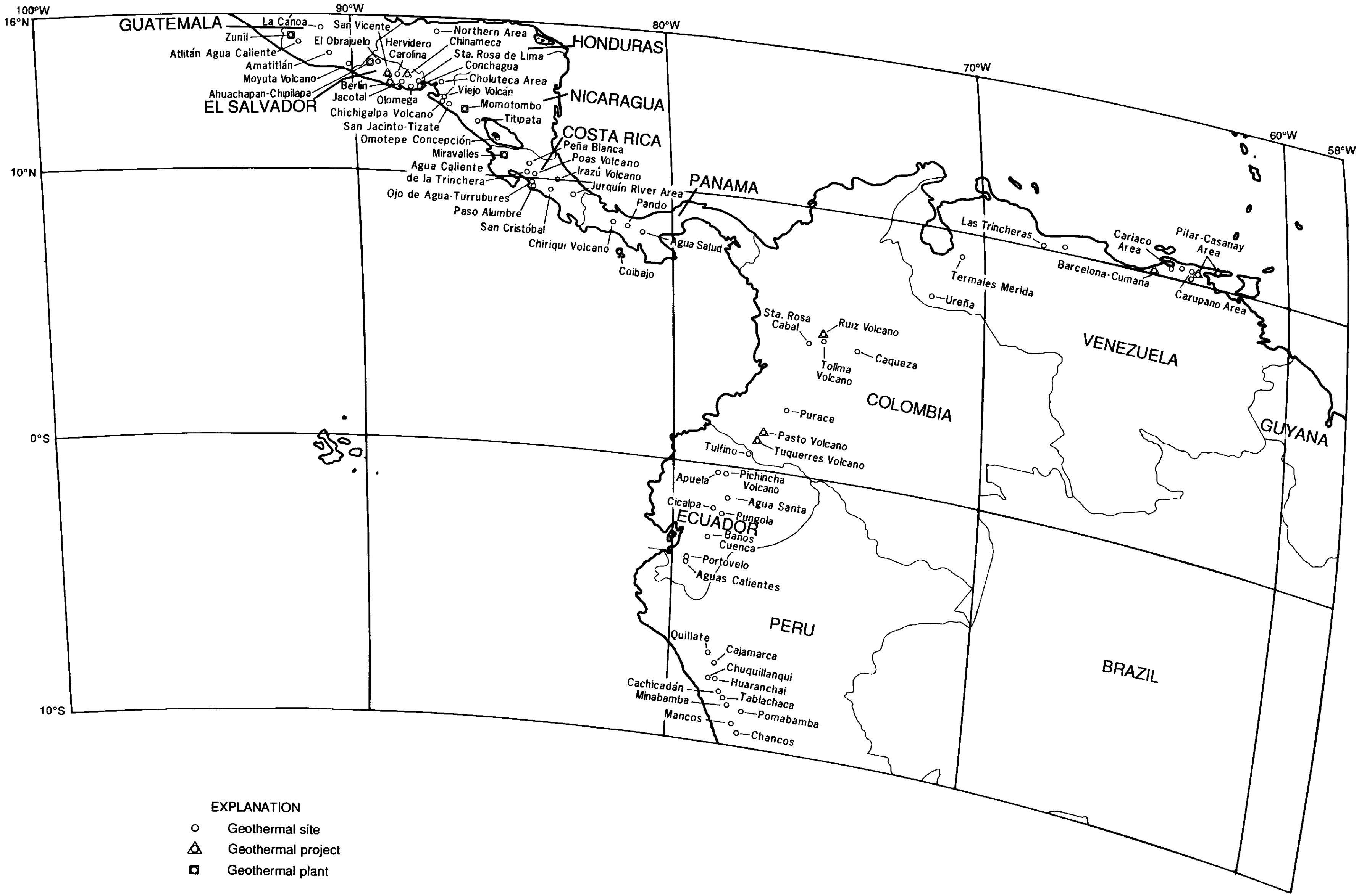

Figure 22. Major geothermal sites in northern segment, Southeast Quadrant, Circum-Pacific region (refer to table 20).

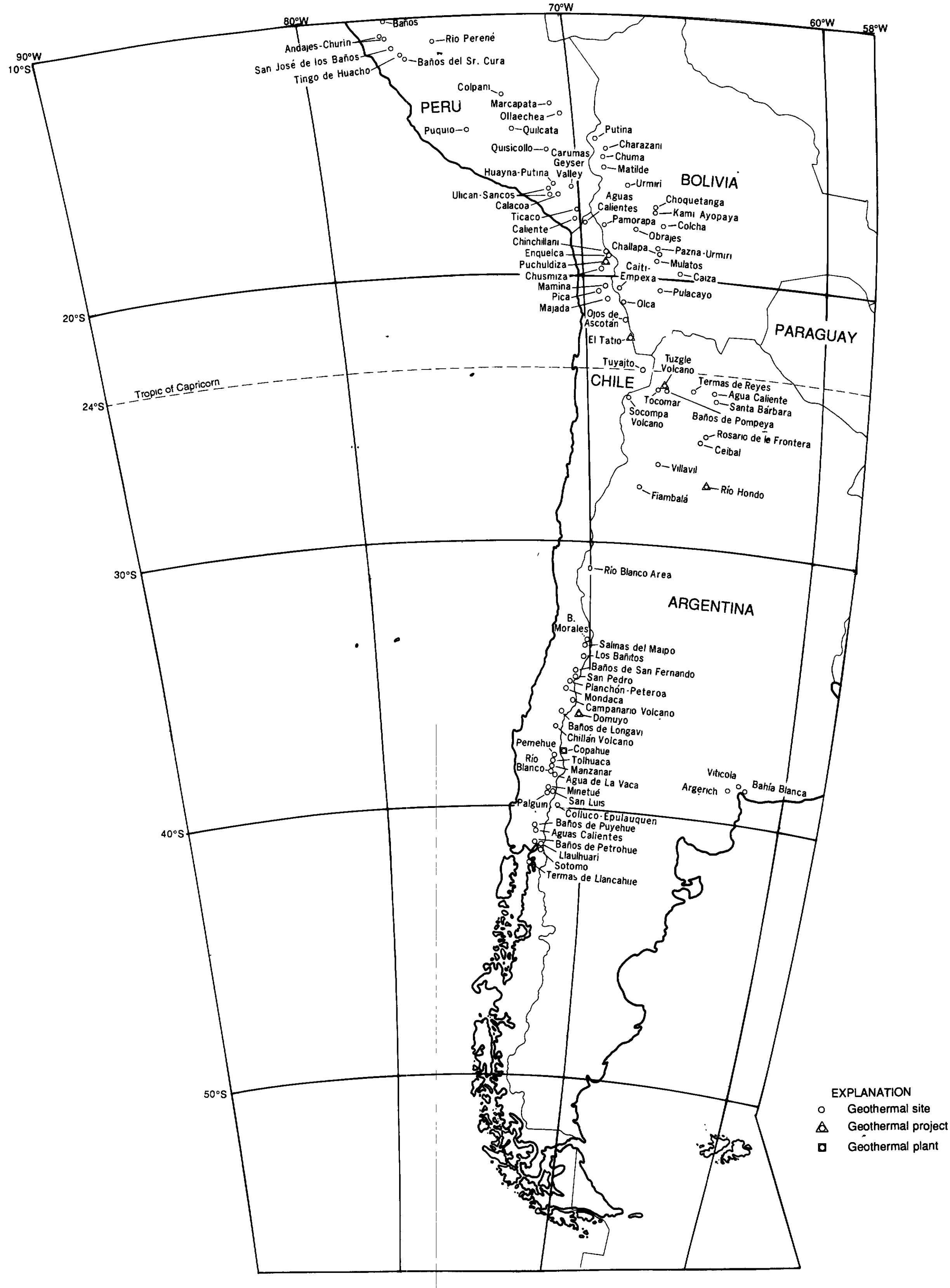

Figure 23. Major geothermal sites in southern segment, Southeast Quadrant, Circum-Pacific region (refer to table 20).

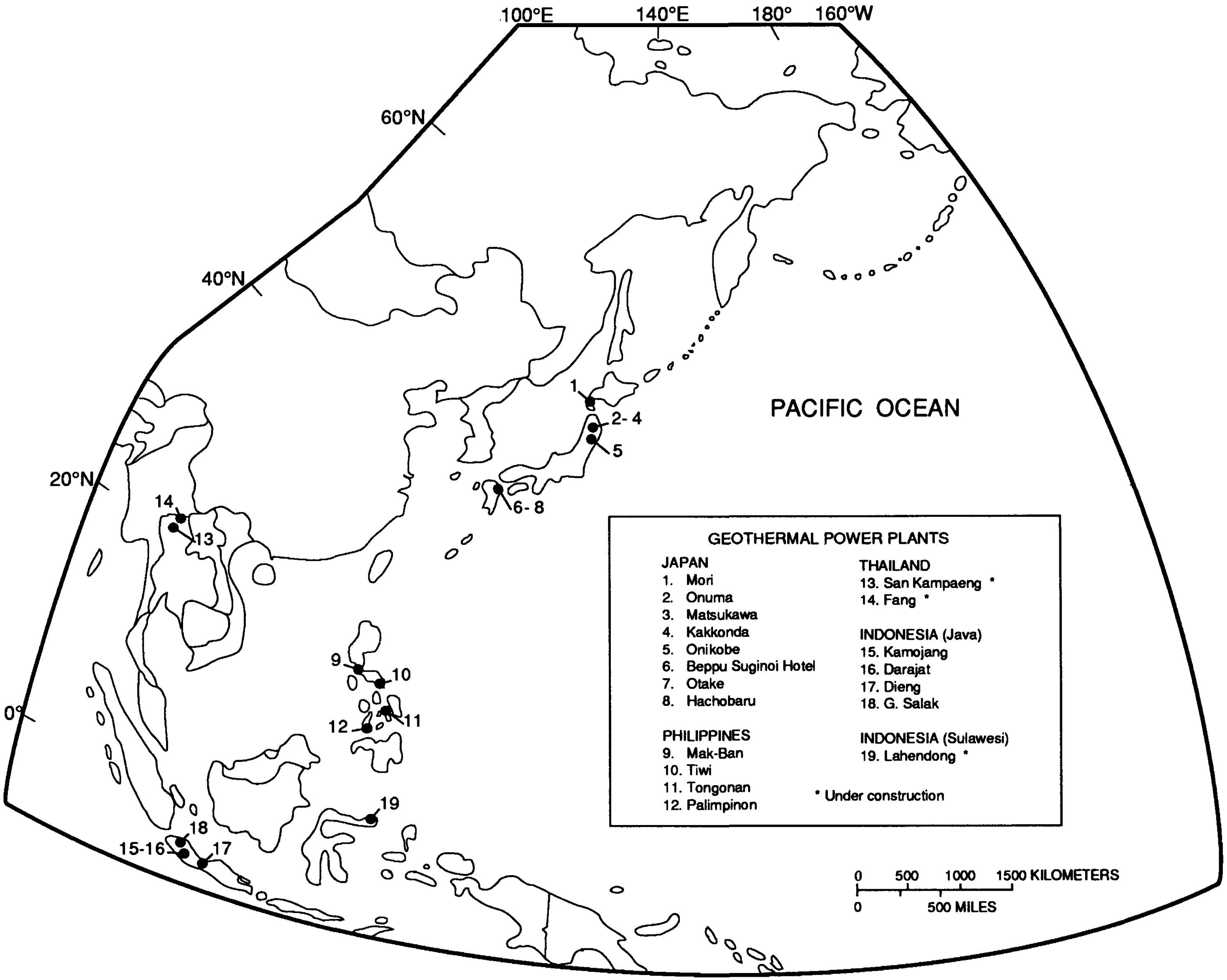

Figure 24. Index map showing location of geothermal power plants, Northwest Quadrant, Circum-Pacific region.

Table 1. Estimated initial and remaining oil and gas reserves by country, Circum-Pacific region

Country	Initial Reserves		Cum. Production (as of 12/31/98)		Remaining Reserves (as of 12/31/98)	
	Oil (MMB)	Gas (BCF)	Oil (MMB)	Gas (BCF)	Oil (MMB)	Gas (BCF)
Canada	23,013	170,838	18,134.2	108,810.6	4,879.2	62,027.1
United States	198,724	1,058,803	177,689.5	894,762.0	21,034.0	164,041.0
Mexico	50,094	59,318	25,393.6	29,254.2	24,700.1	30,064.0
Guatemala	576	23	51.4	2.0	525.0	21.3
Cuba	128	966	67.3	330.0	61.0	636.0
Barbados	7	17	4.6	10.0	2.4	7.1
Argentina	9,468	39,054	7,155.7	15,961.4	2,312.1	23,092.2
Bolivia	520	8,600	393.4	3,293.4	126.3	5,306.3
Chile	443	7,643	412.9	6,046.1	29.9	1,597.2
Colombia	7,378	12,872	4,800.6	4,349.5	2,577.0	8,522.0
Ecuador	6,765	1,402	2,663.3	621.6	4,102.0	780.9
Peru	2,456	8,249	2,132.9	1,253.3	323.5	6,995.8
Trinidad-Tobago	3,537	27,130	2,942.6	5,719.7	594.0	21,409.8
Venezuela	125,369	173,861	50,297.8	27,598.2	75,071.0	146,262.6
FSU	199,692	2,481,000	133,051.2	576,650.2	66,641.1	1,904,350.0
China	56,699	57,650	23,179.1	15,289.6	33,520.0	42,360.0
Japan	328	3,997	267.5	2,617.0	60.2	1,380.0
Taiwan	21	2,700	16.9		4.0	2,700.0
Vietnam	2,425	6,183	427.8	183.1	1,997.1	6,000.0
Myanmar	651	15,563	470.8	563.3	180.0	15,000.0
Thailand	646	19,035	257.3	4,210.0	388.4	14,825.1
Philippines	349	3,500	42.9		306.0	3,500.0
Indonesia	26,523	106,194	17,885.7	29,128.5	8,637.3	77,065.7
Malaysia	8,642	94,556	3,996.9	8,725.2	4,645.0	85,831.0
Brunei	3,953	16,439	2,933.3	6,859.2	1,020.0	9,580.0
Papua New Guinea	567	5,465	233.6	23.1	333.0	5,442.0
Australia	6,682	43,039	4,909.7	14,628.6	1,772.0	28,410.0
New Zealand	329	5,364	219.1	3,131.2	110.0	2,233.0
Total	735,983	4,429,461	480,032	1,760,021.0	255,951.6	2,669,440.2

Data Sources: World Oil, Oil Gas Journal, Olade, Pemex, APEC, CAPP, EIA

Table 2. Oil and gas production in 1998 by country, Circum-Pacific region

Country	Yearly production		Daily production	
	Oil	Gas	Oil	Gas
	(MMB)	(BCF)	(MB)	(MMCF)
Canada	793.4	6,893.8	2,173.6	18,887.1
United States	2,282.0	19,622.0	6,252.0	53,758.9
Mexico	1,120.7	1,748.7	3,070.5	4,791.0
Guatemala	9.3	0.4	25.5	1.1
Cuba	11.5	0.9	31.5	2.3
Barbados	0.6	1.3	1.6	3.6
Argentina	309.3	1,374.4	847.3	3,765.5
Bolivia	13.7	222.2	37.4	608.8
Chile	3.0	100.9	8.1	276.4
Colombia	267.4	279.3	732.5	765.2
Ecuador	137.1	54.0	375.5	147.8
Peru	42.2	39.4	115.6	107.8
Trinidad-Tobago	44.7	365.3	122.6	1,001.0
Venezuela	1,138.8	1,565.2	3,120.0	4,288.3
Russia	2,160.4	23,491.0	5,919.0	64,358.9
China	1,168.0	766.6	3,199.9	2,100.4
Japan	5.0	60.0	13.7	164.4
Taiwan	0.3	30.0	0.9	82.2
Vietnam	82.6	38.7	226.4	105.9
Myanmar	3.7	51.0	10.0	139.7
Thailand	30.5	576.9	83.5	1,580.7
Philippines	0.3	0.3	0.8	0.9
Indonesia	470.5	2,421.7	1,289.0	6,634.8
Malaysia	266.9	847.1	731.2	2,320.7
Brunei	49.5	348.3	135.6	954.3
Papua New Guinea	28.9	4.9	79.1	13.3
Australia	216.0	1,072.3	591.9	2,937.7
New Zealand	16.0	168.3	43.7	461.0
Total	10,672.0	62,144.8	29,238.4	170,259.8

Data Sources: EIA, CAPP, Pemex, OLADE, APEC, OGJ

Table 3. Coal production in 1996 by country, Circum-Pacific region

Country	Yearly production (Thousand Short Tons)			
	Anthracite	**Bituminous**	**Lignite**	**Total**
Canada	0	71,601	11,964	83,565
United States	4,751	971,048	88,056	1,063,856
Mexico	0	10,097	0	10,097
Argentina	0	342	0	342
Chile	0	1,190	42	1,232
Colombia	0	33,141	0	33,141
Peru	10	59	0	69
Venezuela	0	3,843	0	3,843
Russia	21,104	183,535	99,428	304,067
China	296,939	1,170,160	72,499	1,539,597
Japan	183	7,143	18	7,344
North Korea	50,548	0	28,109	78,657
South Korea	5,458	0	0	5,458
Taiwan	0	163	0	163
Vietnam	10,828	0	0	10,828
Myanmar	0	34	45	79
Thailand	6	0	23,671	23,677
Philippines	0	1,239	3	1,242
Indonesia	0	55,482	0	55,482
Malaysia	0	91	0	91
Australia	0	213,170	59,088	272,259
New Zealand	145	3,156	353	3,654
Total	389,971	2,725,494	1,068,413	7,467,106

Data Source: EIA World Energy database

Table 4. Selected giant and major oil fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (MMB)	Est. Ult. Recovery (MMB)
	Canada						
1	Pembina, 1953	W. Canada	Cretaceous	Sandstone	4000	1104.8	1850.0
2	Swan Hills, 1957	W. Canada	Devonian	Carbonate	8000	619.7	860.0
3	Redwater, 1948	W. Canada	Devonian	Carbonate	2600	765.6	815.0
4	Rainbow, 1965	W. Canada	Devonian	Carbonate	5500	381.2	720.0
5	Bonnie Glen, 1952	W. Canada	Devonian	Carbonate	5000	455.7	535.0
6	Swan Hills-S., 1959	W. Canada	Devonian	Carbonate	8000	316.4	515.0
	Totals					**3643.4**	**5295.0**
	Colombia						
1	Cano-Limon, 1983	Llanos	Tertiary	Sandstone	7500	0.0	1000.0
2	La Cira, 1925	Mid. Magdalena	Tertiary-Cretaceous	Sandstone	3250	453.6	550.0
3	Casabe, 1941	Mid. Magdalena	Tertiary-Cretaceous	Sandstone	3800	215.5	260.0
4	Infantas, 1918	Mid. Magdalena	Tertiary-Cretaceous	Sandstone	2000	221.4	255.0
	Totals					**890.5**	**2065.0**
	Ecuador						
1	Shushufindi, 1959	Napo	Cretaceous	Sandstone	9700	392.1	800.0
2	Sacha, 1969	Napo	Cretaceous	Sandstone	9700	290.1	650.0
3	Ancon, 1921	Daule	Tertiary	Sandstone	4000	115.9	135.0
	Totals					**798.1**	**1585.0**
	Peru						
1	La Brea-Parinas, 1869	Talara	Tertiary	Sandstone	5500	910.7	1100.0
	Trinidad						
1	Soldado, 1955	Paria	Tertiary	Sandstone	11000	421.4	650.0
2	Fyzabad-Forrest Reserve, 1913	Paria	Tertiary	Sandstone	8000	420.4	600.0
	Totals					**841.8**	**1250.0**

