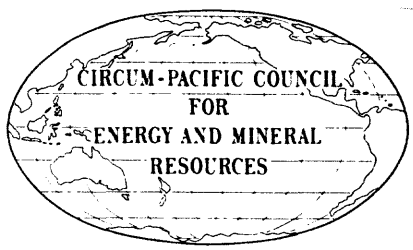
SCOPE AND STATUS OF THE CIRCUM-PACIFIC MAP PROJECT 1988

A programmatic overview including a resume
of project activities during 1986 and 1987

By

Warren O. Addicott and George Gryc
U.S. Geological Survey
Menlo Park, California



U.S. Geological Survey

OPEN-FILE REPORT 88-215

This report is preliminary and has not been reviewed for conformity with Geological Survey editorial standards or stratigraphic nomenclature.

1988

Contents

Figures

Tables

25. East Asia Geotectonic Map progress report.

26. Statement and preliminary proposal for a geologic map of Central America.

27. Agreement by Working Group of Central American Geologists.

28. Proposal for the Geologic Map of Central America.

PREFACE

The Circum-Pacific Map Project is a cooperative international effort to compile and publish new geologic, geophysical, and resources maps of the Pacific Basin and surrounding continental areas. The maps are designed to show the relationship of known energy and mineral resources to the geology, tectonics, and crustal dynamics of the Pacific region. Geologic, geophysical, mineral, and energy data are being compiled at a basic scale of 1:10,000,000 on equal-area map projections. Where feasible, available data are complemented by new, project-developed data sets such as magnetic lineations, earthquake first-motion solutions, lithospheric stress, seafloor mineral deposits, and seafloor sediment. Earth scientists from all of the Pacific-region countries are participating in this work.

Covering more than half of the Earth's surface, the project area extends from the Indian Ocean (lat 90° E) eastward across the Pacific to include most of North and South America (lat 50° W). It also includes the Arctic Ocean and the entire continent of Antarctica.

Five overlapping regional maps at a scale of 1:10,000,000 formed the original cartographic base for the project. The base maps include the four quadrants of the Pacific (Northwest, Southwest, Southeast, and Northeast) and Antarctica (figure 1). A late-1986 decision to include the Arctic as an additional regional map has added a sixth 1:10,000,000-scale regional base map to the project. These maps are complemented by a seventh map of the entire Pacific Basin at a scale of 1:17,000,000.

Currently programmed are eight series of maps of the seven base-map areas to be issued by the Map Project to complete the project's original objectives. Four map series comprising 24 map sheets have already been published: the Geographic, Base, Plate-Tectonic, and Geodynamic Maps. One or more map sheets have been published in the Geologic, Energy-Resources, and Mineral-Resources Map Series (table 1), and an additional thematic map series, the Tectonic, is in preparation. Test compilations are also being made for a Geologic Hazards Map Series, now in the planning stage. Special Pacific Basin maps include the 1:17,000,000-scale Tectonostratigraphic Terrane Map and the Manganese Nodule, Sediment, and Sedimentation-Rate Map published during 1985. A four-panel paleogeographic map of the Pacific Basin is also being compiled. Currently, not including the Geologic Hazards Series, 59 map sheets are projected. Of these, 30 were published and 6 were in proof as of January 1, 1988. The maps are published by the Circum-Pacific Council for Energy and Mineral Resources and are distributed by the American Association of Petroleum Geologists (AAPG), P.O. Box 979, Tulsa, Oklahoma 74101, U.S.A, and the Australia Mineral Foundation, Conyngham St., Glenside, South Australia 5065, Australia.

The framework for the Circum-Pacific Map Project was developed in 1973 by an *ad hoc* group of 12 North American geoscientists. The project was officially started during the First Circum-Pacific Conference on Energy and Mineral Resources, which met in Honolulu, Hawaii, in mid-1974 (Halbouty and others, 1976). Actions taken at the conference, sponsored by the AAPG, the Pacific Science Association (PSA), and the Coordinating Committee for Offshore Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), led to the formation of the Circum-Pacific Council for Energy and Mineral Resources. At the organizational meeting of the Circum-Pacific Council, Michel T. Halbouty was named chairman, and the Map Project, under the chairmanship of John A. Reinemund, was included as a principal activity of the council.

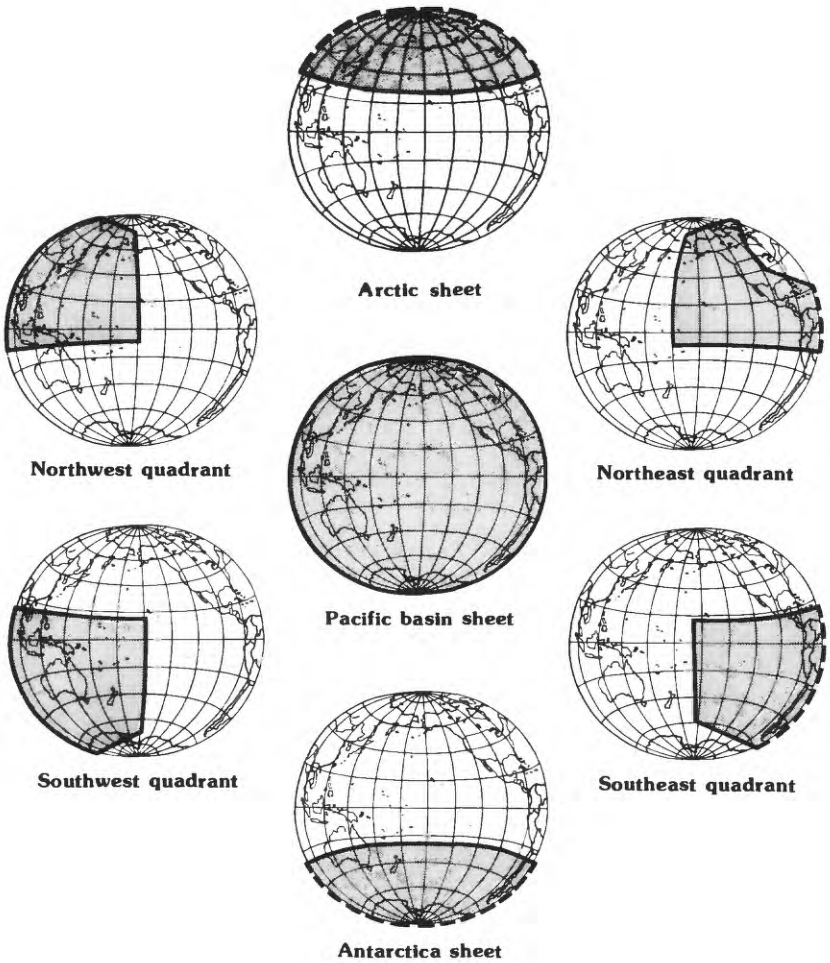


Figure 1. Index maps showing boundaries of the six 1:10,000,000-scale regional map sheets and the 1:17,000,000-scale Pacific Basin sheet.

The Circum-Pacific Council promotes scientific interchanges and resource exploration through its quadrennial conferences, the Circum-Pacific Map Project, educational symposia, scientific training seminars, and publications, including the Earth Science Series. Officers and directors of the Circum-Pacific Council, of which the Circum-Pacific Map Project operates as a principal subactivity, are listed in table 3.

The Circum-Pacific Map Project is currently organized under five panels of geoscientists (table 4) representing national earth-science organizations, universities and natural-resource companies. A sixth panel representing the Arctic region was being formed by General Chairman George Gryc during 1988. The panels correspond to the basic map areas (figure 1). Panel chairmen (figure 2) include Eiji Inoue (Northwest Quadrant), W. David Palfreyman (Southwest Quadrant), Campbell Craddock (Antarctica Region), Jose Corvalan (Southeast Quadrant), and Kenneth J. Drummond (Northeast Quadrant). Drummond succeeded C. A. Burk as chairman of the Northeast Quadrant Panel in 1976; Craddock succeeded F. Alton Wade as chairman of the Antarctica Panel in 1978; H. F. Doutch succeeded Ronald N. Richmond as chairman of the Southwest Quadrant Panel in 1980, and upon his retirement in 1986 was succeeded by Palfreyman; and Inoue succeeded Chikao Nishiwaki as chairman of the Northwest Quadrant Panel in 1986.