Table 4.—continued Selected giant and major oil fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (MMB)	Est. Ult. Recovery (MMB)
	Mexico						
1	Cantarell, 1976	Campeche	Jurassic, Cretaceous, Tertiary	Carbonate, Sandstone	8500	1644.4	9000.0
2	A.J. Bermudez, 1973	Reforma	Jurassic, Cretaceous, Tertiary	Carbonate, Sandstone	12200	1501.8	5800.0
3	Poza Rica, 1930	Tampico	Cretaceous	Carbonate	7100	875.1	1800.0
4	Naranjos-C. Azul, 1909	Tampico	Cretaceous	Carbonate	1800	1208.2	1400.0
5	Sitio Grande, 1972	Reforma	Cretaceous	Carbonate	13700	261.1	1150.0
6	Cactus-Nispero, 1972	Reforma	Cretaceous	Carbonate	15000	366.7	1100.0
7	Ebano-Panuco, 1901	Tampico	Cretaceous	Carbonate	1450	940.3	1050.0
8	Abkatun, 1978	Campeche	Cretaceous, Tertiary	Carbonate	10200	477.6	n.a.
9	Ku, 1979	Campeche	Jurassic, Cretaceous	Carbonate, Sandstone	10000	203.3	n.a.
	Totals					**7478.5**	**21300.0**
	Venezuela						
1	Bolivar Coastal, 1917	Maracaibo	Tertiary	Sandstone	4530	24408.4	32000.0
2	Lamar, 1958	Maracaibo	Tertiary, Cretaceous	Sandstone	12500	1038.4	1650.0
3	Centro, 1959	Maracaibo	Tertiary	Sandstone	10000	725.5	1200.0
4	Oficina, 1917	E. Venezuela	Tertiary	Sandstone	5000	767.9	1100.0
5	Boscan, 1946	Maracaibo	Tertiary	Sandstone	7000	687.9	1100.0
6	La Paz, 1925	Maracaibo	Tertiary, Cretaceous	Sandstone, Carbonate	6000	842.0	1050.0
7	Urdaneta, 1970	Maracaibo	Tertiary, Cretaceous	Sandstone, Carbonate	10000	87.7	1000.0
8	Quiriquire, 1928	E. Venezuela	Tertiary, Cretaceous	Sandstone	3000	758.2	820.0
9	Mene Grande, 1914	Maracaibo	Tertiary	Sandstone	2750	627.9	800.0
10	Guara, 1946	E. Venezuela	Tertiary	Sandstone	7500	555.0	700.0
11	Nipa, 1945	E. Venezuela	Tertiary	Sandstone	7200	498.8	675.0
12	Greater Jusepin, 1938	E. Venezuela	Tertiary	Sandstone	6000	557.0	600.0
13	Mata, 1954	E. Venezuela	Tertiary	Sandstone	9500	499.8	600.0
14	Mara, 1945	Maracaibo	Tertiary	Sandstone	5200	405.0	500.0
15	Santa Rosa, 1941	E. Venezuela	Tertiary	Sandstone	8500	380.4	500.0
16	Chimire, 1948	E. Venezuela	Tertiary	Sandstone	7100	365.8	500.0
	Totals					**33205.7**	**44795.0**

Table 4.—continued Selected giant and major oil fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (MMB)	Est. Ult. Recovery (MMB)
	United States						
	Alaska						
1	Prudhoe, 1968	Cambden	Triassic	Sandstone	10000	3796.8	9500.0
2	Kuparuk, 1971	Cambden	Cretaceous	Sandstone	8000	109.6	1200.0
3	McArthur River, 1965	Cook Inlet	Tertiary	Sandstone	9500	499.0	570.0
4	Swanson River, 1968	Cook Inlet	Tertiary	Sandstone	11000	200.7	220.0
5	Middle Ground Shoal, 1963	Cook Inlet	Tertiary	Sandstone	7800	143.8	165.0
6	Granite Point, 1965	Cook Inlet	Tertiary	Sandstone	8700	97.9	125.0
	Totals					**4847.8**	**11780.0**
	California						
1	Wilmington, 1932	Los Angeles	Tertiary	Sandstone	4000	2151.6	2600.0
2	Midway Sunset, 1894	San Joaquin	Tertiary	Sandstone	3000	1652.1	2200.0
3	Kern River, 1899	San Joaquin	Tertiary	Sandstone	1000	1012.9	1990.0
4	Elk Hills, 1911	San Joaquin	Tertiary	Sandstone	3000	726.7	1475.0
5	Huntington Beach, 1929	Los Angeles	Tertiary	Sandstone	3000	1038.9	1150.0
6	Ventura, 1919	Ventura	Tertiary	Sandstone	8000	865.5	1000.0
7	Long Beach, 1921	Los Angeles	Tertiary	Sandstone	4000	898.8	950.0
8	Belridge South, 1911	San Joaquin	Tertiary	Sandstone	1000	436.0	800.0
9	Coalinga, 1890	San Joaquin	Tertiary	Sandstone	3000	710.8	790.0
10	Buena Vista, 1909	San Joaquin	Tertiary	Sandstone	5000	640.6	660.0
11	Santa Fe Springs, 1919	Los Angeles	Tertiary	Sandstone	4000	609.2	625.0
12	San Ardo, 1947	Salinas	Tertiary	Sandstone	2150	383.7	530.0
13	Coalinga-E. Ext, 1938	San Joaquin	Tertiary	Sandstone	6500	492.8	520.0
14	Kettleman North, 1928	San Joaquin	Tertiary	Sandstone	8000	455.9	460.0
15	Point Arguello, 1983	Santa Maria	Tertiary	Sandstone	7800	0.0	350.0
	Totals					**12075.5**	**16100.0**
	Interior western U.S.A.						
1	East Texas, 1930	Gulf Coast	Cretaceous	Sandstone	4000	4833.4	6000.0
2	Yates, 1926	Permian	Upper Paleozoic	Carbonate	2000	1014.1	1955.0
3	Wasson, 1937	Permian	Upper Paleozoic	Carbonate	6000	1586.2	1800.0
4	Panhandle, 1910	Anadarko	Upper Paleozoic	Carbonate	2700	1388.4	1480.0
5	Sho-vel-trum, 1914	Ardmore	Paleozoic	Carbonate, Sandstone	5350	1244.0	1380.0
6	Kelly-Snyder, 1948	Permian	Upper Paleozoic	Carbonate	4535	1176.1	1350.0
7	Slaughter, 1936	Permian	Upper Paleozoic	Carbonate	7000	944.9	1200.0
8	Hawkins, 1940	Gulf Coast	Cretaceous	Sandstone	4350	778.5	900.0
9	Tom O'Connor, 1933	Gulf Coast	Tertiary	Sandstone	4000	695.0	890.0
10	Goldsmith, 1935	Permian	Upper Paleozoic	Carbonate	4100	723.8	800.0
11	Conroe, 1931	Gulf Coast	Tertiary	Sandstone	3500	705.9	775.0
12	Hastings, 1934	Gulf Coast	Tertiary	Sandstone	4500	681.1	770.0
13	Oklahoma City, 1928	Anadarko	Paleozoic	Sandstone, Carbonate	3600	741.0	748.0

Table 4.—continued Selected giant and major oil fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (MMB)	Est. Ult. Recovery (MMB)
14	Rangely, 1933	Uinta	Upper Paleozoic, Cretaceous	Sandstone	3850	691.2	740.0
15	Salt Creek, 1906	Powder River	Cretaceous, Jurassic	Sandstone	2000	620.5	700.0
16	Bay Marchand, 1949	Gulf Coast	Tertiary	Sandstone	2500	571.9	690.0
17	Spraberry Trend, 1951	Permian	Upper Paleozoic	Sandstone, Carbonate	7000	566.0	645.0
18	Caillou Island, 1930	Gulf Coast	Tertiary	Sandstone	3650	590.9	635.0
19	Webster, 1936	Gulf Coast	Tertiary	Sandstone	5000	551.2	600.0
20	Smackover, 1922	Gulf Coast	Cretaceous, Jurassic	Sandstone, Carbonate	3500	543.2	590.0
21	Burbank, 1920	Arkoma	Upper Paleozoic	Sandstone	3000	529.6	550.0
22	Van, 1928	Gulf Coast	Cretaceous	Sandstone	1000	506.5	545.0
23	McElroy, 1926	Permian	Upper Paleozoic	Carbonate	2850	433.8	540.0
24	Greater Seminole, 1926	Anadarko	Paleozoic	Sandstone, Carbonate	4000	463.2	538.0
25	Levelland, 1938	Permian	Upper Paleozoic	Carbonate	7000	412.9	535.0
26	Elk Basin, 1915	Bighorn	Upper Paleozoic	Sandstone	4000	489.7	530.0
27	S. Cowden Complex, 1932	Permian	Upper Paleozoic	Carbonate	4050	461.1	525.0
28	North Cowden, 1930	Permian	Upper Paleozoic	Carbonate	4000	431.7	515.0
29	Thompson, 1931	Gulf Coast	Tertiary	Sandstone	2400	455.5	508.0
30	South Pass Blk. 24, 1950	Gulf Coast	Tertiary	Sandstone	6500	450.5	505.0
31	Golden Trend, 1945	Anadarko	Paleozoic	Sandstone, Carbonate	6200	438.7	500.0
32	West Delta Blk. 30, 1949	Gulf Coast	Tertiary	Sandstone	2300	413.5	500.0
	Totals					**26134.0**	**30939.0**
		Total Selected Fields, NE Quadrant				**90826.0**	**136209.0**

Table 5. Selected giant and major gas fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (BCF)	Est. Ult. Recovery (BCF)
	Canada						
1	Medicine Hat, 1904	W. Canada	Cretaceous	Sandstone	2500	2090.0	3500.0
2	Taglu, 1971	MacKenzie	Tertiary	Sandstone	10000	0.0	3000.0
3	Elmworth, 1955	W. Canada	Cretaceous	Sandstone	6300	254.7	3000.0
	Totals					**2344.7**	**9500.0**
	Ecuador						
1	Amistad,	Progreso	Tertiary	Sandstone		n.a.	1600.0
	Mexico						
1	A.J.Bermudez, 1973	Reforma	Jurassic, Cretaceous, Tertiary	Carbonate, Sandstone	10000	n.a.	17500.0
2	Poza Rica, 1930	Tampico	Tertiary	Sandstone	7100	n.a.	5000.0
3	Jose Colombo-Chilapilla, 1951	Macuspana	Tertiary	Sandstone	5000	n.a.	4500.0
4	Cantarell, 1976	Campeche	Jurassic, Cretaceous, Tertiary	Sandstone	8500		3900.0
5	Reynosa, 1948	Burgos	Tertiary	Sandstone	3700	n.a.	3700.0
6	Cactus-Nispero, 1972	Reforma	Jurassic, Cretaceous, Tertiary	Sandstone	15000		3000.0
	Totals						**37600.0**
	United States						
	Alaska						
1	Prudhoe, 1967	Cambden	Triassic	Sandstone	9000	n.a.	30000.0
2	Kenai, 1957	Cook Inlet	Tertiary	Sandstone	4500	n.a.	2500.0
	Totals						**32500.0**
	California						
1	Rio Vista, 1936	Sacramento	Tertiary	Sandstone	5000	3218.3	3500.0
2	Kettleman North, 1928	San Joaquin	Tertiary	Sandstone	7000	2920.6	2950.0
	Totals					**6138.9**	**6450.0**

Table 5.—continued Selected giant and major gas fields, Northeast Quadrant, Circum-Pacific region

Map No.	Field, Year Discovered	Basin	Major Reservoir Age	Major Reservoir Lithology	Depth (Feet)	Cum. Prod. 12/31/84 (BCF)	Est. Ult. Recovery (BCF)
	Interior western U.S.A.					**1/1/77**	
1	Hugoton-Panhandle, 1918	Anadarko	Upper Paleozoic	Carbonate	2500	33000.0	70000.0
2	Blanco-Basin, 1927	San Juan	Cretaceous	Cretacous	6050	8592.0	10000.0
3	Monroe, 1916	Gulf Coast	Tertiary, Cretaceous	Carbonate	2125	6876.0	9400.0
4	Gomez, 1963	Permian	Lower Paleozoic	Carbonate	19800	2876.0	9000.0
5	Jalmat-Eunice, 1927	Permian	Upper Paleozoic	Carbonate	3400	1594.0	8100.0
6	Katy, 1964	Gulf Coast	Tertiary	Tertiary	6775	6122.0	8000.0
7	Carthage, 1936	Gulf Coast	Cretaceous	Carbonate	5900	2320.0	7600.0
8	Puckett, 1952	Permian	Lower Paleozoic	Carbonate	13400	2783.0	6500.0
9	Old Ocean, 1934	Gulf Coast	Tertiary	Tertiary	10000	2606.0	5000.0
10	Mocane-Laverne 1952	Anadarko	Upper Paleozoic	Sandstone, Carbonate	7000	3372.0	4800.0
11	LaGloria, 1939	Gulf Coast	Tertiary	Sandstone	8100	3061.0	4100.0
12	Agua Dulce, 1928	Gulf Coast	Tertiary	Sandstone	7100	2237.0	4000.0
16	Big Piney-Labarge, 1925	Green River	Triassic, Tertiary	Sandstone	5150	779.0	3010.0
	Totals					**76218.0**	**149510.0**
		Total Selected Fields, Northeast Quadrant					**228660.0**

Table 6. Giant oil and gas fields with an estimated ultimate recovery of more than 500 MMB and (or) 3 TCF, Southeast Quadrant, Circum-Pacific region

[MMB, million barrels; TCF, trillion cubic feet; -, no data. See figures 8 and 9 for location of selected basins and fields]

Field Name	Country	Basin	Year Discovered	Major Reservoir				Cumulative Production (12-31-87)		Estimated Ultimate Recovery	
				Age	Lithology	Average Depth (Ft)	Type of Trap	MMB	TCF	MMB	TCF
South Flank Group	Argentina	San Jorge	1946	Jurassic/ Cretaceous	Sandstone	1600-8500	Fault Block	680		816	530
North Flank Group	Argentina	San Jorge	1907	Cretaceous/ Tertiary	Sandstone	2000-10,500	Fault Block	568		842	79
Loma de la Lata (Upper)	Argentina	Neuquen	1977	Cretaceous	Limestone	5200-7200	Stratigraphic Structural	30		500	
Loma de la Lata (Lower)	Argentina	Neuquen	1977	Jurassic	Sandstone	6200-8200	Stratigraphic Structural		.62		12
Punta Bardas/ V. Muerta	Argentina	Cuyo	1961	Triassic/ Cretaceous	Sandstone	7200-8000	Anticline	338		500	
La Cira	Colombia	Middle Magdalena	1925	Cretaceous/ Tertiary	Sandstone	3250	Anticline	459		520	
Caño Limón	Colombia	Arauca	1983	Cretaceous/ Tertiary	Sandstone	7500-8200	Fault Block	108		1000	
Shushufindi	Ecuador	Oriente	1969	Cretaceous	Sandstone	7500-8900	Anticline	495		1350	
Sacha	Ecuador	Oriente	1969	Cretaceous	Sandstone	7800-9300	Anticline	338		743	
Amistad	Ecuador	Progreso	1970	Tertiary?	Sandstone	-	Anticline		-		3
La Brea - Parinas	Peru	Talara	1869	Tertiary	Sandstone Conglomerate	5500	Fault Blocks	539		592	
San Martin	Peru	Ucayali	1984	Cretaceous	Sandstone	12,800	Anticline		-		3
Cashiriari	Peru	Ucayali	1986	Cretaceous	Sandstone	8800	Anticline		-		8
Fyzabad Group	Trinidad	South Basin	1913	Tertiary	Sandstone	3000-8000	Stratigraphic Structural	630		850	
Soldado	Trinidad	South Basin	1954	Tertiary	Sandstone	4000-8000	Stratigraphic Structural	463		600	
East Coast	Trinidad	S.E. Coast	1961	Tertiary	Sandstone	5000-11,000	Stratigraphic Structural	555		700	
Galeota Group	Trinidad	Galeota	1968	Tertiary	Sandstone	8000-14,000	Stratigraphic Structural		5		7
North Coast Group	Trinidad	W. Tobago	1971	Tertiary	Sandstone	11,000	Stratigraphic Structural		NIL		3
Tia Juana	Venezuela	Maracaibo	1928	Tertiary	Sandstone	3500	Stratigraphic Fault	10,360		15,050	
Bachaqero	Venezuela	Maracaibo	1930	Tertiary	Sandstone	3450	Stratigraphic Fault	6264		9367	
Lagunillas	Venezuela	Maracaibo	1926	Tertiary	Sandstone	3000	Stratigraphic Fault	3462		5220	
Lama	Venezuela	Maracaibo	1957	Cretaceous/ Tertiary	Sandstone	10,000	Stratigraphic Fault	2140		2850	
Ceuta	Venezuela	Maracaibo	1956	Cretaceous/ Tertiary	Sandstone	-	Stratigraphic Fault	505		1239	
Cabimas	Venezuela	Maracaibo	1917	Tertiary	Sandstone	2200	Stratigraphic Fault	489		515	
Boscán	Venezuela	Maracaibo	1946	Tertiary	Sandstone	8800	Anticline Stratigraphic	729		2471	
Urdaneta	Venezuela	Maracaibo	1956	Cretaceous/ Tertiary	Sandstone	10,000	Anticline Stratigraphic	122		2058	
Centro	Venezuela	Maracaibo	1957	Cretaceous/ Tertiary	Sandstone	10,000	Anticline Stratigraphic	777		1702	
Lamar	Venezuela	Maracaibo	1958	Cretaceous/ Tertiary	Sandstone	12,500	Anticline Stratigraphic	1095		1594	
La Paz	Venezuela	Maracaibo	1925	Cretaceous/ Tertiary	Sandstone	11,400	Faulted Anticline	857		1042	
Mene Grande	Venezuela	Maracaibo	1914	Tertiary	Sandstone	8000	Faulted Anticline	637		686	
Santa Rosa	Venezuela	Oriental	1941	Tertiary	Sandstone	10,600	Faulted Anticline	390		697	
Mata	Venezuela	Oriental	1954	Tertiary	Sandstone	9500	Faulted Monocline	469		648	
Guara	Venezuela	Oriental	1946	Tertiary	Sandstone	7800	Faulted Monocline	424		606	
Oficina	Venezuela	Oriental	1917	Tertiary	Sandstone	6900	Fault Block	384		525	
Cerro Negro	Venezuela	Orinoco	1979	Tertiary	Sandstone	-	Stratigraphic	20.3		11,183	
San Diego	Venezuela	Orinoco	-	-	-	-	-	-		4557	
Iguana	Venezuela	Orinoco	-	-	-	-	-	-		4176	
Jobo	Venezuela	Orinoco	1956	-	-	-	-	267		1453	
Morichal	Venezuela	Orinoco	1958	-	-	3300	-	169		946	
Santa Clara	Venezuela	Orinoco	-	-	-	-	-	-		913	
Quiriquire	Venezuela	Oriental	1928	Cretaceous/ Tertiary	Sandstone	7000	Stratigraphic	760		885	
Uverito	Venezuela	Orinoco	1981	Tertiary	Sandstone	-	-	1		854	
Bare	Venezuela	Orinoco	-	-	Sandstone	-	-	7.5		763	
Sur	Venezuela	Orinoco	-	Cretaceous/ Tertiary	Sandstone	14,000	Stratigraphic	-		602	
Melones	Venezuela	Orinoco	1934	Tertiary	Sandstone	5200	Faulted Monocline	114		600	
Arecuna	Venezuela	Orinoco	-	-	Sandstone	-	-	-		567	
El Furrial	Venezuela	Oriental	1985	Tertiary	Sandstone	-	Fault Block	8		529	
El Placer	Venezuela	Oriental	1984	Tertiary	Sandstone	-	Stratigraphic		.25		4.5

Table 7. Major oil and gas fields with an estimated ultimate recovery of more than 100 MMB and (or) 600 BCF, Southeast Quadrant, Circum-Pacific region

[MMB, million barrels; TCF, trillion cubic feet; n.a., data not available; ---, no data. See figures 10 and 11 for location of selected basins and fields]

Field Name	Country	Basin	Year Discovered	Major Reservoir				Cumulative Production (12-31-87)		Estimated Ultimate Recovery	
				Age	Lithology	Average Depth (Ft)	Type of Trap	MMB	TCF	MMB	TCF
Caimancito	Argentina	Orán	1969	Cretaceous/ Tertiary	Limestone	12,000	Anticline	60.9		64	.33
Aguaragüe	Argentina	Tarija	1927	Paleozoic	Sandstone	11,000	Anticline	23		138	2.4
Campo Durán	Argentina	Tarija	1951	Paleozoic	Sandstone	10,800	Anticline	53	.9	55	1.3
Madrejones	Argentina	Tarija	1953	Paleozoic	Sandstone	13,100	Anticline	26.6	5.5	27	.6
Ramos	Argentina	Tarija	1979	Paleozoic	Sandstone	12,600	Anticline	4.7	.1	26	1.4
Barrancas	Argentina	Cuyo	1939	Triassic/ Cretaceous	Sandstone	6500	Anticline	179		220	
Vizcacheras	Argentina	Cuyo	1963	Cretaceous/ Tertiary	Sandstone	7000	Anticline	252		310	
Tupungato Group	Argentina	Cuyo	1934	Triassic/ Cretaceous	Sandstone	6600	Anticline	101		114	
Sierra Barrrosa	Argentina	Neuquen	1957	Jurassic/ Cretaceous	Sandstone	6900	Anticline	10.7	.3	19	.6
Centenario	Argentina	Neuquen	1977	Jurassic/ Cretaceous	Sandstone	8400	Faulted Anticline	45	.4	69	.8
Rio Neuquén	Argentina	Neuquen	1971	Jurassic/ Cretaceous	Sandstone	6600-8900	Anticline	43	.4	62	1
Lindero Atravesado	Argentina	Neuquen	1971	Jurassic/ Cretaceous	Sandstone	9500	Faulted Anticline	15	.4	24	1
Puesto Hernández	Argentina	Neuquen	1968	Jurassic/ Cretaceous	Sandstone	3900	Anticline	121		190	
Medanito	Argentina	Neuquen	1968	Jurassic/ Cretaceous	Sandstone	3900	Stratigraphic	126		140	
Charco Bayo	Argentina	Neuquen	1967	Jurassic/ Cretaceous	Sandstone	7200	Stratigraphic	96		146	
El Trebol	Argentina	San Jorge	1933	Cretaceous	Sandstone	7000	Fault Blocks	72		100	
Tordillo	Argentina	San Jorge	1935	Cretaceous	Sandstone	7000	Fault Blocks	70		115	
Pampa Castillo	Argentina	San Jorge	1949	Cretaceous	Sandstone	6000	Fault Blocks	56		100	
Dragón Group	Argentina	San Jorge	1958	Cretaceous	Sandstone	6500	Fault Blocks	250		278	
Valle Hermoso	Argentina	San Jorge	1959	Cretaceous	Sandstone	7000	Fault Blocks	190		263	
Koluel Kaike	Argentina	San Jorge	1957	Cretaceous	Sandstone	8100	Fault Blocks	57		100	
San Sebastían	Argentina	Magallanes	1966	Cretaceous	Sandstone	6000	Anticline	14	.5	25	1.5
Cañ. Alfa Group	Argentina	Magallanes	1972	Cretaceous	Sandstone	6100	Anticline	51	.3	81	.4
Condor	Argentina	Magallanes	1966	Cretaceous	Sandstone	6000	Anticline	29	1	37	1.3
Rio Grande	Bolivia	Santa Cruz	1965	Paleozoic	Sandstone	1600-2900	Anticline	60		73	1.4
La Vertiente	Bolivia	Santa Cruz	1977	Paleozoic-Cretaceous	Sandstone	2000-3200	Anticline	4		161	
Vuelta Grande	Bolivia	Santa Cruz	1978	Cretaceous	Sandstone	2000-2600	Anticline	2		52	1.6
Colpa	Bolivia	Santa Cruz	1961	Paleozoic-Cretaceous	Sandstone	1600-2800	Anticline	18		22	.7
Caranda	Bolivia	Santa Cruz	1960	Paleozoic-Cretaceous	Sandstone	1400-2000	Anticline	54		68	.3
Posesión	Chile	Magallanes	1960	Cretaceous	Sandstone	5600	Anticline	5	.6	40	1.6
Spiteful	Chile	Magallanes	1977	Cretaceous	Sandstone	6300	Anticline	41		243	
Provincia	Colombia	Mid Magdalena	1962	Cretaceous-Tertiary	Sandstone	8000	Anticline	156		N.A.	
Velásquez	Colombia	Mid Magdalena	1946	Cretaceous-Tertiary	Sandstone	7500	Anticline	165		N.A.	
Lago Agrio	Ecuador	Oriente	1967	Cretaceous	Sandstone	9800	Anticline	107		298	
Auca	Ecuador	Oriente	1970	Cretaceous	Sandstone	8700-9800	Anticline	65		198	
Cononaco	Ecuador	Oriente	1972	Cretaceous	Sandstone	9700-10,200	Anticline	21		100	
Libertador	Ecuador	Oriente	1980	Cretaceous	Sandstone	9000	Anticline	49		174	
Ancón Group	Ecuador	Progreso	1913	Tertiary	Sandstone	4000	Anticline	116		122	
Capahuari Sur	Peru	Marañón	1973	Cretaceous	Sandstone	13,000	Anticline	129		144	
Penña Negra	Peru	Coastal	1960	Cretaceous-Tertiary	Sandstone	3000-8500	Anticline	104		152	
Corrientes	Peru	Marañón	1971	Cretaceous	Sandstone	12,000	Anticline	87		170	
Teak	Trinidad/ Tobago	S.E. Coast	1971	Tertiary	Sandstone	15,200	Stratigraphic Structural	228		352	
Forest Reserve	Trinidad/ Tobago	Southern	1913	Tertiary	Sandstone	11,000	Stratigraphic Structural	259		275	
Samaan	Trinidad/ Tobago	S.E. Coast	1971	Tertiary	Sandstone	11,800	Stratigraphic Structural	174		250	
Poui	Trinidad/ Tobago	S.E. Coast	1974	Tertiary	Sandstone	11,650	Stratigraphic Structural	150		240	
Palo Seco Trintopec	Trinidad/ Tobago	Southern	1926	Tertiary	Sandstone	12,700	Stratigraphic Structural	117		150	
Palo Seco Trintoc	Trinidad/ Tobago	Southern	1929	Tertiary	Sandstone	12,700	Stratigraphic Structural	91		110	
Coora Quarry	Trinidad/ Tobago	Southern	1920	Tertiary	Sandstone	14,000	Stratigraphic Structural	93		101	
Guayaguavare	Trinidad/ Tobago	Southern	1902	Tertiary	Sandstone	10,750	Stratigraphic Structural	86		100	
								(Note: E.U.R. figures are roughly estimated)			
Mara	Venezuela	Occidental	1945	Cretaceous/ Tertiary	Sandstone/ Limestone	5250	Fault Block	406		464	
Lago	Venezuela	Occidental	1958	Cretaceous/ Tertiary	Sandstone/ Limestone	11,450	Fault Block	228		396	
Motatán	Venezuela	Occidental	1952	Tertiary	Sandstone	4130	Anticline	72		290	
La Concepción	Venezuela	Occidental	1925	Cretaceous/ Tertiary	Sandstone/ Limestone	8000	Anticline	136		176	

Table 7.—continued Major oil and gas fields with an estimated ultimate recovery of more than 100 MMB and (or) 600 BCF, Southeast Quadrant, Circum-Pacific region

[MMB, million barrels; TCF, trillion cubic feet; n.a., data not available; ---, no data. See figures 10 and 11 for location of selected basins and fields]

Field Name	Country	Basin	Year Discovered	Major Reservoir				Cumulative Production (12-31-87)		Estimated Ultimate Recovery	
				Age	Lithology	Average Depth (Ft)	Type of Trap	MMB	TCF	MMB	TCF
Las Cruces	Venezuela	Occidental	1916	Cretaceous/ Tertiary	Sandstone	8000	Anticline	116		137	
Alturitas	Venezuela	Occidental	1950	Tertiary	Sandstone	-	Anticline	1		127	
Chimire	Venezuela	Oriental	1948	Tertiary	Sandstone	6000-7200	Faulted Monocline	352		411	
Dación	Venezuela	Oriental	1950	Tertiary	Sandstone	6600	Faulted Monocline	223		355	
San Joaquín	Venezuela	Oriental	1939	Tertiary	Sandstone	8700	Faulted Anticline	101		354	
Pilón	Venezuela	Oriental	1937	Tertiary	Sandstone	-	Stratigraphic	150		353	
Yopales	Venezuela	Oriental	1943	Tertiary	Sandstone	4300	Faulted Monocline	127		343	
Nipa	Venezuela	Oriental	1945	Tertiary	Sandstone	9900	Faulted Monocline	206		287	
Aguasay	Venezuela	Oriental	1955	Tertiary	Sandstone	8100-13,400	Faulted Monocline	107		286	
Temblador	Venezuela	Oriental	1936	Tertiary	Sandstone	3900	Faulted Monocline	109		270	
El Roble	Venezuela	Oriental	1939	Tertiary	Sandstone	7100	Faulted Monocline	37		261	
Nardo	Venezuela	Oriental	1954	Tertiary	Sandstone	9900	Faulted Monocline	136		259	
M.A.	Venezuela	Oriental	-	Tertiary	Sandstone	-	Faulted Monocline	110		257	
Santa Ana	Venezuela	Oriental	1936	Tertiary	Sandstone	9400	Faulted Anticline	120		233	
Limón	Venezuela	Oriental	1954	Tertiary	Sandstone	9800	Faulted Monocline	116		233	
Zapatos	Venezuela	Oriental	1955	Tertiary	Sandstone	11,500	-	180		233	
Jusepin	Venezuela	Oriental	1938	Tertiary	Sandstone	7000	Stratigraphic	196		226	
Oscurote	Venezuela	Oriental	1952	Tertiary	Sandstone	9000	Faulted Monocline	144		217	
Soto	Venezuela	Oriental	1949	Tertiary	Sandstone	7750	Faulted Monocline	97		198	
Santa Barbara	Venezuela	Oriental	1941	Tertiary	Sandstone	6500	Faulted Monocline	171		189	
Orocual	Venezuela	Oriental	1933	Tertiary	Sandstone	5500	Syncline	29		187	
Elotes	Venezuela	Oriental	1954	Tertiary	Sandstone	-	-	85		161	
Mapire	Venezuela	Oriental	1949	Tertiary	Sandstone	11,800	Faulted Monocline	104		155	
Trico	Venezuela	Oriental	1941	Tertiary	Sandstone	6900	Faulted Monocline	100		155	
San Félix	Venezuela	Orinoco	-	Tertiary	Sandstone	-	-	1		153	
Zorro	Venezuela	Oriental	1953	Tertiary	Sandstone	9000	Faulted Monocline	77		148	
G.M.4	Venezuela	Oriental	1946	Tertiary	Sandstone	-	-	67		141	
Guario	Venezuela	Oriental	1939	Tertiary	Sandstone	8800	Faulted Anticline	49		133	
La Ceibita	Venezuela	Oriental	1953	Tertiary	Sandstone	12,000	Faulted Monocline	78		123	
Lido	Venezuela	Oriental	1954	Tertiary	Sandstone	9800	Faulted Monocline	63		122	
Zumo	Venezuela	Oriental	1954	Tertiary	Sandstone	12,500	Faulted Monocline	77		118	
Pedernales	Venezuela	Oriental	1933	Tertiary	Sandstone	5100	Faulted Anticline	59		113	
Boca	Venezuela	Oriental	1951	Tertiary	Sandstone	8700	Faulted Monocline	77		106	
Güico	Venezuela	Oriental	1944	Tertiary	Sandstone	7800	Faulted Monocline	88		101	
Budare	Venezuela	Oriental	1959	Tertiary	Sandstone	-	-	66		100	
Oveja	Venezuela	Orinoco	1942	Tertiary	Sandstone	-	-	224		300	
Oritupano	Venezuela	Orinoco	1950	Tertiary	Sandstone	8800	Faulted Monocline	150		234	
Miga	Venezuela	Orinoco	1957	Tertiary	Sandstone	-	-	113		186	
Ostra	Venezuela	Orinoco	1943	Tertiary	Sandstone	-	-	70		125	
Sinco	Venezuela	Barinas/ Apure	1953	Cretaceous/ Tertiary	Sandstone/ Limestone	9100	Faulted Monocline	264		359	
Guafita	Venezuela	Barinas/ Apure	1984	Tertiary	Sandstone	-	Faulted Block	12		208	
Silvestre	Venezuela	Barinas/ Apure	1948	Cretaceous	Sandstone/ Limestone	8850	Faulted Dome	141		182	
Páez Mingo	Venezuela	Barinas/ Apure	1963	-	Sandstone/ Limestone	-	-	52		136	
OFFSHORE GAS											
Patao	Venezuela	Carúpano	1979	Tertiary	Sandstone	4000	Stratigraphic		-		1.51
Dragón	Venezuela	Carúpano	1980	Tertiary	Sandstone	3500	Stratigraphic		-		1.11
Mejillones	Venezuela	Carúpano	1980	Tertiary	Sandstone	3500	Stratigraphic		-		.74

Table 8. List of sedimentary basins, Northwest Quadrant, Circum-Pacific region (numbers refer to figure 12)

001 North Chukchi Basin
002 Colville Basin
003 Hope Basin
004 Norton Sound Basin
005 St. Lawrence Basin
006 Bristol Basin
007 St. George Basin
008 Sanak Basin
009 Anadyr Basin
010 Navarin Basin
011 Aleutian Basin
012 Komandrasky Basin
013 Bowers Basin
014 Aleutian Trench Basin
015 Laptev Basin
016 East Siberia Basin
017 Mochigmen Basin
018 Penzhina Basin
019 West Kamchatka Basin
020 Central Kamchatka Basin
021 East Kamchatka Basin
022 Kuril–Kamchatka Trench Basin
023 North Okhotsk Basin
024 South Okhotsk Basin
025 North Sakhalin Basin
026 Tarasky Basin
027 Yenisey–Khatanga Basin
028 Anabar–Lena Basin
029 Tunguska Basin
030 Olenek Basin
031 Verkhoyansk Basin
032 Indigirka–Zyranka Basin
033 Vilyuy Basin
034 Kansk Basin
035 Angara–Lena Basin
036 Irkutsk Basin
037 Lake Baikal Basin
038 Aginskiy Basin
039 Zeya Bureya Basin
040 Uda Basin
041 Upper Bureya Basin
042 Etorufu Basin
043 Japan Sea Basin
044 Tsushima Basin
045 Yamato Basin
046 San'in–Hokuriku Basin
047 Toyama Basin
048 Niigata–Akita Basin
049 Oshima Basin
050 Teshio Basin
051 Ishikari Basin
052 Tokachi Basin
053 Joban–Sanriku Basin
054 Kanto Basin
055 Tokai–Kumano Basin
056 Tosa Basin
057 Miyazaki Basin
058 Fukue Basin
059 Danjo Basin
060 Okinawa Trough Basin
061 Shimajiri Basin
062 Gobi Basin
063 Hailar Basin
064 Erlian Basin
065 Songliao Basin
066 Sanjiang Basin
067 Jiuquan–Minle Basin
068 Chaidamu Basin
069 Minghe Basin
070 North Tibet Basin
071 Heime Basin
072 Chagpu Basin
073 Himalaya Basin
074 Eerdosi (Ordos) Basin
075 Fenhe Basin
076 Huabei Basin
077 Bohai Basin
078 Korea Bay Basin
079 Yellow Sea Basin
080 Shanghai Basin
081 East China Sea Basin
082 Nanxiang Basin
083 Jianghan Basin
084 Yuanma Basin
085 Shichuan Basin
086 Chuxiong Basin
087 Lamping–Simao Basin
088 Baise Basin
089 Shiwandashan Basin
090 West Taiwan Basin
091 Beibu Gulf Basin
092 Tonkin Basin
093 Pearl River Mouth Basin
094 South China Sea Basin
095 Ganges Basin
096 Assam Basin
097 Bengal Basin
098 North Myanmar (Burma) Basin
099 South Myanmar (Burma) Basin
100 Irrawaddy Delta Basin
101 Gulf of Martaban Basin
102 Andaman Basin
103 Nicobar Basin
104 Andaman Sea Basin
105 Nicobar Trench Basin
106 Nicobar Fan Basin
107 Fang Basin
108 Chao–Phraya Basin
109 Khorat Basin
110 Bangkok Basin
111 Thai Basin
112 Mekong Basin
113 Saigon Basin
114 Spratly Basin
115 Cagayan Basin
116 Lingayen Basin
117 Ilocos Basin
118 Zambales Basin
119 Southern Luzon Basin
120 Mindoro Basin
121 Iloilo Basin
122 Reed Bank Basin
123 West Palawan Basin
124 Balabac Basin
125 Sulu Basin
126 Visayan Sea Basin
127 Cotabato Basin
128 Agusan–Davao Basin
129 Malay Basin
130 Penyu Basin
131 Sokang Basin
132 Sarawak Basin
133 Brunei–Sabah Basin
134 North Sumatra Basin
135 Sibolga Basin
136 Central Sumatra Basin
137 South Sumatra Basin
138 Bengkulu Basin
139 Sunda Basin
140 Northwest Java Basin
141 South Java Basin
142 Pati Basin
143 Northeast Java Basin
144 Lombom Bali Basin
145 Flores Basin
146 Sawu Basin
147 Tukangbesi Basin
148 Timor Basin
149 Ketungau Basin
150 Melawi Basin
151 Tarakan Basin
152 Kutei Basin
153 Minasa Basin
154 Belitung Basin
155 Pembuang Basin
156 Barito Basin
157 Asem–Asem Basin
158 Gorontalo Basin
159 Larian Basin
160 Makasar Basin
161 Spermonde Basin
162 Bone Basin
163 Banggai Basin
164 Manhui Basin
165 Buton Basin
166 Sula Basin
167 South Sula Basin
168 Buru Basin
169 North Obi Basin
170 South Obi Basin
171 North Halmahera Basin
172 East Halmahera Basin
173 South Halmahera Basin
174 Salawati Basin
175 Bintuni Basin
176 Misool Basin
177 Seram Basin
178 South Seram Basin
179 West Weber Basin
180 Weber Basin
181 Tanimbar Basin
182 Palungaru Basin
183 Waropen Basin
184 Biak Basin
185 Waipoga Basin
186 Akimegah Basin
187 Sahul Basin
188 Wewak Basin
189 Sepik Basin
190 Ramu Basin
191 Madan Basin
192 Morehead Basin
193 Papuan Basin
194 Cape Vogel Basin
195 New Ireland Basin
196 Bougainville Basin
197 Solomon Basin