The international scope of the Circum-Pacific Map Project is indicated by the broad base of support and involvement by Pacific-region countries. Since its inception, the project has been sustained through appreciable contributions in data, staffing, and services by 50 participating countries and some 200 cooperating organizations (table 5).

Project coordination and final cartography are being carried out through the cooperation of the Office of International Geology of the U.S. Geological Survey under the direction of Map Project General Chairman George Gryc of Menlo Park, California, with the assistance of Warren O. Addicott, Project Advisor, and George W. Moore, Consultant for Marine Geology and Resources. Project headquarters are located at 345 Middlefield Road, MS 952, Menlo Park, California 94025, U.S.A. John A. Reinemund served as General Chairman of the Map Project from 1974 until 1982, when he was appointed Director of the Project. Addicott served as General Chairman from 1982 to 1986. Paul W. Richards was Deputy Chairman of the Project from 1975 until 1979.

An annual meeting of the panel chairmen, project consultants, and representatives from the Circum-Pacific Council for Energy and Mineral Resources (CPCEMR) has been held each year since 1975.

Figure 2. Chairmen of the Circum-Pacific regional quadrant panels, standing, from left to right: Kenneth J. Drummond, Northeast Panel; W. David Palfreyman, Southwest Panel; Eiji Inoue, Northwest Panel; Jose Corvalan, Southeast Panel. Seated from left to right: John A. Reinemund, Map Project Director; Michel T. Halbouty, Chairman and President of the Circum-Pacific Council; George Gryc, General Chairman.

INTRODUCTION AND STATUS OVERVIEW

This report summarizes the status and scope of the Circum-Pacific Map Project as of December 1987. It is based for the most part on discussions and actions taken at the 1986 and 1987 Panel Chairmen's meetings. Resumes of regional panel meetings held during 1986 and 1987 are also included. The status of each thematic map series as of January 1988 and significant developments that have taken place since the previous status report (Addicott, 1985) are summarized.

Thirty maps, including one or more sheets in seven of the nine currently planned map series, had been printed by January 1, 1988 (table 2). Of the 36 map sheets remaining to be published, 6 had reached the color proof stage by the beginning of 1988. Several sheets in the Resources and Tectonic Series were scheduled for submittal to cartography during the first half of 1988.

Principal accomplishments during 1986 and 1987 were the publication of the first sheet in the Energy-Resources Map Series, completion of two proofs of the first sheet in the Tectonic Map Series, and significant progress on the final sheets in the Geologic Map Series, including printing, in late 1987, of the Northwest Map. Proofs of the Energy- and Mineral-Resources Maps of the Southeast Quadrant were also completed. Significant progress in the compilation of the Tectonic and Resources Maps of the other quadrants was realized. In response to continuing demand, the Plate-Tectonic Maps of the Southwest, Northwest, and Northeast Quadrants were revised and reprinted.

As of late 1987 only one thematic map of the Northeast Quadrant, the Tectonic Map, remained to be published. In the 1985 meeting of the Northeast Quadrant Panel in Mexico City, the members adopted a plan for a 1:1,000,000-scale geologic map of Central America as a second-phase activity of the panel. Subsequent meetings held in San Jose, Costa Rica, in 1986 and 1987 set the project in motion and added a geodynamic map to this new second-phase series.

Three of the six thematic maps of the Southeast Quadrant have been published. Two more are in proof—Mineral-Resources and Energy-Resources. Plans for second-phase mapping by the Southeast Quadrant Panel were first considered at a 1985 meeting in Lima. In May 1987 the panel adopted a three-map program in the second phase including (1) paleogeography and facies of the Andes chain, (2) late Cenozoic magmatism and associated mineralization in the central Andes, and (3) nonmetallic minerals. The scale of these maps has not been established.

Three thematic maps of the Northwest Quadrant have been printed. The panel meets yearly with the Committee for Coordination of Joint Prospecting for Mineral Resources in East Asian Offshore Areas (CCOP). In 1983 the Panel elected to join with CCOP and the International Union of Geological Scientists (IUGS) in a program of geologic and resources mapping of Southeast Asia at a scale of 1:2,000,000. Details of the Northwest Panel's participation were worked out at meetings in Singapore and Madang, Papua New Guinea, in 1986, and in Bangkok, Thailand, in 1987.

Three thematic maps of the Southwest Quadrant have been printed and another—the Tectonic Map—is in proof. The panel usually meets with the Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (SOPAC). Plans for second-phase mapping of the boundary between the Pacific and Australia-India plates at a scale of 1:2,000,000 are under consideration.

As of January 1, 1988, two thematic maps of the Antarctic Region had been published and a third, the Geologic Map of the Antarctic Region, was in proof. The Antarctic Region Panel holds informal meetings from time to time in connection with international symposia on Antarctic geology or meetings of the Scientific Committee for Antarctic Research (SCAR).

ACKNOWLEDGEMENTS

This report was prepared in large part from a transcript of tape recordings of the 1986 Panel Chairmen's meeting held in Singapore and from hand-written notes from the 1987 Panel Chairmen's meeting in Honolulu. Summaries of the 1987 Panel Chairmen's meeting made by W. David Palfreyman and Kenneth J. Drummond were also used. The cooperation of members of the Map Committee in providing drafts of revised compilation guidelines and otherwise assisting in the preparation of this report is acknowledged with appreciation.

1986 PANEL CHAIRMEN'S MEETING

Introduction

The 1986 Panel Chairmen's Meeting was held in Singapore on August 14 and 15, 1986, a few days prior to the 4th Circum-Pacific Conference on Energy and Mineral Resources. The 24 participants in the meeting included map consultants, directors of the Circum-Pacific Council, representatives from regional mapping organizations, and headquarters staff (table 6; figure 3).

Map Project Director John A. Reinemund noted the retirement of three project leaders during July and August 1986: Chikao Nishiwaki, the longest serving panel chairman, retired as chairman of the Northwest Quadrant Panel in August 1986; H. F. Doutch retired as chairman of the Southwest Quadrant Panel in July 1986; and W. O. Addicott retired as General Chairman at the end of August 1986. Reinemund expressed appreciation for their contributions and noted the excellent qualifications of their replacements—Eiji Inoue, David Palfreyman, and George Gryc, respectively.

Specific goals for the year cited by Reinemund were to schedule the completion of the remaining map sheets and to incorporate the new leadership into the program. He recommended increased cooperation with newly developing international programs, such as the global sedimentology program initiated by the Society of Economic Paleontologists and Mineralogists (SEPM) and now being conducted as a commission of the IUGS and with the global transects program of the International Committee on the Lithosphere (ICL).

Figure 3. Participants in the 1986 Panel Chairmen's meeting held in Singapore.

Council Chairman Michel T. Halbouty acknowledged the achievements of the Map Committee, noting that when the project got underway "One thing developed after another and in my opinion it is now the most enterprising scientific endeavor in the entire geologic field. The worldwide attention it has attracted has led to a number of scientific societies getting together to test the feasibility of having an Atlantic replica of the Circum-Pacific Map Project." He welcomed George Gryc, incoming General Chairman, to the Map Project, noting his distinguished career in Arctic geology and recommended that the Map Committee add the Arctic as a sixth region to the project.

Reviewing progress during the 1985-86 project year, General Chairman Warren O. Addicott noted the August 1986 publication of the Energy-Resources Map of the Northeast Quadrant—the 30th Circum-Pacific Map sheet to be printed and the initial map in the Energy-Resources Series. Also completed during August was the first proof of the Tectonic Map of the Southwest Quadrant, the pilot map in the Tectonic Series. Two sheets in the Plate-Tectonic Map Series, the Northeast and Southwest Quadrants, were revised and reprinted during the year, and progress was made on the long-planned revised reprinting of the Geographic and Base Maps of Antarctica.

It was noted that the Explanatory Notes for three of the five map regions — Northeast, Southeast, and Antarctica - are being published in both English and Spanish. The Explanatory Notes for the Plate-Tectonic Map Series were translated into Chinese through the kindness of Zheng Jiandong of the State Seismological Bureau of China and published in a Chinese journal (Moore, 1985). Zheng also agreed to translate the Explanatory Notes for the Geodynamic Map Series into Chinese.

Addicott pointed out that map cartography is being contributed to the Map Project by the Office of International Geology of the U.S. Geological Survey. Additional contract cartographic assistance was provided by the Circum-Pacific Council during the year.