Table 9. General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
009		**Anadyr Basin**				
1	G	Anadyr	–	–	–	–
025		**North Sakhalin Basin**				
1	O	Kolenda	1963	Miocene–Pliocene	Sandstone	–
2	O	Giljako	1949	Miocene–Pliocene	Sandstone	–
3	G	Nizhnie Dagi	–	Miocene–Pliocene	Sandstone	–
4	O	Nekrasovka	1967	Miocene–Pliocene	Sandstone	–
5	O	Odoptu	1965	Miocene–Pliocene	Sandstone	–
6	O	Sabo	–	Miocene–Pliocene	Sandstone	–
7	O	Mukhta	1959	Miocene–Pliocene	Sandstone	–
8	O	Paromai	1929	Miocene–Pliocene	Sandstone	–
9	O	Katangli	1929	Miocene–Pliocene	Sandstone	–
10	O	Pogranichnoye	–	Miocene–Pliocene	Sandstone	–
026		**Tarasky Basin**				
1	O	Nevelsk	–	–	–	–
2	G	Aniva	–	–	–	–
033		**Vilyuy Basin**				
1	G	Sredne–Tyungskoye	1976	Triassic–Jurassic	Sandstone	–
†2	*G*	*Sredne–Vilyuiskoye*	*1963*	*Triassic–Jurassic*	*Sandstone*	–
3	*G*	*Tolon–Mastakhskoye (Maastakh)*	*1967*	*Triassic–Jurassic*	*Sandstone*	–
4	G	Sobolokh–Nedzhelinskoye	–	Triassic–Jurassic	Sandstone	–
5	G	Badaranskoye	1963	Triassic–Jurassic	Sandstone	–
6	G	Nizhne–Vilyuiskoye	–	Triassic–Jurassic	Sandstone	–
7	G	Ust–Vilyuskoye	1956	Triassic–Jurassic	Sandstone	–
8	O/G	Irelyakhshoye	1961	Triassic–Jurassic	Sandstone	–
9	O/G	Machchobinskoye	–	Triassic–Jurassic	Sandstone	–
10	*O/G*	*Sredne–Botuobinskoye*	*1970*	*Precambrian–Cambrian*	*Sandstone–carbonate*	–
11	O/G	Tas–Yurakhskoye	1981	Triassic–Jurassic	Sandstone	–
12	G	Iktekhskoye	–	Triassic–Jurassic	Sandstone	–
13	*O/G*	*Verhne–Vilyuchanskoye*	*1975*	*Triassic–Jurassic*	*Sandstone*	–
14	O/G	Vilyuisko–Dzherbinskoye	1977	Triassic–Jurassic	Sandstone	–
15	O/G	Verkhne–Chopskoye	–	Triassic–Jurassic	Sandstone	–
16	G	Ozernoye	1963	Triassic–Jurassic	Sandstone	–
17	G	Nizhne–Khamakinskoye	–	Triassic–Jurassic	Sandstone	–
18	G	Talakanskoye	–	Triassic–Jurassic	Sandstone	–
035		**Angara–Lena Basin**				
1	O/G	Danilovskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
2	O/G	Dilisminskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
3	O	Yarakinskoye	1971	Proterozoic	Sandstone	–
4	O/G	Ayanskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
5	O/G	Markovo	1962	Proterozoic–Cambrian	Sandstone–carbonate	–
6	O	Pilyudinskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
036		**Irkutsk Basin**				
1	G	Atovskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
2	G	Bilchirskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–
3	G	Yuzhno–Raduiskoye	–	Cambrian	Carbonate	–
4	G	Khristoforovskoye	1968	Cambrian	Carbonate	–
5	G	Balukhtinsko–Tuptinskoye	–	Proterozoic–Cambrian	Sandstone–carbonate	–

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
048		**Niigata–Akita Basin**				
1	O	Yabase	1933	Miocene–Pliocene	Sandstone	33,216,000
2	G	Aga–oki	1972	Miocene–Pliocene	Sandstone	6,069,000
3	O/G	Niitu–Minami Aga	1899	Miocene–Pliocene	Sandstone	13,824
4	O/G	Higashi Niigata–Matsuzaki	1959	Miocene–Pliocene	Sandstone	9,871,000
5	G	Nakajo–Shin Tainai	1961	Miocene–Pliocene	Sandstone	6,924,000
6	G	Yoshii–Higashi Kashiwazaki	1968	Miocene	Volcanics	16,982,000
7	O/G	Kubiki	1959	Miocene–Pliocene	Sandstone	13,162,000
053		**Joban–Sanriku Basin**				
1	G	Iwaki	1973	Miocene	Sandstone	167,000
065		**Songliao Basin**				
1	*O*	*Daqing*	*1959*	*Cretaceous*	*Sandstone*	*7,094,000,000*
2	O	Tengluku	1958	Cretaceous	Sandstone	–
3	O	Kongchuling	1958	Cretaceous	Sandstone	–
4	O	Chinshankou	1958	Cretaceous	Sandstone	–
067		**Jiuquan–Minle Basin**				
1	O	Yaerhxia	–	Miocene, Cretaceous, Silurian	Sandstone	–
2	*O*	*Laojumiao*	*1938*	*Miocene*	*Sandstone*	–
3	O	Shiyougou	1928	Miocene	Sandstone	–
074		**Eerdosi (Ordos) Basin**				
1	O	Chingtuching	–	–	–	–
2	O	Machiatan	1951	Triassic–Jurassic	Sandstone–carbonate	–
3	O	Shatingtzu	1950	Triassic–Cretaceous	Sandstone–carbonate	–
4	O	Yungping	1930	Triassic	Sandstone	–
5	O	Tsaoyuan	1952	Triassic	Sandstone	–
6	O	Yenchang	1957	Jurassic	Sandstone	–
076		**Huabei Basin**				
1	*O*	*Renqiu*	*1975*	*Precambrian–Ordovician*	*Carbonate*	*970,380*
2	O	Dagang	1964	Cenozoic	Sandstone–carbonate	408,000,000
3	O	Lin–i	1976	Precambrian	Carbonate	–
4	O	Sha–yen	–	–	–	–
5	O	Qianjiang	1966	–	–	192,590
6	*O*	*Zhongyuan*	*1975*	*Paleogene*	*Sandstone*	–
7	G	Guxinzhuang	–	–	–	–
077		**Bohai Basin**				
1	O	Shengli	1962	Paleogene	Sandstone	2,623,000
2	*O*	*Gudao*	*1968*	*Miocene*	*Sandstone*	–
3	O	Chengbei	1972	–	–	11,000,000
4	O	Haishi	1970	–	–	10,000,000
081		**East China Sea Basin**				
1	G	Longjing	1981	–	–	–
2	G	Chingtzaohu	1967	Miocene	Sandstone	–
3	G	Tiehchenshan	1959	Miocene	Sandstone	105,000,000
4	G	Chinshui–Yunghoshan	1971	Oligocene–Miocene	Sandstone	–
5	G	Chuhuangkeng	1904	Oligocene–Miocene	Sandstone	3,000,000
083		**Jianghan Basin**				
1	O	Wangchang	1965	Paleogene	Sandstone	–
2	O	Zhongshi	1965	Paleogene	Sandstone	–
3	O	Xijakou	–	Paleogene	Sandstone	–
4	O	Huayuan	–	Paleogene	Sandstone	–

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
5	O	Xingou	–	Paleogene	Sandstone	–
085		**Shichuan Basin**				
1	*O*	*Lungnussu*	*1956*	*Jurassic*	*Sandstone*	–
2	O	Loutuhsi	1956	Jurassic	Sandstone	–
3	O	Penglaichen	1954	Jurassic	Sandstone	–
4	G	Chiliuing	200 B.C.	Triassic	Carbonate	–
5	G	Shengdengshan	1938	Triassic	Carbonate	–
6	G	Yenkaoxi	1955	Permian	Carbonate	–
7	G	Chanyuanpa	1955	Permian–Triassic	Carbonate	–
8	G	Nashi	1955	Permian–Triassic	Carbonate	–
9	*O/G*	*Shiyoukou-Tungchi*	*1955*	*Triassic*	*Carbonate*	–
10	*O/G*	*Huangkuanshan*	*1955*	*Triassic*	*Carbonate*	–
088		**Baise Basin**				
1	O	Lunxu	–	Eocene	Sandstone	–
2	O	Xinzhou	1961	Eocene	Sandstone	–
3	O	Naman	1961	Eocene	Sandstone	–
4	O	Linpeng	1961	Eocene	Sandstone	–
091		**Beibu Gulf Basin**				
1	O	Wan	1977	–	–	–
2	O	Wushi	1981	–	–	–
092		**Tonkin Basin**				
1	G	Wenchang	1984	–	–	–
2	G	Yacheng	1983	–	–	–
093		**Pearl River Mouth Basin**				
1	O	Xijiong	1985	Oligocene–Miocene	Sandstone–carbonate	–
2	O	Huizhou	1985	Oligocene–Miocene	Sandstone–carbonate	–
3	O	Zhu 5	1979	–	–	–
096		**Assam Basin**				
1	*O*	*Nahorkatiya–Hugrijan*	*1953*	*Oligocene–Miocene*	*Sandstone*	*303,880*
2	O	Digboi	1980	Miocene	Sandstone	74,250
3	O	Makum	–	–	–	–
4	*O/G*	*Moran*	*1956*	*Oligocene–Miocene*	*Sandstone*	*93,900*
5	O	Rudrasagar	1960	–	–	33,806,000
097		**Bengal Basin**				
1	G	Badarpur	–	Oligocene	Sandstone	–
2	G	Chhatak	1959	Miocene–Pliocene	Sandstone	–
3	G	Sylhet	1955	Miocene	Sandstone	–
4	G	Kailas Tila	1961	Miocene	Sandstone	–
5	G	Rashidpur	1960	Miocene	Sandstone	–
6	G	Habiganj	1963	Miocene	Sandstone	–
7	G	Titas	1962	Miocene	Sandstone	–
8	G	Bakhrabad	1968	Miocene	Sandstone	–
9	G	Kutubdia	1974	Miocene–Pliocene	Siltstone	–
10	*O/G*	*Feni*	*1980*	*Pliocene*	*Sandstone*	–
099		**South Myanmar (Burma) Basin**				
1	O	Indaw	1918	Miocene	Sandstone	1,000,000
2	O	Lanywa	1927	–	–	
3	O	Chauk	1902	Oligocene	Sandstone	128,000,000
4	O	Mann	1960	–	–	19,000,000

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
5	O	Yenangyaung	1800	Oligocene–Miocene	Sandstone	192,000,000
6	O	Minbu	1910	Miocene	Sandstone	–
7	O	Htaukshabin	1960	–	–	88,000,000
100		**Irrawaddy Delta Basin**				
1	O	Prome	1965	Miocene	Sandstone	7,000,000
2	O	Myanaung	1964	Miocene	Sandstone	21,000,000
3	O	Shwepyitha	1966	–	–	–
4	G	Payagon	–	Miocene	Sandstone	–
107		**Fang Basin**				
1	O	Mae Fang	1953	Miocene–Pliocene	Sandstone	–
2	O	Mae Suhn	1963	Miocene–Pliocene	Sandstone	3,000,000
108		**Chao–Phraya Basin**				
1	O	Sirikit	1981	–	–	34,100,000
2	O	Pru Krathiam	1984	–	–	17,000
110		**Bangkok Basin**				
1	G	Bung Ya	1984	Oligocene–Miocene	Sandstone	–
2	G	Platong	1976	Oligocene–Miocene	Sandstone	5,523,200
111		**Thai Basin**				
1	G	Trat	1981	–	–	–
2	G	Pakarang	1982	–	–	–
3	*O/G*	*Satun*	*1980*	*Pliocene*	*Sandstone*	*6,010,500*
4	G	Erawan	1973	–	–	16,736,700
5	G	Jakrawan	1976	–	–	–
6	G	Baanpot	1974	–	–	2,018,300
7	G	Funan	1981	–	–	–
123		**West Palawan Basin**				
1	O	Nido	1977	Oligocene-Miocene	Carbonate	15,797,886
2	O	Matinloc	1978	Miocene	Carbonate	9,448,230
3	O	Cadlao	1977	Miocene	Carbonate	9,919,265
4	O	Pandan	1980	–	–	–
5	O	Libro	1980	–	–	–
6	O	Galoc	1981	Miocene	Sandstone	383,460
7	O	Tara	1987	–	–	145,885
129		**Malay Basin**				
1	G	Pilong	1971	Oligocene–Miocene	Sandstone	–
2	G	Tekok–Telok Barat	1979	–	–	–
3	O	Guntong	1978	–	Sandstone	17,000,000
4	O	Tabu	1978	–	Sandstone	7,000,000
5	O	Tapis	1975	Miocene	Sandstone	201,000,000
6	O	Kepong Tinggi	1979	Miocene	Sandstone	72,000,000
7	O	Tiong	1978	Miocene	Sandstone	102,000,000
8	O	Pulai	1973	Miocene	Sandstone	54,596,000
9	O	Bekok	1976	Miocene	Sandstone	91,000,000
10	O	Sotong	1973	–	–	–
11	O	Malong	1983	–	Sandstone	–
12	G	Belumut	1971	–	Sandstone	–
13	G	Duyong	1974	–	Sandstone	54815.8*
14	G	Angsi	1974	–	Sandstone	–
15	O	Trerebuk	–	–	–	–

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
16	O	Belanak	–	–	–	–
17	O	Udang	1974	Oligocene–Miocene	Sandstone	–
132		**Sarawak Basin**				
1	G	M–3–1X	1980	Miocene	Carbonate	–
2	G	*F–6–1X (Central Luconia)*	*1969*	*Miocene*	*Carbonate*	–
3	G	F–13–1X	1969	Miocene	Carbonate	–
4	G	E–11	1974	Miocene	Carbonate	2302834*
5	G	B–11–1	1980	Miocene	Carbonate	–
6	G	D–12–1	1980	Miocene	Carbonate	–
7	G	F–29–1	1980	Miocene	Carbonate	–
8	G	M4–1	1980	Miocene	Carbonate	–
9	G	M5–1X	1980	Miocene	Carbonate	–
10	O	Acis South	1962	Miocene	Sandstone	–
11	O	J–4–1 X	1978	Miocene	Sandstone	–
12	O	J–12–1	1980	Miocene	Sandstone	–
13	O	Temana	1972	Miocene	Sandstone	–
14	O	C–8–1	1981	Miocene	Sandstone	–
133		**Brunei-Sabah Basin**				
1	O	Miri	1910	Miocene–Pliocene	Sandstone	79,727,300
2	O	Tukau	1966	Miocene–Pliocene	Sandstone	91,749,000
3	O	W. Lutong	1966	Miocene–Pliocene	Sandstone	121,690,000
4	O	Bakau	1967	Miocene–Pliocene	Sandstone	7,047,000
5	O	Bokor	1971	Miocene–Pliocene	Sandstone	34,011,000
6	O	Betty	1968	Miocene–Pliocene	Sandstone	62,327,000
7	O	Baram	1964	Miocene–Pliocene	Sandstone	135,989,000
8	O	Baronia	1967	Miocene–Pliocene	Sandstone	148,770,000
9	O	Fairley–Baram	1973	Miocene–Pliocene	Sandstone	5,845,000
10	O	Salbian	1979	Miocene–Pliocene	Sandstone	–
11	G	Beryl	1969	Miocene–Pliocene	Sandstone	–
12	G	Fatimah	1980	Miocene–Pliocene	Sandstone	–
13	O	Fairley	1969	Miocene	Sandstone	111,299,000
14	O	Ampa	1963	Miocene	Sandstone	–
15	*O/G*	*S.W. Ampa*	*1963*	*Miocene*	*Sandstone*	*529,598,000*
16	*O/G*	*Seria*	*1929*	*Miocene*	*Sandstone*	*981,198,000*
17	O	Tali	–	Miocene	Sandstone	–
18	O/G	Magpie	1975	Miocene	Sandstone	73,499,000
19	*O*	*Champion*	*1970*	*Miocene*	*Sandstone*	*299,701,000*
20	G	Samarang Kecil	1972	Miocene	Sandstone	–
21	G	Glayzer	1981	Miocene	Sandstone	–
22	O	Samarang	1972	Miocene	Sandstone	235,380,000
23	O	Ketam	1977	Miocene	Sandstone	901,000
24	O	Lokan	1979	Miocene	Sandstone	–
25	O	S.E. Collins	1981	Miocene	Sandstone	–
26	O	W. Erb	1977	Miocene	Sandstone	21,620,000
27	O	Tembungo	1971	Miocene	Sandstone	31,276,000
28	O	S.W. Emerald	1980	Miocene	Sandstone	–
29	O	St. Joseph	1975	Miocene	Sandstone	20,271,000
30	O	S. Furious	1974	Miocene	Sandstone	13,499,000
31	O	Barton	1971	Miocene	Sandstone	10,402,000

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
134		**North Sumatra Basin**				
1	*G*	*Arun*	*1971*	*Miocene*	*Carbonate*	*335,835,117*
2	O	Tualang	1973	Miocene	Sandstone	29,985,653
3	O	Iee Tabeue	1971	Miocene	Sandstone	11,897,472
4	O	Rantau	1929	Miocene–Pliocene	Sandstone	238,240,510
5	O	Serang Jaya	1926	Miocene–Pliocene	Sandstone	3,640,310
6	O	P. Tabuhan	1937	Miocene–Pliocene	Sandstone	26,553,070
136		**Central Sumatra Basin**				
1	*O*	*Bangko*	*1970*	*Miocene*	*Sandstone*	*346,229,390*
2	O	Balam South	1969	Miocene	Sandstone	98,472,165
3	O	Menggala	1968	Miocene	Sandstone	7,999,690
4	O	Sintong	1971	Miocene	Sandstone	54,655,550
5	O	Pematang	1959	Miocene	Sandstone	218,644,450
6	O	Petani	1964	Miocene	Sandstone	273,691,320
7	O	Kulin	1970	Miocene	Sandstone	31,524,395
8	O	Bekasap	1955	Miocene	Sandstone	406,933,685
9	*O*	*Duri*	*1941*	*Miocene*	*Sandstone*	*472,448,085*
10	O	Pungut	1951	Miocene	Sandstone	46,518,425
11	O	Petapahan	1971	Miocene–Pliocene	Sandstone	92,703,400
12	O	Kotabatak	1952	Miocene	Sandstone	136,355,390
13	*O/G*	*Minas*	*1944*	*Miocene–Pliocene*	*Sandstone*	*3,332,145,345*
14	O	Go Tam	1980	Miocene–Pliocene	Sandstone	–
15	O	Beruk	1974	Miocene–Pliocene	Sandstone	47,694,545
16	O	Zamrud	1975	Miocene–Pliocene	Sandstone	64,899,790
17	O	N. Pulai	1941	Miocene–Pliocene	Sandstone	37,199,610
18	O	S. Pulai	1941	Miocene–Pliocene	Sandstone	4,949,860
19	O	Lirik	1939	Miocene	Sandstone	38,146,330
20	O	Sago	1940	Miocene	Sandstone	122,391,750
21	O	Molek	1956	Miocene–Pliocene	Sandstone	11,724,530
22	O	Binio	1972	Miocene–Pliocene	Sandstone	11,820,840
137		**South Sumatra Basin**				
1	O	Kenali Asam	1931	–	–	93,495,150
2	O	Tempino	1931	–	–	86,285,370
3	O	Mangundjaja	1934	–	–	23,010,846
4	O	Kluang	1913	–	–	33,853,017
5	O	Ramba	1982	Oligocene–Miocene	Sandstone	44,790,645
6	O	Tanjung Laban	1982	–	–	6,258,109
7	O	Benakat	1932	Miocene	Sandstone–carbonate	133,729,970
8	O	Rambutan	1972	–	–	3,222,896
9	O	Abab	1951	Oligocene–Miocene	Sandstone	38,589,560
10	O	Benuang	1942	Oligocene–Miocene	Sandstone	7,626,590
11	O	G. Kemala	1938	–	–	27,235,250
12	O	T. Jimar	1937	Miocene	Sandstone	171,283,970
13	O	Limau	1928	Miocene	Sandstone	188,056,910
14	O	Ogan	1943	–	–	3,935,790
15	O	T. Tiga	1948	Miocene	Carbonate	53,956,521
16	O	T. Miring	1935	–	Sandstone	11,379,770
17	O	Belimbing	1965	Oligocene–Miocene	Sandstone	20,834,860
18	*O*	*Kuang*	*1940*	*Oligocene–Miocene*	*Sandstone*	*7,120,130*

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
139		**Sunda Basin**				
1	O	Sundari	1982	–	–	10,782,195
2	O	Karmila	1983	–	–	29,728,296
3	O	Farida	1982	–	–	11,632,953
4	O	Yvonne	1980	–	–	12,621,026
5	O	Krisna	1976	–	–	59,655,016
6	O	Titi	1982	–	–	1,654,547
7	O	Zelda	1971	Oligocene–Miocene	Sandstone–carbonate	36,647,449
8	O	Wanda	1984	–	–	1,585,811
9	O	Cinta	1970	Miocene	Sandstone–carbonate	175,971,048
10	O	Kitty	1971	Miocene	Sandstone–carbonate	13,973,095
11	O	Selatan	1971	–	–	20,797,606
12	O	Gita	1972	Miocene	Sandstone–carbonate	7,504,813
13	O	Duma	1983	–	–	698,312
14	O/G	Rama	1974	Oligocene–Miocene	Carbonate	91,186,520
15	O	Nora	1973	Miocene	Carbonate	8,807,389
140		**Northwest Java Basin**				
1	*O/G*	*Ardjuna*	*1969*	*Miocene*	*Sandstone–carbonate*	*683,283,000*
2	O	Arimbi	1972	Miocene	Carbonate	26,331,000
3	O/G	Jatibarang	1969	Oligocene	Volcanics–carbonate	86,509,260
143		**Northeast Java Basin**				
1	O	Todanan	–	–	–	–
2	O	Tjepu	–	–	–	–
3	O	Blora	–	–	–	–
4	O	Rembang	–	–	–	–
5	O	Tanjungan	–	–	–	–
6	O	Kalitidu	–	–	–	–
7	O	Gresik	–	–	–	–
8	O	Redco	–	–	–	–
9	O	Surabaja	–	–	–	–
10	O	Waron	–	–	–	–
148		**Timor Basin**				
1	O	Matai	1961	Triassic	–	–
2	O	Ossulan	–	–	–	–
3	O	Aliambata	–	–	–	–
151		**Tarakan Basin**				
1	O	Mengatal	1974	Miocene	Sandstone	–
2	O	Bunju	1922	–	–	–
3	O	Pamusian	1905	Pliocene	Sandstone	–
152		**Kutei Basin**				
1	O	Kerindingan	1972	Pliocene	Sandstone	4,940,230
2	O	Melahin	1972	Pliocene	Sandstone	6,513,220
3	*O*	*Attaka*	*1970*	*Pliocene*	*Sandstone*	*451,865,821*
4	*O*	*Nilam*	*1974*	–	–	*20,347,122*
5	*O*	*Handil*	*1974*	*Pliocene*	*Sandstone*	*654,495,230*
6	O	Pamaguan	1974	Miocene	Sandstone	6,622,202
7	O	Sanga–Sanga	1897	Miocene–Pliocene	Sandstone	267,623,502
8	O	Sambodja	1909	Miocene–Pliocene	Sandstone	64,542,145
9	O	Sepinggan	1973	Pliocene	Sandstone	43,703,543
10	O	Bekapai	1972	Miocene–Pliocene	Sandstone	156,640,170

Table 9.—continued General characteristics of selected oil and gas fields, Northwest Quadrant, Circum-Pacific region (refer to figures 13 and 14)

[Basin number refers to figure 13; field number refers to figure 14; O=Oil, G=Gas, O/G=Oil and Gas; –, data not available]

Basin number Field number	Type Field	Basin–Field name	Year discovered	Reservoir age	Lithology	Cumulative production[1]
11	*O/G*	*Badak*	*1972*	*Miocene–Pliocene*	*Sandstone*	*39,600,000*
156		**Barito Basin**				
1	O	Tanjung	1938	Eocene	Sandstone	102,463,940
174		**Salawati Basin**				
1	O	Kasim	1972	Miocene	Carbonate	47,242,198
2	O	Jaya	1973	Miocene	Carbonate	25,802,223
3	O	Klamono	1936	Miocene	Carbonate	34,910,590
4	O	Walio	1972	Miocene	Carbonate	152,075,105
5	O	Sele	1954	Miocene	Carbonate	1,421,940
175		**Bintuni Basin**				
1	O	Wasian	1939	Miocene	Carbonate	–
2	O	Mogo	1941	Miocene	Carbonate	–
177		**Seram Basin**				
1	O	Bula	1897	Pliocene–Pleistocene	Sandstone–carbonate	15,090,196
186		**Akimegah Basin**				
1	G	Juha	1983	Jurassic–Cretaceous	Sandstone	–
193		**Papuan Basin**				
1	G	Iehi	1960	Jurassic–Cretaceous	Sandstone	–
2	G	Bwata	1960	Miocene	Carbonate	–
3	G	Kuru	1956	Miocene	Carbonate	–
4	G	Uramu	1968	Miocene	Carbonate	–
5	G	Puri	1958	Miocene	Carbonate	–
6	O/G	Pasca	1968	Miocene	Carbonate	–
7	G	Pandora	1988	Miocene	Carbonate	–
8	O/G	Hedinia	1987	Jurassic–Cretaceous	Sandstone	–
9	O/G	Iagifu	1986	Jurassic–Cretaceous	Sandstone	–

[1]As of December 31, 1988, in barrels.

* Million cubic feet of gas.

† *Italics indicate giant oil fields (more than 500 million barrels and (or) 3 trillion cubic feet of gas estimated ultimate recovery). Source:* Carmalt, S.W., and St. John, Bill, 1986, Giant oil and gas fields, *in* Halbouty, M. T., ed., Future petroleum provinces of the world, Proceedings of the Wallace E. Pratt Memorial Conference, Phoenix, Arizona, December 1984: AAPG Memoir 40, p. 11-53.

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Table 10. Sedimentary basins, Southwest Quadrant, Circum-Pacific region

1	Adavale Basin	36	Laura Basin	71	South Nicholson Basin
2	Amadeus Basin	37	Lorne Basin	72	Salawati Basin
3	Arafura Basin	38	Mallabie Depression	73	Bintuni Basin
4	Arckaringa Basin	39	Maryborough Basin	74	Manokwari Basin
5	Arrowie Basin	40	Macarthur Basin	75	North Coast Basin
6	Bancannia Trough	41	Money Shoal Basin	76	Akimegah Basin
7	Barka Basin	42	Murray Basin	77	Iwur Basin
8	Berri Embayment	43	Nadda Basin	78	Aitape Basin
9	Biloela Basin	44	Nambour Basin	79	Sepik Basin
10	Birrindudu Basin	45	Namurkah Trough	80	Ramu Basin
11	Bonaparte Basin	46	Ngalia Basin	81	Cape Vogel Basin
12	Bowen Basin	47	Oaklands Basin	82	Papuan Basin
13	Bremer Basin	48	Officer Basin	83	Aure Trough
14	Canning Basin	49	Ord Basin	84	Mendi Sub-basin
15	Carnarvon Basin	50	Otway Basin	85	Kutubu Trough
16	Carpentaria Basin	51	Pedirka Basin	86	South New Guinea Basin
17	Clarence-Moreton Basin	52	Perth Basin	87	Morehead Sub-basin
18	Collie Basin	53	Pirie Torrens Basin	88	New Ireland Basin
19	Cooper Basin	54	Polda Basin	89	Queen Emma Basin
20	Cowell Basin	55	Simpson Basin	90	Bougainville Basin
21	Daly River Basin	56	St. Vincent Basin	91	Shortland Basin
22	Darling Basin	57	Stansbury Basin	92	Russell Basin
23	Denman Basin	58	Styx Basin	93	Vanikolo Basin
24	Drummond Basin	59	Surat Basin	94	Banks Basin
25	Duaringa Basin	60	Sydney Basin	95	Central Basin
26	Eromanga Basin	61	Tarrara Basin	96	Northland Basin
27	Esk Trough	62	Tasmania Basin	97	Waikato Basin
28	Eucla Basin	63	Torrens Basin	98	Wanganui Basin
29	Galilee Basin	64	Troubridge Basin	99	East Coast Basin
30	Georgina Basin	65	Victoria River Basin	100	Taranaki Basin
31	Gippsland Basin	66	Warburton Basin	101	West Coast Basin
32	Gunnedah Basin	67	Warrabin Basin	102	Murchison Basin
33	Ivanhoe Basin	68	Wiso Basin	103	Canterbury Basin
34	Karumba Basin	69	Ashburton Trough	104	Southland Basin
35	Kimberley Basin	70	Nabberu Basin	105	Solander Basin

Table 11. Major oil and gas fields, Southwest Quadrant, Circum-Pacific region

Basin/Field/ Discovery year	Age	Lithology	Cumulative production
Salawati Basin			
Kasim 1972	Miocene	Carbonate	47,242,198
Jaya 1973	Miocene	Carbonate	25,802,223
Klamono 1936	Miocene	Carbonate	34,910,590
Walio 1972	Miocene	Carbonate	152,075,105
Sele 1954	Miocene	Carbonate	1,421,940
Bintuni Basin			
Wasian 1939	Miocene	Carbonate	–
Mogo 1941	Miocene	Carbonate	–
Akimegah Basin			
Juha 1983	Jurassic-Cretaceous	Sandstone	–
Papuan Basin			
Iehi 1960	Jurassic-Cretaceous	Sandstone	–
Bwata 1960	Miocene	Carbonate	–
Kuru 1956	Miocene	Carbonate	–
Uramu 1968	Miocene	Carbonate	–
Puri 1958	Miocene	Carbonate	–
Pasca 1968	Miocene	Carbonate	–
Pandora 1988	Miocene	Carbonate	–
Hedinia 1987	Jurassic-Cretaceous	Sandstone	–
Iagifu 1986	Jurassic-Cretaceous	Sandstone	–
Amadeus Basin			
Mereenie 1964	Ordovician	Sandstone	5,152,475
Palm Valley	Ordovician	Sandstone	?
Bonaparte Basin			
Petrel 1969	*Permian*	*Sandstone*	–
Bowen Basin			
Canning Basin			
Carnarvon Basin			
Goodwyn 1971	*Triassic*	*Sandstone*	–
North Rankin 1972	*Triassic*	*Sandstone*	*37,000,000*
Cooper/Eromanga Basin			
Gidgealpa 1964	*Permian*	*Sandstone*	–
Moomba 1964	*Permian*	*Sandstone*	–
Gippsland Basin			
Barracouta 1965			35,498,000
Bream 1969			20,260,000
Cobia 1972			94,456,000
Dolphin 1967			2,788,000
Flounder 1968			36,487,000
Fortescue 1978			206,886,000
Halibut 1967	*Eocene*	*Sandstone*	*733,447,000*
Kingfish 1967	*Eocene*	*Sandstone*	*979,933,000*
Mackerel 1969			397,849,000
Marlin 1966	*Eocene*	*Sandstone*	*64,647,000*
Perch 1968			3,341,000
Seahorse 1978			260,000
Snapper 1968	*Paleogene*		*18,681,000*
Tarwhine 1981			18,681,000
Tuna 1968			41,647,000
West Kingfish 1968			98,527,000
Whiting 1983			5,924,000
Otway Basin			
Perth Basin			
Surat Basin			
Taranaki Basin			
Maui 1969	*Eocene*	*Sandstone*	–

Table 12. Estimated petroleum resources, proved and probable by basin, Southwest Quadrant, Circum-Pacific region

Country/Basin	Crude oil (millions bbl)	Condensate (millions bbl)	LPG (millions bbl)	Gas (10.9 cu. m.)
Australia				
Amadeus/Bonaparte	189.6	2.6	8.9	12.23
Bowen	1.4	2.4	2.5	4.96
Canning	2.6	–	–	–
Carnarvon	173.5	357.2	307.3	255.92
Cooper/Eromanga	77.6	42.9	71.1	77.72
Gippsland	768.6	139.6	274.9	160.5
Otway	–	–	–	0.97
Perth	8.7	<0.1	–	3.40
Surat	0.8	0.2	0.4	1.29
New Zealand				
Taranaki	277.4	210.9	?	1,222.3 (mmboe)
Papua New Guinea				
Papuan	200	?	?	8,000.0 (bcf)

Table 13. Estimated proven reserves of oil and gas by country, Southwest Quadrant, Circum-Pacific region

Country	Oil (1,000 bbl)	Gas (bcf)
Australia	1,523,700	15,057
Brunei	1,350,000	11,200
Indonesia	6,581,293	64,837
Malaysia	3,045,000	59,055
Burma (Myanmar)	50,000	9,350
New Zealand	170,230	3,449
Papua New Guinea	200,000	8,000
Philippines	38,000	100
Thailand	262,000	13,600
Vietnam	500,000	100

Table 14. List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Ash (Percent)
Canada								
Alberta	31	Tertiary	Lignite	2	N		<1	<15
	38	Tertiary	Lignite		N	L		
	28	Tertiary	Lignite-subbituminous		N	M		
	26	Tertiary	Lignite-subbituminous		N	L		
British Columbia	43	Cretaceous	Bituminous			L		
	44	Tertiary	Lignite		N	S		
	45	Tertiary	Lignite		N	S		
	46	Tertiary	Lignite		N			
	47	Cretaceous-Tertiary	Bituminous	3		L		
	48	Cretaceous	Bituminous			L		
	49	Cretaceous	Bituminous	3		S		
	50	Cretaceous	Bituminous	4	P	S		
	51	Tertiary	Lignite	1	N	L	<3	>15
	52	Cretaceous	Bituminous	4	P-E	L	<3	>15
	56	Tertiary	Lignite		N	S		
	58	Tertiary	Bituminous	6	P-E	L		
	59	Cretaceous	Lignite		N	L		
	60	Tertiary	Lignite		N	S		
	62	Jurassic-Cretaceous	Bituminous-Anthracite	1	X	S		
	63	Jurassic-Cretaceous	Bituminous-Anthracite	13	X	L		
	64	Tertiary	Subbituminous-Bituminous	3	N	L		
	65	Tertiary	Lignite	1	N	L		
	66	Cretaceous	Bituminous	1	Y	M		
	68	Tertiary	Subbituminous	Several	N	S		
	69	Tertiary	Lignite		N	S		
	71	Tertiary	Lignite	1	N	L		
	72	Tertiary	Lignite		N	S		
	76	Tertiary	Lignite		Y	L		
	82	Tertiary	Lignite	5	N	S		
	84	Tertiary	Lignite	15+	N	M		
	86	Cretaceous	Bituminous	3	Y	S		
	90	Tertiary	Bituminous	Numerous	Y	M	<1	
	92	Tertiary	Lignite-Bituminous	2	Y	S		
	101	Cretaceous	Bituminous		Y	S		
	102	Tertiary	Lignite		N	S		
	103	Tertiary	Lignite		N	S		
	107	Cretaceous	Bituminous		Y	S		
	109	Mississippian	Bituminous		Y	L		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Ash (Percent)
Northwest Territories	122	Cretaceous	Lignite		N	L		
	123	Cretaceous	Bituminous	8+		L	<3	>15
	154	Cretaceous	Bituminous			S		
	155	Cretaceous	Bituminous			L		
	226	Tertiary	Lignite	3	N	L		
	228	Tertiary	Lignite		N	M		
	229	Cretaceous	Subbituminous-Bituminous	3	N	M		
	243	Tertiary	Lignite		N	L		
	244	Tertiary	Lignite		N	M		
	242	Cretaceous	Lignite		N	L		
	129	Tertiary-Cretaceous	Lignite-Subbituminous		N	S		
	133	Tertiary-Cretaceous	Lignite-Subbituminous		N	S		
	156	Tertiary-Cretaceous	Bituminous			L		
	266	Devonian-Cretaceous	Bituminous	Many		L		
	249	Devonian	Bituminous			L		
	183	Devonian	Bituminous			L		
	241	Cretaceous	Lignite		N	L		
Yukon	308	Cretaceous	Lignite		N	L		
	309	Tertiary	Lignite	2	N	L		
	310	Cretaceous-Tertiary	Lignite	3	N	L		
	311	Cretaceous	Lignite-Bituminous	3	Y	L	<1	<15
	312	Cretaceous-Tertiary	Lignite-Subbituminous		N	L		<8
	313	Tertiary	Subbituminous	3	N	M		
	314	Cretaceous	Anthracite	3	N	M		
	315	Cretaceous	Bituminous			S		
	319	Cretaceous	Bituminous			L		
	320	Tertiary	Lignite		N	L		
	324	Cretaceous	Subbituminous-Bituminous	5	Y	L		
	330	Tertiary	Lignite		N	L		
	331	Tertiary	Lignite		N	L		
	332	Cretaceous	Lignite		N	S		
	337	Cretaceous	Lignite			S		
	345	Tertiary	Subbituminous	1	N	M		
	350	Cretaceous				L		
	352	Tertiary	Lignite		N	L		
	353	Tertiary	Lignite		N	L		
	354	Tertiary	Lignite		N	L		
	357	Mississippian	Bituminous		Y	M		
	329	Cretaceous	Bituminous	1		M		
Saskatchewan	282	Cretaceous	Lignite	Several	N	L		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Guatemala	1	Tertiary	Lignite		N	S	<3	>15
	2	Tertiary	Lignite		N	S		
	4	Tertiary	Lignite		N	S		
	5	Tertiary	Lignite		N	S	>3	>15
	6	Tertiary	Lignite		N	S	<3	>15
	8	Tertiary	Lignite		N	S		
	14	Tertiary	Lignite		N	S		
	18	Tertiary	Lignite		N	S		
	19	Tertiary	Lignite		N	S		<8
	22	Tertiary	Lignite		N	S		
	26	Tertiary	Lignite		N	S		
	27	Tertiary	Lignite		N	S		<15
Honduras	1	Triassic-Jurassic	Subbituminous-Bituminous	5				
	2	Triassic-Jurassic	Subbituminous	3	N	S	<3	>15
	3	Triassic-Jurassic	Subbituminous-Bituminous		N	S	<1	>15
	4	Triassic-Jurassic	Subbituminous	Several	N	S	<3	>15
	5	Triassic-Jurassic	Subbituminous	1	N	S	<1	>15
	8	Triassic-Jurassic	Subbituminous	4	N	S	>3	>15
	9	Tertiary	Subbituminous-Bituminous	1	N	S		
	10	Tertiary	Lignite			S		
	11	Tertiary	Lignite		N	S		
	12	Tertiary	Lignite		N	S		
Nicaragua	1	Tertiary	Lignite		N	S		
	2	Tertiary	Lignite		N	S		
	3	Tertiary	Lignite		N	S		
	4	Tertiary	Lignite		N	S		
	5	Tertiary	Lignite		N	S		
	6	Tertiary	Lignite		N	S		
	7	Tertiary	Lignite		N	S		
Cuba	1	Tertiary	Lignite		N	S		
	3	Tertiary	Lignite		N	S		
	9	Tertiary	Lignite		N	S		
	11	Tertiary	Lignite		N	S		
	13	Tertiary	Lignite		N	S		
	14	Tertiary	Lignite		N	S		
Jamaica	1							
	2							
	9							
	11							

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Dominican Republic	1	Tertiary	Lignite-Bituminous		N	M	>3	>15
	2	Tertiary	Lignite		N	S		
	3	Tertiary	Lignite-Bituminous	Several	N	S		
Haiti	1	Tertiary	Lignite	5	N	S	>3	>15
	2	Tertiary	Lignite	Several	N	S	>3	>15
	3	Tertiary	Lignite	Several	N	S	>3	>15
	4	Tertiary	Lignite-Bituminous	Several	N	S		
Costa Rica	1	Tertiary	Lignite		N	S		>15
	2	Tertiary	Lignite	Several	N	M	<3	>15
	3	Tertiary	Bituminous		N	S	<2	>15
	5	Tertiary	Subbituminous		N	M		
	6	Tertiary	Subbituminous	Several	N	M		
	8	Tertiary	Subbituminous	Several	N	S	<3	>15
	9	Tertiary	Subbituminous	Several	N	M	<3	>15
El Salvador	1	Tertiary	Lignite		N	S		>15
	2	Tertiary	Lignite		N	S		
	6	Tertiary	Lignite		N	S		
	7	Tertiary	Lignite		N	S		
	15	Tertiary	Lignite		N	S		>15
Panama	1	Tertiary	Lignite		N	S		
	2	Tertiary	Lignite		N	S		
	3	Tertiary	Lignite		N	S		
	5	Tertiary	Lignite	3	N	S	<1	<8
	8	Tertiary	Lignite	3	N	S		<15
	10	Tertiary	Lignite	3	N	S		
	12	Tertiary	Lignite		N	S		
	13	Tertiary	Lignite		N	S		
	14	Tertiary	Lignite		N	S		
	15	Tertiary	Lignite		N	S		
Anguilla	1	Tertiary	Lignite	1+	N	S		
Puerto Rico	1	Tertiary	Lignite	1+	N	S		
	2	Tertiary	Lignite	1+	N	S		>15
	3	Tertiary	Lignite	1+	N	S		>15
Mexico								
Chihuahua	1	Tertiary	Lignite		N	S		
	2	Cretaceous	Bituminous		Y	S		
	3	Jurassic	Anthracite		N	S		
	4	Jurassic	Anthracite		N	S		
	5	Cretaceous	Bituminous		Y	L		
	6	Tertiary	Lignite		N	S		
Chiapas	8	Jurassic	Bituminous		Y	S		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Coahuila	10	Cretaceous	Bituminous	1	Y	S		
	11	Cretaceous	Bituminous	1	Y	L	<2	>15
	12	Cretaceous	Bituminous	1	Y	L	<2	>15
	13	Cretaceous	Bituminous	1	Y	L	<2	>15
	14	Cretaceous	Bituminous	1	Y	L	<2	>15
	18	Cretaceous	Bituminous	1	Y	L	<2	>15
	22	Cretaceous	Subbituminous	1	Y	L		>15
	23	Cretaceous	Bituminous	1	Y	L		
	24	Cretaceous	Bituminous	1	Y	L		
Colima	27	Tertiary	Lignite		N	S		
Durango	28	Tertiary	Lignite		N	S		
	29	Cretaceous	Bituminous			S		
Guanajuato	30					S		
	31	Tertiary	Lignite		N	S		
Guerrero	32		Bituminous		Y	S		
	33		Lignite		N	S		
	34	Tertiary	Lignite		N	S		
	35	Jurassic	Bituminous		Y	S		
	36				N	S		
Hidalgo	37		Bituminous		Y	S		
	38	Tertiary	Bituminous		Y	S		
	39	Tertiary	Lignite		N	S		
Jalisco	40					S		
	41					S		
	42					S		
	43	Cretaceous	Bituminous		Y	S		
	44	Cretaceous	Bituminous		Y	S		
	45	Cretaceous	Bituminous		Y	S		
Mexico D. F.	46							
Michoacan	47					S		
	48					S		
	50		Anthracite			S		
	54					S		
	55		Bituminous		Y	S		
	56		Lignite		N	S		
	57		Bituminous		Y	S		
	58	Tertiary	Lignite		N	S		
Nayarit	59	Tertiary	Lignite		N	S		
	60	Tertiary	Lignite		N	S		
Nuevo Leon	61	Cretaceous	Bituminous		Y	S		
Oaxaca	62	Jurassic	Bituminous		N	S		>15
	64	Jurassic	Bituminous		N	S		>15
	65	Tertiary	Bituminous		N	S		>15
	66	Jurassic	Bituminous		N	S		>15
	67	Jurassic	Bituminous		N	S		>15
	68	Jurassic	Bituminous		Y	S		>15
	72		Bituminous		N	S		>15

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Puebla	86	Jurassic	Bituminous		Y	S		
	90	Tertiary	Lignite		N	S		
	130					S		
	131					S		
Querretaro	94		Bituminous			S		
	96		Lignite		N	S		
Sonora	98	Cretaceous						
	99	Triassic	Anthracite		N	S		
	100	Triassic	Anthracite	9+	N	L	<1	>15
	101	Triassic	Anthracite	10+	N	M	<3	>15
San Luis Potosi	116	Cretaceous	Lignite		N	S		
Tabasco	117	Tertiary	Lignite		N	S		
Tamaulipas	118	Tertiary	Lignite		N	L	<2	>15
	120	Cretaceous	Bituminous		Y	S		
	121	Cretaceous	Bituminous		Y	S		
Vera Cruz	122	Jurassic				S		
	123	Cretaceous	Bituminous		Y	S		
	124	Tertiary	Lignite		N	S		
	127					S		
	128					S		
United States								
Alaska	14	Tertiary	Subbituminous	30	N	M	<2	<15
	16	Cretaceous	Subbituminous-Bituminous	Several		M	<1	<8
	19	Paleozoic	Bituminous	1	Y	S	<3	<8
	24	Cretaceous	Subbituminous		N	M	<3	<8
	25	Tertiary	Lignite	5	N	M		
	26	Tertiary	Lignite	2+	N	S		
	27	Tertiary	Anthracite			S		
	29	Cretaceous	Bituminous			S		
	30	Cretaceous	Bituminous			S		
	32	Cretaceous	Subbituminous	3	N	S		
	34	Cretaeous	Subbituminous		N	S		
	36	Cretaceous	Subbituminous	1	N	S		
	37	Cretaceous	Lignite-Subbituminous		N	S		
	39	Cretaceous	Bituminous			S		
	40	Cretaceous	Bituminous	1		S		
	42	Cretaceous	Subbituminous		N	S		
	45	Tertiary	Subbituminous	1	N	M		
	50	Tertiary	Lignite-Subbituminous			S		
	52	Cretaceous	Bituminous			S		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Arizona	59	Cretaceous			N	S		
	60	Cretaceous	Bituminous	1+		L	>3	
	61	Cretaceous	Bituminous	2+	M	M	>3	>15
	62	Permian	Lignite	1	N	M		>15
	65	Cretaceous	Subbituminous	2+	N	M		>15
	68	Cretaceous				S		
California	79	Tertiary	Bituminous	1		M	>3	>15
	80	Tertiary	Bituminous			S		
	82	Tertiary	Lignite	2	N	M	<3	>15
	83	Tertiary	Subbituminous	2+	N	M	<3	<15
	84	Tertiary	Subbituminous	1+	N	M		<15
	85	Cretaceous-Tertiary	Lignite	1+	N	S		
	86	Cretaceous-Tertiary	Lignite	1+	N	S	<3	<15
	87	Tertiary	Lignite	Numerous	N	S		<15
	89	Tertiary	Lignite	3	N	L	<2	<15
	90	Tertiary	Lignite		N	S		
	91	Tertiary	Lignite		N	S		
Colorado	111	Pennsylvanian		1+		S		
	113	Pennsylvanian		1+		S		
	116	Pennsylvanian		1+		S		
	117	Pennsylvanian		1+		S		
	118	Pennsylvanian		1+		S		
	119	Cretaceous-Tertiary	Subbituminous-Bituminous	3		L		
Idaho	134	Tertiary	Lignite-Subbituminous	Several	N	M	<1	>15
	135	Tertiary	Lignite	2	N	S	<2	>15
	140	Tertiary	Lignite-Subbituminous	1	N	L	<1	>15
	141	Tertiary	Lignite	2+	N	S		>15
	142	Tertiary	Lignite	1	N	S		>15
Montana	195	Tertiary	Lignite		N	M	>3	<15
	196	Tertiary	Lignite	3	N	S	<1	>15
	198	Tertiary	Lignite		N	S	<1	>15
	200	Tertiary	Lignite		N	S	<1	>15
	202	Tertiary	Lignite		N	M	<1	>15
	203	Tertiary	Lignite		N	S	<1	>15
	205	Tertiary	Lignite		N	L	<1	>15
	206	Tertiary	Lignite		N	S	<1	>15
	217	Cretaceous	Bituminous		Y	S		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Nevada	229	Tertiary	Bituminous	4-6		M		>15
	230	Tertiary	Lignite	Several	N	S	<2	>15
	231	Tertiary	Lignite	Several	N	S		
	232	Tertiary	Bituminous	Several		S		>15
	233	Tertiary	Lignite	1	N	S		>15
	234	Tertiary	Lignite	3	N	S		>15
	235	Tertiary	Lignite	Several	N	S		>15
	236	Mississippian	Bituminous	3		S		
	427	Mississippian	Subbituminous	1	N	S		>15
	428	Tertiary	Lignite	5	N	S		>15
	429	Tertiary	Lignite	4		S	>3	>15
	431	Tertiary	Lignite	1	N	S		
	432	Mississippian	Subbituminous		N	S		
	433	Tertiary	Subbituminous		N	S		>15
	434	Tertiary	Lignite	1	N	S		
	435	Tertiary				S		
	436		Anthracite			S		<8
	437	Tertiary	Lignite		N	S		
New Mexico	237	Cretaceous	Bituminous	Several	Y	M		
	238	Cretaceous	Bituminous	2	E	M	<1	<15
	239	Cretaceous	Bituminous	Several		S	<1	<15
	242	Cretaceous	Bituminous	Several		S	>3	>15
	243	Cretaceous	Bituminous-Anthracite	4	X	L	<2	>15
	244	Pennsylvanian	Bituminous	1	N	S		>15
	245	Cretaceous	Bituminous	3		M	<1	>15
	255	Cretaceous	Bituminous	2		L	<1	>15
	267	Cretaceous		1		S	<3	>15
	268	Pennsylvanian	Bituminous	Several		S	<3	>15
	273	Pennsylvanian	Bituminous	Several		S	<3	>15
Oregon	287	Tertiary	Subbituminous	5	N	M	<1	<8
	289	Tertiary	Subbituminous	Many	N	M	>3	>15
	291	Tertiary	Subbituminous		N	M		
	292	Tertiary	Subbituminous		N	M		
	293	Tertiary	Subbituminous			M		
	295	Tertiary	Subbituminous	4	N	S	<3	>15
	297	Tertiary	Subbituminous	Several	N	S		
	298	Tertiary	Subbituminous		N	S		
	300	Tertiary	Subbituminous-Bituminous		N	S		
	301	Tertiary	Subbituminous-Bituminous			S		
	302	Tertiary	Subbituminous			S		
	303	Tertiary	Subbituminous			S	<1	<15
	304	Tertiary				S		
	305	Tertiary				S		
	306	Tertiary				S		

Table 14.—continued List of deposits, Coal Supplement Map, Northeast Quadrant, Circum-Pacific region

Country and State	No. of Occurrence[1]	Age	Rank	No. of Beds	Coking[2]	Identified & Hypothetical Resources[3]	Sulfur (Percent)	Age (Percent)
Texas	330	Cretaceous	Bituminous-Anthracite	1		M		
	331	Cretaceous	Bituminous	2		L	<1	>15
	334	Cretaceous	Bituminous-Anthracite	Several		L		
	329a	Cretaceous	Bituminous	2		M		>15
	329b	Cretaceous	Bituminous	2		M		>15
	332	Tertiary	Lignite	Numerous	N	L	>3	>15
Utah	343	Cretaceous-Tertiary	Subbituminous	3	N	L	<2	>15
	362	Tertiary	Lignite		N	M		
	363	Tertiary	Lignite		N	M		
	364	Cretaceous	Lignite		N	M	<2	<15
Washington	383	Tertiary	Bituminous	17+	Y	L	<1	>15
	385	Tertiary	Bituminous-Anthracite	3+	Y	S	<2	>15
	386	Tertiary	Lignite-Subbituminous		Y	M	<2	>15
	388	Tertiary				M		
	389	Tertiary			N	M		
	390	Tertiary	Lignite		N	M		
	391	Tertiary	Lignite		N	S		
	392	Tertiary	Lignite			S		
	394	Tertiary				S		
Alabama	332	Tertiary	Lignite	Numerous	N	L	<3	>15
Louisiana	332	Tertiary	Lignite	Numerous	N	L	<2	>15
Arkansas	332	Tertiary	Lignite	Numerous	N	L	<1	>15
Mississippi	332	Tertiary	Lignite	Numerous	N	L	<3	>15

[1] See Figure 11 for location.

[2] E = Excellent; G = Good; P = Poor; = Unknown; N = No; Y = Yes; X = Partly

[3] S = <10 x 10^6 short tons; M = <100 x 10^6 short tons; L = >100 x 10^6 short tons

Table 15. List of selected deposits in the coal supplement map, Southeast Quadrant, Circum-Pacific region (refer to figures 19 and 20)

[A.S.T.M., American Society for Testing Materials; BTU, British thermal unit; -, no data]

Country	Deposit Name	Age	Rank of Coal A.S.T.M.	Number of beds	Calorific Value (BTU/lb)	Size *	Sulphur (Wt%)	Ash (Wt%)
Argentina (Figure 20)	Río Tambillos	Carboniferous	Bituminous	1	10,800	Small	1.4	26
	La Negra	Carboniferous	Bituminous	1	10,330	Small	0.57	28.6
	La Delfina	Carboniferous	Bituminous	3	9,800	Small	1.48	28
	Rickard	Rhaetic	Bituminous	6	9,150	Small	5.6	31.8
	Santa Maxima/ El Saltito	Carboniferous	Bituminous	2	7,200	Small	-	45
	Cervantes	Liassic	Anthracitic	2	11,500	Small	3.0	25.9
	Burgos	Callovian	Bituminous	1	10,620	Small	-	20.4
	J. Newbery	Tertiary	Bituminous	2	12,000	Small	-	21.7
	Pico Quemado	Tertiary	Bituminous	4	10,990	Small	0.5	23
	Indio	Tertiary	Subbituminous	2	7,300	Small	0.3	33.4
	Santa Ana	Tertiary	Subbituminous	2	8,825	Small	-	16.6
	Lepa	Tertiary	Subbituminous	2	10,467	Small	0.6	24.2
	La Criolla	Tertiary	Bituminous	2	10,590	Small	-	17.7
	Cabo Curioso	Tertiary	Subbituminous	3	-	Small	-	45
	Río Coyle	Tertiary	Lignitic	3	-	Large	-	-
	Río Santa Cruz	Tertiary	Lignitic	-	3,600	Large	-	-
	Río Turbio	Tertiary	Bituminous/ Subbituminous	5	10,300	Large	1.0	0.12
	Tierro del Fuego	Pliocene/ Pleistocene	Peat	1	6,840	Medium	-	-
Bolivia (Figure 20)	Beu-Buenaventura	Permian	Anthracitic	1	-	Small	1.3 - 4.8	30 - 50
	Ulla-Ulla	Quaternary	Peat	1	-	Small	-	-
	Copacabana/1. Sol	Permian	Anthracitic	1	-	Medium	-	-
	Chacaltaya/ Chuquiaguillo	Quaternary	Peat	1	-	Small	-	-
	Guaqui/Azafranal/ Alchiri/Corocoro	Miocene	Lignitic	-	5,380	Small	-	-
	Monte Blanco	Quaternary	Peat	1	-	Small	-	-
	Tacagua/El Alto		Lignitic	-	5,400	Small	-	-
	Apillampa/ San Pedro	Permian	Anthracitic	1	-	Small	-	-
Bolivia	Cochabamba/ Sacaba	Pliocene/ Quaternary	Lignitic	-	4,300	Small	4.2	30.1
	Chochoca/ Totora	Quaternary	Peat	1	-	Small	-	-
	Uncio	Quaternary	Peat	1	-	Small	-	-
	Ticucha	Tertiary	Lignitic	-	-	Small	-	-
	Tarija/Padcaya/ Tariquia	Miocene/ Quaternary	Lignitic	3	7,500-11,700	Small	1.0	7 - 34
Chile (Figure 20)	Concepción	Eocene	Bituminous	3	13,500	Large	2.0	4
	Lota-Schwager	Eocene	Bituminous	3	13,500	Large	1.75	1.7 - 3.4
	Arauco	Eocene	Bituminous	3	14,000	Large	2.5	3.4
	Valdivia	Miocene	Subbituminous/ Lignitic	-	8,626	Small	0.5	21
	Llanguihue	Miocene	Subbituminous	-	8,000	Small	0.5	15
	Pto. Natales	Oligocene/ Miocene	Subbituminous	5	10,320	Medium	0.5	17
	Río Ruebens	Oligocene/ Miocene	Subbituminous	3	-	Large	0.6	11
	Seno Skyring	Oligocene/ Miocene	Subbituminous	2	-	Large	0.5	10
	Isla Riesco	Oligocene/ Miocene	Subbituminous	3	8,750-9,940	Large	0.4	10
	Pen. Brunswick	Oligocene/ Miocene	Subbituminous	5	6,940-8,730	Large	1.3	13
Colombia (Figure 19)	El Cerrejón	Paleocene	Bituminous	15	13,500	Large	1.0	1.7 - 5
	La Jagua	Paleocene/ Eocene	Bituminous	5	11,500-13,600	Large	1.0	1 - 5
	Norte Santander	Maastrichtian/ Eocene	Bituminous	4 - 9	6,000+	Small	1.0	2 - 7
	Cundinamarca/ Boyacá	Maastrichtian/ Paleocene	Bituminous	1 - 7	12,000-15,000	Large	1.0	3 - 5
	Alto S. Jorge	Oligocene	Bituminous	6	5,100-6,300	Large	0.4 - 1.0	1.3 - 6.0
	Antioquía	Oligocene/ Miocene	Bituminous	8	5,000-6,300	Large	1.0	1.3 - 6.0
	Valle del Cauca	Paleocene/ Oligocene	Anthracitic/ Bituminous	7 - 10	11,260-15,000	Large	1.0 - 6.0	4 - 24
Costa Rica (Figure 19)	1	Tertiary	Lignitic	-	-	Small	-	>15
	2	Tertiary	Lignitic	Several	-	Medium	<3	>15
	3	Tertiary	Bituminous	-	-	Small	<2	>15
	5	Tertiary	Subbituminous	-	-	Medium	-	-
	6	Tertiary	Subbituminous	Several	-	Medium	-	-
	8	Tertiary	Subbituminous	Several	-	Small	<3	>15
	9	Tertiary	Subbituminous	Several	-	Medium	<3	>15
Ecuador (Figure 19)	Pinchincha	Quaternary	Peat	1	6,000	Small	-	-
	Azogues/Biblian	Maastrichtian/ Eocene	Lignitic/ Subbituminous	5	3,800-7,900	Small	6.0	21
	Loja	Oligocene	Subbituminous	6	7,000-9,360	Small	7.0 - 8.0	9 - 30
	Malacatos	Miocene	Subbituminous	4	8,100	Small	8.0	15
	Napo (Oriente)	Neocomian	Lignitic	8	-	Small	-	-
El Salvador (Figure 19)	1	Tertiary	Lignitic	-	-	Small	-	>15
	2	Tertiary	Lignitic	-	-	Small	-	-
	6	Tertiary	Lignitic	-	-	Small	-	-
	7	Tertiary	Lignitic	-	-	Small	-	-
	15	Tertiary	Lignitic	-	-	Small	-	>15
Guatemala (Figure 19)	1	Tertiary	Lignitic	-	-	Small	<3	>15
	2	Tertiary	Lignitic	-	-	Small	-	-
	4	Tertiary	Lignitic	-	-	Small	-	-
	5	Tertiary	Lignitic	-	-	Small	>3	>15
	6	Tertiary	Lignitic	-	-	Small	<3	>15
	8	Tertiary	Lignitic	-	-	Small	-	-
	14	Tertiary	Lignitic	-	-	Small	-	-
	18	Tertiary	Lignitic	-	-	Small	-	-
	19	Tertiary	Lignitic	-	-	Small	-	>8
	22	Tertiary	Lignitic	-	-	Small	-	-

Table 15.—continued

[A.S.T.M., American Society for Testing Materials; BTU, British thermal unit; -, no data]

Country	Deposit Name	Age	Rank of Coal A.S.T.M.	Number of beds	Calorific Value (BTU/lb)	Size *	Sulphur (Wt%)	Ash (Wt%)
Guatemala (Figure 19)	1	Tertiary	Lignitic	-	-	Small	<3	>15
	2	Tertiary	Lignitic	-	-	Small	-	-
	4	Tertiary	Lignitic	-	-	Small	-	-
	5	Tertiary	Lignitic	-	-	Small	>3	>15
	6	Tertiary	Lignitic	-	-	Small	<3	>15
	8	Tertiary	Lignitic	-	-	Small	-	-
	14	Tertiary	Lignitic	-	-	Small	-	-
	18	Tertiary	Lignitic	-	-	Small	-	-
	19	Tertiary	Lignitic	-	-	Small	-	>8
	22	Tertiary	Lignitic	-	-	Small	-	-
	26	Tertiary	Lignitic	-	-	Small	-	-
	27	Tertiary	Lignitic	-	-	Small	-	>15
Honduras (Figure 19)	1	Triassic/ Jurassic	Subbituminous/ Bituminous	5	-	-	-	-
	2	Triassic/ Jurassic	Subbituminous	3	-	Small	<3	>15
	3	Triassic/ Jurassic	Subbituminous/ Bituminous	-	-	Small	<1	>15
	4	Triassic/ Jurassic	Subbituminous	Several	-	Small	<3	>15
Honduras	5	Triassic/ Jurassic	Subbituminous	1	-	Small	<1	>15
	8	Triassic/ Jurassic	Subbituminous	4	-	Small	<3	>15
	9	Tertiary	Subbituminous/ Bituminous	1	-	Small	-	-
	10	Tertiary	Lignitic	-	-	Small	-	-
	11	Tertiary	Lignitic	-	-	Small	-	-
	12	Tertiary	Lignitic	-	-	Small	-	-
Nicaragua (Figure 19)	1	Tertiary	Lignitic	-	-	Small	-	-
	2	Tertiary	Lignitic	-	-	Small	-	-
	3	Tertiary	Lignitic	-	-	Small	-	-
	4	Tertiary	Lignitic	-	-	Small	-	-
	5	Tertiary	Lignitic	-	-	Small	-	-
	6	Tertiary	Lignitic	-	-	Small	-	-
	7	Tertiary	Lignitic	-	-	Small	-	-
Panama (Figure 19)	1	Tertiary	Lignitic	-	-	Small	-	-
	2	Tertiary	Lignitic	-	-	Small	-	-
	3	Tertiary	Lignitic	-	-	Small	-	-
	5	Tertiary	Lignitic	3	-	Small	<1	>8
	8	Tertiary	Lignitic	3	-	Small	-	>15
	10	Tertiary	Lignitic	3	-	Small	-	-
	12	Tertiary	Lignitic	-	-	Small	-	-
	13	Tertiary	Lignitic	-	-	Small	-	-
	14	Tertiary	Lignitic	-	-	Small	-	-
	15	Tertiary	Lignitic	-	-	Small	-	-
Peru (Figure 19)	Tumbes	L. Tertiary	Lignitic	-	Low	Large	-	High
	Pebas Chambara	L. Tertiary	Lignitic	-	Low	-	-	-
	Yanacancha	L. Cretaceous	Bituminous	-	-	Small	-	-
	Piñata/Tuco	E. Cretaceous	Anthracitic	-	-	Medium	-	-
	Cupisnique	E. Cretaceous	Anthracitic	-	-	Small	-	-
	Alto Chicama	E. Cretaceous	Anthracitic	-	-	Large	-	-
	Conchucos	E. Cretaceous	Anthracitic	-	-	Small	-	-
	Tarica/Shivas	E. Cretaceous	Anthracitic	-	-	Small	-	-
	Santa	E. Cretaceous	Anthracitic	-	-	Large	-	-
	Buenaventura/ Caraz	E. Cretaceous	Anthracitic	-	-	Small	-	-
Peru	San Marcos/ Huari	E. Cretaceous	Anthracitic	-	-	Small	-	-
	Huallanca	E. Cretaceous	Anthracitic	-	-	Small	-	-
(Figure 20)	Goyllarisquizga	E. Cretaceous	Bituminous	6	-	Small	12.1	54
	Oyon/Checras	L. Jurassic- E. Cretaceous	Anthracitic/ Bituminous	-	-	Large	1.2	16
	Jatunhuasi	E. Cretaceous	Subbituminous/ Bituminous	2 (6)	-	Medium	5.1	42.3
	Changos Alto	E. Cretaceous	Subbituminous	-	-	-	-	-
	Murco/Sumbay	L. Jurassic- E. Cretaceous	Bituminous	-	-	Small	-	-
	Carumas	L. Jurassic- E. Cretaceous	Bituminous/ Anthracitic	-	-	Small	-	-
Venezuela (Figure 20)	Zulia/Guasare	Paleocene	Bituminous	20	-	Large	-	-
	Tachira	Eocene	Bituminous	3	-	Large	-	-
	Falcón	Miocene	Lignitic	-	-	Medium	-	-
	Parapara/Ortiz	Miocene	Subbituminous	-	-	-	-	-
	Taguay	Oligocene/ Miocene	Bituminous	-	-	Medium	-	-
	Altagracia	Oligocene/ Miocene	Bituminous	-	-	Medium	-	-
	Fila Maestra	Eocene/ Oligocene	Bituminous	Several	-	Medium	-	-
	Niricual	Eocene/ Oligocene	Bituminous	Several	-	Medium	-	-
	Sur Panaguán	Quaternary	Peat	1	-	-	-	-
	Anzoátegui/ Monagas	Quaternary	Peat	1	-	-	-	-
	Piacoa	Quaternary	Peat	1	-	-	-	-

*Small: less than 10 x 10^6 metric tons; medium: less than 100 x 10^6 metric tons; large: more than 100 x 10^6 metric tons.

Table 16. General characteristics of selected major coal fields, Northwest Quadrant, Circum-Pacific region (numbers refer to figure 21)

Country Field number	Field name	Age	Rank	Number of beds	Coking[1]	Hypothetical resources[2]	Sulfur(%)	Ash(%)
Russia								
1	Kempendgeisk	Jurassic-Cretaceous	Subbituminous	1	N	M	<1	<9
2	Spoln	Jurassic	Bituminous	1	N	M	-	>5
3	Kilofsk	Cretaceous	-	-	N	L	<1	<12
4	Mamontofsk	Cretaceous	-	-	-	M	<1	>11
5	Kirdgemsk	Jurassic	Bituminous	11	N	L	<1	<20
6	Kangarask	Cretaceous	Bituminous	10	N	L	<2	<32
7	Harabarahsk	Jurassic	Bituminous	-	-	M	<1	<11
8	Nadeginsk	Jurassic	Bituminous	4	-	M	<1	<19
9	Soginsk	-	Bituminous	2	-	M	<1	<8
10	Kyralsk	-	Bituminous	3	-	M	<1	>12
11	Dalpilsk	Cretaceous	Bituminous	Numerous	-	L	<1	<14
12	Velhunealkaganinsk	Cretaceous	Bituminous	2	-	L	<1	<10
13	Nidgnealkagarinsk	-	Bituminous	Numerous	-	L	<1	>9
14	Kenofsk	Cretaceous	Bituminous	3	-	M	<1	<10
15	Garimofsk	Cretaceous	Subbituminous	12	-	M	<1	<14
16	Ergensk	-	Subbituminous-bituminous	Numerous	-	M	<2	<10
17	Klasnoletchensk	Cretaceous	Bituminous	Numerous	-	M	<1	<10
18	Elogion	Cretaceous	Bituminous	Numerous	-	M	<1	<5
19	Biolkemyusk	Cretaceous	Bituminous	Numerous	-	M	<1	<5
20	Darn	Triassic	Bituminous	3	-	M	<2	>13
21	Kyhtyisk	Tertiary	Bituminous	Numerous	-	S	<1	>13
22	Kovensk	Tertiary	Subbituminous-bituminous	Numerous	-	-	<1	<4
23	Rankofsk	Tertiary	Bituminous	Numerous	-	L	<1	10
24	Merkovodnensk	-	Subbituminous	Several	-	L	<1	>20
25	Erigenyilsk	Tertiary	Bituminous	2	-	S	<4	<4
26	Anadyilsk	Tertiary	Bituminous	Numerous	-	M	-	<18
Japan								
27	Kushiro	Tertiary	Subbituminous	Numerous	N	L	<1	<10
28	Tempoku	Tertiary	Subbituminous	Numerous	N	M	<1	<10
29	Rumoi	Tertiary	Subbituminous-bituminous	Numerous	N-Y	M	-	<10
30	Kabato	Tertiary	Bituminous	Numerous	N	S	-	<5
31	Ishikari	Tertiary	Bituminous	Numerous	E	L	<1	<20
32	Mogami	Tertiary	Lignite	Numerous	N	M		<10
33	Nishitagawa	Tertiary	Subbituminous-bituminous	Numerous	Y	S	<1	>10
34	Johban	Tertiary	Subbituminous-bituminous	Numerous	N	L	<6	>10
35	Kumano	Tertiary	Anthracite	2	N	S	<3	>10
36	Omine &Ube	Triassic-Tertiary	Bituminous-anthracite	Numerous	N	L	-	<30
37	Chikuho	Tertiary	Bituminous	Numerous	N-Y	L	<1	>10
38	Miike	Tertiary	Bituminous	Numerous	E	L	-	-
39	Ikeshima	Tertiary	Bituminous	3	G	L	-	<10
40	Takashima	Tertiary	Bituminous	Numerous	E	L	<1	>10
41	Amakusa	Tertiary	Anthracite	3	N	M	-	<7
Korea								
42	Sanchok	Carboniferous-Permian	Anthracite	Numerous	N	M	<1	<20
43	Mungyong-Eunsong	Permian	Anthracite	-	N	S	-	-
44	Hwasan	Permian-Jurassic	Anthracite	-	N	M	-	<20
45	Chung Nam	Jurassic	Anthracite	Numerous	N	M	-	-
46	Ham Beak	Permian	Anthracite	-	N	M	-	>50
47	Tangyang	Permian	Anthracite	3	N	M	-	-
China								
48	Hegang	Jurassic	Bituminous	10	N-P	L	<1	>12
49	Shuang-ya-shan	Jurassic	Bituminous	3	N	L	<1	>12

Table 16.—continued General characteristics of selected major coal fields, Northwest Quadrant, Circum-Pacific region (numbers refer to figure 21)

Country Field number	Field name	Age	Rank	Number of beds	Coking[1]	Hypothetical resources[2]	Sulfur(%)	Ash(%)
50	Fuxun	Tertiary	Subbituminous-bituminous	Numerous	N-P	L	<1	>12
51	Benxi	Permian-Carboniferous	Bituminous-semianthracite	Numerous	E	L	<2	<10
52	Liaoyang	Jurassic	Bituminous	4	-	L	<1	<5
53	Fuxin	Jurassic	Bituminous	Numerous	-	L	-	<8
54	Beipiao	Jurassic	Bituminous	6	-	L	-	<11
55	Kailuan	Permian-Carboniferous	Bituminous	Numerous	E	L	<2	<18
56	Jingxi	Carboniferous	Anthracite	4	N	L	<1	<20
57	Datong	Carboniferous-Jurassic	Bituminous	6	P-G	-	L	<1
58	Yangchuang-Jingxing	Carboniferous-Permian	Bituminous	Several	G	L	<6	<20
59	Taiyuan	Carboniferous-Permian	Bituminous-semianthracite	5	N-P	L	<8	<14
60	Xuangang-chen	Carboniferous-Permian	Bituminous	5	-	L	<6	<7
61	Fujia-tan	Carboniferous-Permian	Bituminous	Numerous	E	M	<2	<7
62	Fengfeng	Carboniferous-Permian	Bituminous	Numerous	E	L	-	-
63	Jiaozuo	Carboniferous-Permian	Anthracite	1	N	L	<1	<8
64	Pingting-shan	Carboniferous-Permian	Bituminous	Numerous	E	M	-	-
65	Xintai	-	Bituminous	19	E	M	<1	<12
66	Zipo	Carboniferous-Permian	Bituminous	Numerous	N	M	<4	<25
67	Huaibei	Carboniferous-Permian	Anthracite	3	N	L	-	>5
68	Suchou-Huainan	Carboniferous-Permian	Bituminous	Numerous	-	L	-	<13
69	Huangshi	Jurassic	Anthracite	2	N	M	<3	<16
70	Fengcheng	Permian	-	2	-	L	-	13
71	Pingxiang	Carboniferous	Bituminous	-	-	L	<1	17
72	Xiangtan	Jurassic	Bituminous	2	-	M	2	7
73	Zixing	Permian	Anthracite	4	N	L	-	-
74	Qujiang	Permian	Semi-anthracite	Several	N	L	<1	<13
75	Mei-xian	Paleozoic	-	5	-	-	<2	20
76	Zhangping-Longyan	Carboniferous	Anthracite	2	N	L	-	16
77	Shaowu	Carboniferous	Anthracite		N	-	2	4
78	Chongan-Jianou	Mesozoic	Bituminous	3	Y	-	-	22
79	Guiyang	Permian	Bituminous	Several	Y	M	-	<7
80	Anshun-Liuzhi	Permian	Bituminous	6	-	M	-	19
81	Shuicheng-Panxian	Permian	Bituminous	-	Y	M	<1	10
82	Xuanliang-Pinglang	Permian	Bituminous	-	-	M	-	-
83	Baotou	Jurassic	Bituminous	25	P-G	M	<1	<5
Taiwan								
84	Chilung	Tertiary	Subbituminous-bituminous	-	-	L	<3	<10
85	Taipei	Tertiary	Subbituminous-bituminous	-	-	M	<3	<10
86	Hsinchu-Nangchung	Tertiary	Subbituminous	-	-	M	<2	<10
Philippines								
87	Polillo	Tertiary	Bituminous	4	Y	S	<1	<4
88	Panganiban	Tertiary	Bituminous-semianthracite	4	Y	S	<1	16
89	Liguan	Tertiany	Subbituminous	2	N	S	<1	5
90	Calanga & Eastern Batan	Tertiary	Subbituminous	2	N	S	<3	6
91	Gatbo	Tertiary	Subbituminous	1	N	S	<2	4

Table 16.—continued General characteristics of selected major coal fields, Northwest Quadrant, Circum-Pacific region (numbers refer to figure 21)

Country Field number	Field name	Age	Rank	Number of beds	Coking[1]	Hypothetical resources[2]	Sulfur(%)	Ash(%)
92	Bulalacao	Tertiary	Subbituminous	Several	N	S	5	<4
93	Semirara	Tertiary	Subbituminous	Numerous	N	S	<1	<4
94	Cajumayjumayan	Tertiary	Subbituminous	Numerous	N	-	-	-
95	Escalante	Tertiary	Subbituminous-bituminous	4	Y	S	<5	5-7
96	Camansi-Licos	Tertiary	Subbituminous	Several	N	S	<1	<10
97	Toledo-Uling	Tertiary	Subbituminous-bituminous	Several	N-P	S	<5	<10
98	Argo-Dalagnete Mantalongon	Tertiary	Subbituminous-bituminous	Several	N-P	S	<1	<10
99	Lingig-Bislig	Tertiary	Bituminous-subbituminous	Numerous	N-P	S	<1	<14
100	Lalat-Lumbang	Tertiary	Bituminous	Numerous	-	S	-	<6
Vietnam								
101	Nong Son	Triassic	Bituminous	-	-	S	<2	<10
102	Phan Me	Triassic	Bituminous	Numerous	N	-	1	<18
103	Bo Ha	Triassic	Anthracite	Numerous	N	-	-	-
Myanmar (Burma)								
104	Qung Yen	Triassic	Anthracite	-	N	L	<1	<7
105	Lo-an	Cretaceous	Bituminous	-	Y	S	-	<12
106	Panlaung	Cretaceous	Bituminous	-	-	-	-	13
107	Hlemauk-Kywezim	Cretaceous	Bituminous	-	-	-	-	<7
108	Kalewa	Tertiary	Lignite	3	N	-	<1	<3
109	Kyobin	Tertiary	Lignite	-	-	-	-	7
110	Shwebo	Tertiary	Lignite	-	-	-	-	<15
Thailand								
111	Mae Mo	Tertiary	Lignite	2	N	M	3	16
112	Li	Tertiary	Subbituminous	2	N	M	<2	11
113	Krabi	Tertiary	Subbituminous	1	N	M	<3	9
Malaysia								
114	Batu Anang	Tertiary	Subbituminous	2	N	S	<0.5	9
115	Enggor	Tertiary	Subbituminous	1	N	S	-	9
116	Silantek	Tertiary	Anthracite	Numerous	N	S	<0.9	11
117	Merit-Pila	Tertiary	Subbituminous	Numerous	N	M	<0.1	1
118	Bintula	Tertiary	Bituminous	2	-	M	<3	<7
119	Labuan	Tertiary	Subbituminous	4	N	S	<2	<6
120	Silimpopon	Tertiary	Bituminous	4	N-P	M	2.5	<12
Indonesia								
121	Onbilin	Tertiary	Bituminous	7	Y	L	<1	1-2
122	Bukit Asam	Tertiary	Lignite-bituminous	6-7	N-P	M	-	<1.5
123	Berau	Tertiary	Bituminous	4	P	M	<1	3
124	Kaltin Prima	Tertiary	Bituminous	4	P	S	<1	1
125	Kideco Jaya Agung	Tertiary	Subbituminous	Numerous	N	M	<1	2
126	Utah	Tertiary	Bituminous	3	N-P	M	3	20

[1]Coking: E, excellent; G, good; P, poor; -, unknown; N, no; Y, yes.

[2]Hypothetical resources: S = <10x10^6 short tons; M = <100x10^6 short tons; L = >100x10^6 short tons.

Table 17. Coal fields, Southwest Quadrant, Circum-Pacific region

Country	Field	Age	Rank	Resources
Australia				
New South Wales	Sydney/Gunnedah	Permian	Bituminous	L
	Ashford	Permian	Bituminous	S
	Gloucester	Permian	Bituminous	M
	Lorne	Triassic	Subbituminous	S
	Nymboida	Triassic	Bituminous	S
New South Wales/ Queensland	Clarence/Moreton	Jurassic	Bituminous	L
Queensland	Bowen	Permian	Bituminous	L
	Blair Athol	Permian	Bituminous	L
	Calen	Permian	Bituminous	S
	Galilee	Permian	Subbituminous	L
	Little River/Oakey	Permian	Subbituminous	S
	Mount Mulligan	Permian	Bituminous	S
	Oaklands/Coorabin	Permian	Subbituminous	L
	Olive River	Permian	Bituminous	S
	Wolfang	Permian	Bituminous	L
	Callide	Triassic	Subbituminous	L
	Ipswich	Triassic	Bituminous	L
	Tarong	Triassic	Subbituminous	L
	Eromanga	Jurassic/Cretaceo us	Lignite/ Subbituminous	L?
	Laura	Jurassic	Bituminous	S?
	Maryborough	Cretaceous	Bituminous	S
	Mulgildie	Jurassic	Subbituminous	M
	Styx	Cretaceous	Bituminous	S
	Surat	Jurassic	Bituminous	L
	Tiaro	Jurassic	Bituminous	S
	Waterpark Creek	Tertiary	Lignite	S?
Queensland/South Australia	Cooper	Permian	Bituminous	L
South Australia	Arckaringa	Permian	Subbituminous	L
	Leigh Creek	Triassic	Subbituminous	L
	Polda	Jurassic	Subbituminous	L
	South Aust misc.	Tertiary	Lignite	L
South Australia/ Northern Territory	Pedirka	Permian	Bituminous	?
Northern Territory/ Western Australia	Bonaparte	Permian	Subbituminous	?
Western Australia	Canning	Permian	Subbituminous/ Bituminous	?
	Collie/Wilga	Permian	Subbituminous	L
	Carnarvon	Triassic	Subbituminous	?
	Perth	Jurassic	Subbituminous	M
	Bremer	Tertiary	Lignite	S
Tasmania	Tasrnania	Permian/Triassic	Anthracite/ Subbituminous/ Cannel	L
Victoria	Gippsland	Cretaceous	Bituminous	S
	Anglesea	Tertiary	Lignite	L
	Otway	Tertiary	Lignite	L
	Gelliondale	Tertiary	Lignite	L
	Stradbroke	Tertiary	Lignite	L

Table 17.—continued Coal fields, Southwest Quadrant, Circum-Pacific region

Country	Field	Age	Rank	Resources
New Zealand				
North Island	Northland	Tertiary	Subbituminous	S
	Waikato	Tertiary	Subbituminous	L
	Taranaki	Tertiary	Subbituminous	L
South Island	Nelson-Westland	Cretaceous/Tertiary	Bituminous/ Subbituminous	L
	Canterbury	Cretaceous/Tertiary	Subbituminous	M
	Otago	Cretaceous/Tertiary	Lignite/ Subbituminous	L
	Southland	Cretaceous/Tertiary	Lignite/ Subbituminous	L
New Caledonia				
	Nondoue	Cretaceous	Bituminous?	S
	Moindou	Cretaceous	Bituminous	S

Table 18. Australian oil shale deposits, Southwest Quadrant, Circum-Pacific region

State	Deposit	Age	Shale resources (Mt)	Recoverable oil (millions of cubic meters)
Queensland	Alpha	Permian	5.3	1.3
	Condor	Tertiary	17,849	994
	Duaringa	Tertiary	?	477
	Julia Creek	Cretaceous	4,000	238
	Lowmead	Tertiary	?	?
	Nagoorin/Littlemore	Tertiary	?	?
	Rundle	Tertiary	4,678	361
	Stuart	Tertiary	5,000	318
	Toolebuc Formation	Cretaceous	3,838,000	230,000
	Yaamba	Tertiary	?	267
New South Wales	Baerami	Permian	16	4
	Newnes/Glen Davis	Permian	20	9
Tasmania	Northern Tasmanian deposits	Permian	31	4

Table 19. New Zealand oil shale deposits, Southwest Quadrant, Circum-Pacific region

Location	Deposit	Age	Shale resources (Mt)	Recoverable oil (million liters/mt)
South Island	Cambrian	Tertiary	0.5	128
	Freshford	Tertiary	0.075	144
	Idaburn	Tertiary	?	?
	Nevis	Tertiary	8	117
	Orepuki	Tertiary	7	190
	Waitati	Tertiary	1.5	88

Table 20. Major geothermal sites by country, Southeast Quadrant, Circum-Pacific region (refer to figures 22 and 23)

Country	Locality	Temperature (C°)	Type
Argentina (Figure 23)	Tuzgle Volcano (geothermal project)	68°	thermal and hot springs
	Tocomar	57°, max.	thermal springs
	Baños de Pompeya (resort)	57°, max.	thermal springs
	Socompa Volcano	68°?	hot water springs
	Termas de Reyes (resort)	40°-90°	hot springs
	Agua Caliente	76°	hot springs
	Santa Bárbara (El Ramal)	46°-90°	hot springs
	Rosario de la Frontera (resort)	62°-90°	hot springs
	Ceibal (Candelaria)	52°-80°	hot springs
	Villavil (resort)	55°-64°	thermal springs
	Rio Hondo (geothermal project and resort)	48°-90°	hot springs
	Fiambalá	54°-58°	thermal springs
	Rio Blanco area	50°	thermal springs
	Dumuyo (geothermal project):		
	La Bramadora	92°	hot springs and fumaroles
	El Humazo	98°	hot springs and fumaroles
	Los Tachos	94°	hot springs and fumaroles
	Copahue (670 KW geothermal plant and resort)	93°-138° (max. 238° at 930 m)	hot springs and fumaroles
	Viticola (artesian wells)	55°	thermal spring
	Bahía Blanca (artesian wells)	55°-70°	hot springs
	Argerich (artesian wells)	64°	thermal spring
	Colluco-Epulauquen	60°	thermal springs
Bolivia (Figure 23)	Putina (Ulla-Ulla)	72°	hot springs
	Charazani	-	hot springs
	Chuma	-	hot springs
	Matilde	65°	thermal springs
	Urmiri (resort)	-	thermal springs
	Choquetanga	-	thermal springs
	Kami-Ayopaya (resort)	-	thermal springs
	Colcha (resort)	-	thermal springs
	Pomarapa Volcano	-	strong hot springs
	Obrajes (resort)	71°	hot springs
	Capachos (resort)	45°	thermal springs
Bolivia	Pazna-Urmiri (resort)	55°	thermal springs
	Challapata	-	"NaCl" hot springs
	Mulatos	-	low thermal CO_2 springs
	Caiza (resort)	-	strong sulphuric hot springs
	Caiti-Empexa (resort)	74°	hot springs
	Pulacayo	59°-80°	thermal and boiling springs
	Olca (Salar de la Laguna)	74°	hot springs, fumaroles
Chile (Figure 23)	Aguas Calientes	86°?	hot springs
	Suriri (50 MW geothermal project)	60°-80°	hot springs
	Chinchillani	86°?	hot springs
	Enquelca	86°?	hot springs
	Puchuldiza (geothermal project)	180°-250°	hot springs
	Chusmiza	more than 60°	hot spring
	Mamina	more than 60°	hot spring
	Pica	more than 60°	hot spring
	Majada	more than 60°	hot spring
	Ojos de Ascotán	more than 60°	hot spring
	El Tatio (100 MW geothermal project)	160°-265°	hot spring and fumaroles
	Tuyajto	more than 60°	hot spring
	Baños Morales (resort)	68°	hot spring
	Salinas del Maipo	more than 60°	hot spring
	Los Bañitos (resort)	66°-70°	hot springs
	Baños San Fernando (resort)	70°-96°	hot springs, fumaroles
	San Pedro	more than 60°	hot springs
	Planchón-Peteroa (resort)	60°	multiple hot springs
	Mondaca	more than 60°	hot springs
	Campanario Volcano	more than 60°	hot springs
	Baños de Longavi (resort)	66°-71°	thermal spring
	Chillán Volcano	more than 60°	thermal springs
	Pemehue	more than 60°	hot springs
	Tolhuaca	90°	hot spring
	Manzanar	more than 60°	thermal springs
	Rio Blanco	90°	hot springs
	Aqua de la Vaca	more than 60°	thermal springs
	Minetue	more than 60°	hot springs
Chile	San Luis	more than 60	hot springs
	Palguin	more than 60°	thermal springs
	Baños de Puyehue (resort)	55°-70°	thermal, hot springs, and fumaroles
	Aguas Calientes	50°-75°	hot springs
	Baños de Petrohue (resort)	60°	thermal springs
	Llauhuari	more than 60°	thermal springs
	Sotomo	more than 60°	thermal springs
	Termas Llancahue (resort)	58°	thermal spring
Colombia (Figure 22)	Ruiz Volcano (geothermal project)	50°-90°	thermal and hot springs
	Tolima Volcano	more than 60°	hot springs
	Santa Rosa Cabal	54°-72°	thermal and hot springs
	Caqueza	65°	thermal springs
	Puarace	50°-86°	thermal and hot springs
	Pasto Volcano (geothermal project)	max. 102°	hot spring, fumaroles
	Tuquerres Volcano (geothermal project)	70°	hot spring

Table 20.—continued Major geothermal sites by country, Southeast Quadrant, Circum-Pacific region (refer to figures 20 and 23)

Country	Locality	Temperature (C°)	Type
Costa Rica (Figure 22)	Miravalles (50 MW geothermal project)	more than 60°	hot spring, solfatares
	Peña Blanca	more than 60°	hot springs
	Agua Caliente de la Trinchera	"warm"	thermal springs
	Poas Volcano	58°-100°	hot springs and fumaroles
	Irazu Volcano	-	hot springs, solfatares, and fumaroles
	Ojo de Agua-Turrubures (resort)	"warm"	hot springs
	Paso Alumbre (resort)	60°-66°	thermal saline springs
	San Cristobal (resort)	66°-68°	thermal springs
	Jurquin River area	46°-70°	thermal and hot springs
Ecuador (Figure 22)	Tulfino	50°	thermal spring
	Guagua-Pichincha Volcano	50°	thermal springs
	Apuela	52°	thermal springs
	Agua Santa (resort)	54°	thermal springs
	Cicalpa	-	thermal and hot springs
	Pungola	50°	thermal spring
	Baños Cuenca (resort)	87°	hot spring
	Portovelo	-	thermal and hot springs
	Aguas Calientes (resort)	-	thermal and hot springs
El Salvador (Figure 22)	Hervidero El Obrajuelo	72°-82°	hot springs
	Ahuachapan Chipilapa (geothermal plant)	70°-237°	hot springs, fumaroles
	Hervidero Carolina	100°	hot spring, geyser, fumaroles
	Chinameca (geothermal project)	-	hot springs, fumaroles
	Berlin (geothermal project)	-	hot springs, fumaroles
	San Vicente (geothermal project)	99°	boiling springs, fumaroles
	Santa Rosa de Lima (resort)	89°	hot springs
	Jacotal	-	hot springs
	Olomega	-	hot springs, fumaroles
	Conchagua	-	hot springs
Guatemala (Figure 22)	Zunil (15 MW geothermal plant)	max. 287°	boiling water, hot springs
	Zunil, Fuentes Georginas (resort)	55°-65°	thermal springs
	Atitlan Agua Caliente	47°-50°	hot springs, fumaroles
	La Canoa (resort)	-	hot springs
	Amatitlan (south shore)	60°-98°	hot springs, fumaroles
	Moyuta Volcano	150°	boiling springs
Honduras (Figure 22)	Northern area	-	thermal and hot springs
	Choluteca area	-	several hot springs
Nicaragua (Figure 22)	Viejo Volcano	91°	hot springs, fumaroles
	Chichigalpa Volcano	-	fumaroles, and solfataras
	San Jacinto-Tizate	-	boiling mud vents and springs
	Momotombo (35 MW geothermal plant)	max. 230°	fumaroles, and solfataras
	Titipata	-	boiling springs, sulphur deposits
	Omotepe Concepción	-	fumaroles, and solfataras
Panama (Figure 22)	Chiriqui Volcano	-	fumaroles and hot springs
	Pando	72°	hot springs
	Agua Salud (resort)	42°-72°	several thermal springs
	Coibajo	52°	thermal spring
Peru (Figure 22)	Quillate	more than 50°	hot springs
	Cajamarca (Inca bathing resort)	-	hot springs, fumaroles
	Chuquillanqui	more than 50°	thermal springs
	Huaranchai (Pampa spring)	75°	hot springs
	Cachicadán	71°	hot springs
	Tablachaca	53°	thermal and hot springs
Peru	Minabamba	60°-80°	hot springs
	Pomabamba	more than 50°	thermal springs
	Mancos	50°	thermal springs
	Chancos	70°-75°	hot springs
	Tauripampa	more than 50°	thermal springs
	Baños	56°-61°	hot springs
	Andajes-Churin (resort)	50°-55°	hot springs
	Rio Perené	-	-
	San José de Baños (resort)	-	hot springs
	Tingo de Huacho	58°	thermal springs
	Baños del Sr. Cura (resort)	more than 50°	thermal springs
	Colpani	59°	thermal springs
	Marcapata	60°-70°	thermal springs
	Ollaechea	66°-69°	hot springs
	Quilcata	more than 50°	thermal springs
	Puqufo (resort)	more than 50°	thermal springs
	Quisicollo	55°-62°	thermal springs
	Huayana-Putina	80°	hot springs
	Carumas Geyser Valley	-	geysers, boiling springs, fumaroles
	Ulican-Sancos	more than 50°	thermal springs
	Calacoa	more than 180°	hot water reservoir
	Ticaco	69°	hot water
	Caliente (resort)	-	"boiling" springs, fumaroles
Venezuela (Figure 22)	Pilar-Casanay area (geothermal project)	-	hot springs
	Golfo Cariaco area	-	thermal springs
	Carupano area (resort)	-	hot springs, solfataras
	Barcelona-Cumana (geothermal project)	-	hot springs
	Las Trincheras	90°-97°	hot springs
	Termales Mérida (resort)	-	thermal springs
	Ureña	-	thermal springs

APPENDIX I

CONVERSION FACTORS

1 cubic meter of oil and pentanes+ (101.325 kilopascals and 15° Celsius)	=	6.29287 barrels (35 imperial gallons)
1 cubic meter of natural gas (101.325 kilopascals and 15° Celsius)	=	35.49373 cubic feet (14.65 psia and 60° Fahrenheit)
1 tonne	=	2,240 pounds 1.12 tons

APPENDIX II

LIST OF ABBREVIATIONS USED

ASTM	American Society for Testing and Materials
API	American Petroleum Institute
B	billion (10^9)
bbl	barrel
BCF	billion cubic feet
b/d	barrels/day
cf	cubic feet
cf/d	cubic feet/day
EUR	estimated ultimate recovery
M	thousand (10^3)
MCF	thousand cubic feet
MM	million (10^6)
MMB	million barrels
T	trillion (10^{12})
TCF	trillion cubic feet

APPENDIX III

GLOSSARY

Crude oil—A mixture of hydrocarbons that is recovered in a liquid phase at atmospheric conditions of pressure and temperature through a wellbore from a naturally occurring underground reservoir. Crude oil may include small amounts of non-hydrocarbons produced with the liquids.

Acceptable ranges for further classification of crude oil by density suggested by a study group of the World Petroleum Congress (Martinez and others, 1984) are as follows:

Heavy, 10-22.3° API gravity (1000-920 kg/m3)
Medium, 22.3-31.1° API gravity (920-870 kg/m3)
Light, greater than 31.1° API gravity (less than 870 kg/m3)

To be added to this are definitions of Meyer and others (1985):

Extra heavy, less than 10° API gravity (greater than 1000 kg/m3) but mobile in the reservoir, hence, producible through a wellbore.

Bitumen, less than 10° API gravity (greater than 100 kg/m3) and immobile in the reservoir.

Estimated Ultimate Recovery (EUR)—An estimate of the total reserves which will ultimately be produced from a field or field complex. The EUR includes cumulative production and remaining established reserves, and may include an estimate of possible future additions through extensions and new pool tests.

Field—An area consisting of a single reservoir or multiple reservoirs all related to the same geologic, structural, or stratigraphic feature.

Field Complex—An area which encompasses two or more fields that are in close proximity which share a common geologic mode of occurrence. Examples are fault-separated fields such as the A. J. Bermuda Complex of Mexico and the pinnacle reefs of Rainbow, Canada.

Gravity, API—A standard adopted by the American Petroleum Institute to express the specific gravity of oil. The lower the specific gravity, the higher the API gravity. API gravity = (141.5/specific gravity at 60° F) 131.5.

Hydrocarbon—Chemical compounds consisting wholly of hydrogen and carbon.

Initial Established Reserves—An estimate of the original total reserves prior to any production which are deemed to be recoverable with current technology and under present economic conditions, proved by drilling, testing, or production plus recoverable reserves interpreted to exist with reasonable certainty.

Remaining Established Reserves—Initial established reserves less cumulative production.

Natural Gas—A mixture of hydrocarbon compounds and small quantities of various non-hydrocarbons that exist in the gaseous phase or in solution with crude oil in natural underground reservoirs and which is gaseous at atmospheric conditions of pressure and temperatures. Natural gas is generally classified into two categories based on the type of occurrence in the reservoir.

Non-associated Gas—Free natural gas not in contact with crude oil in the reservoirs.

Associated Gas—Generally includes both associated and dissolved gas. Associated gas is free natural gas, commonly known as gas cap gas, which overlies and is in contact with crude oil. Dissolved gas is natural gas which is in solution with crude oil at reservoir conditions.

Raw Gas—Natural gas as it is produced from the reservoir that includes varying amounts of the heavier hydrocarbons which liquefy at atmospheric conditions, water vapor, sulphur compounds, such as hydrogen sulfide, and other non-hydrocarbon gases, such as carbon dioxide, nitrogen, or helium.

Marketable Gas—Natural gas which is available to a transmission line after removal of certain hydrocarbons and non-hydrocarbon compounds present in the raw natural gas and which meets specifications for use as a domestic, commercial, or industrial fuel. Marketable natural gas excludes field and plant fuel and losses, excepting those related to downstream reprocessing plants.

Natural Gas Liquids—Those hydrocarbons in the reservoir which are separated from the natural gas as liquids either in the reservoir through the process of retrograde condensation or at the surface through the process of condensation, absorption, or adsorption or other methods in field separators, and gas plants. Generally such liquids consist of propane and heavier hydrocarbons and are commonly referred to as condensate and liquified petroleum gases. Where hydrocarbon components lighter than propane are recovered as liquids these components are also included in the natural gas liquids.

Oil Sand—Sand and other rock material impregnated with crude oil that is classified as bitumen. The gravity is generally in the range of 10° API and less (greater than 1000 kg/m3), immobile in the reservoir, and generally not recoverable by conventional wellbore methods. Often referred to as tar sands.

Oil Shale—Shale that contains an oil-yielding material called kerogen.

Pentanes Plus—A mixture mainly of pentanes and heavier hydrocarbons which ordinarily may contain some butanes and which is obtained from the processing of raw gas, condensate, or crude oil.

Synthetic Oil—A mixture of hydrocarbons, which is derived by upgrading bitumen in oil sands or kerogen in oil shales.

APPENDIX IV

Summarized A.S.T.M. Classification of coals by rank

Class Group	Fixed Carbon* (Percent)		Volatile Matter* (Percent)		Calorific Value* (Btu)	
	Equal or Greater Than	Less Than	Greater Than	Equal or Less Than	Equal or Greater Than	Less Than
Anthracitic	86			14		
Bituminous						
Low volatile bituminous	78	86	14	22		
Medium volatile bituminous	69	78	22	31		
High volatile bituminous		69	31		10,500	14,000
Subbituminous					8,300	11,500
Lignitic					6,300	8,300

* Dry, Mineral - Matter Free Basis (Latour and Chrismas, 1970)

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