Panel Chairmen Reports

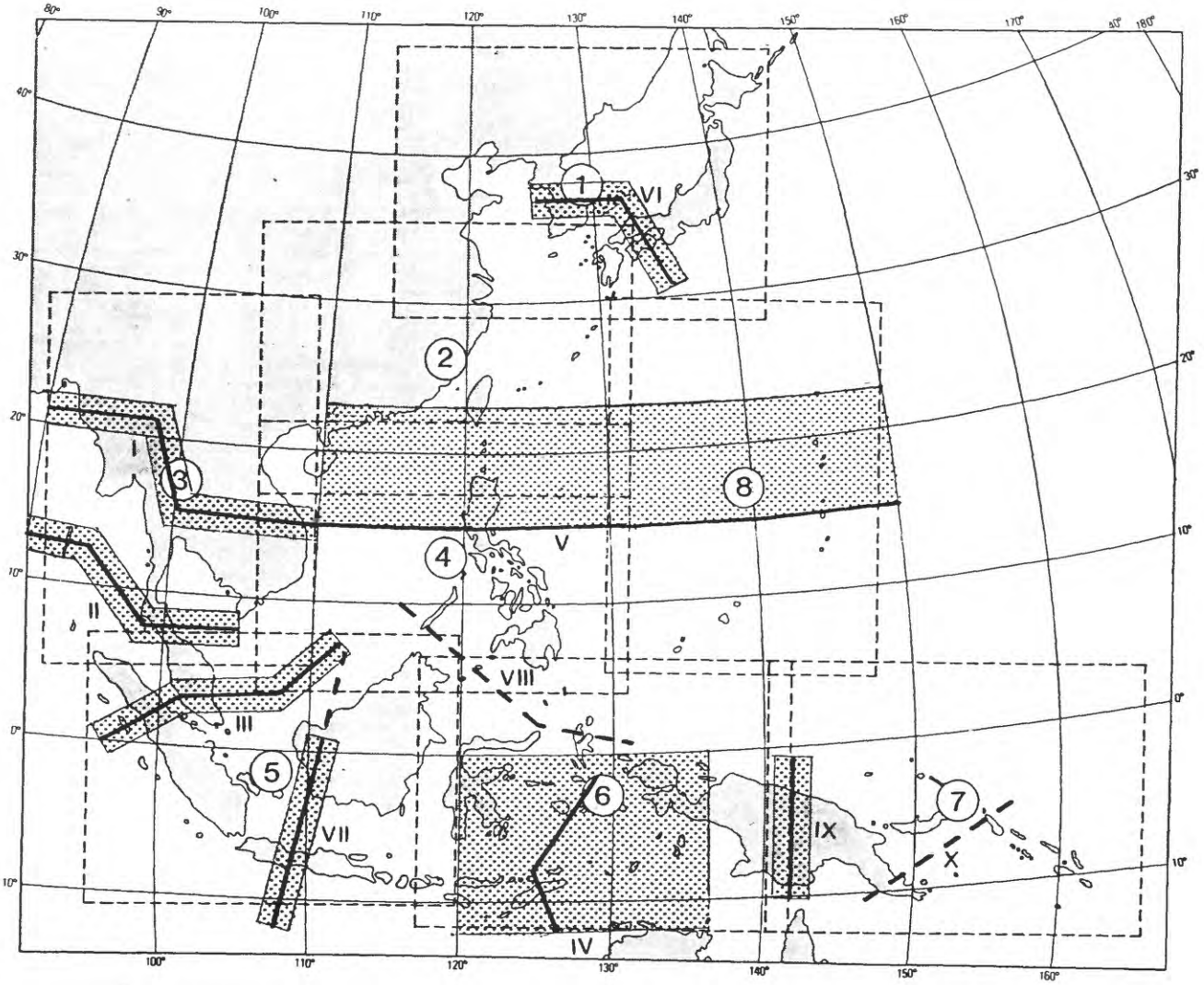
Kenneth J. Drummond, Chairman of the Northeast Quadrant Panel, announced that all but one of then-programmed maps of his quadrant had been published. The Energy-Resources Map of the Northeast Quadrant (Drummond, 1986a) was published a few days before the meeting. The Explanatory Notes were subsequently published in early 1987. At a February 1986 meeting of the panel in San Jose, Costa Rica, a preliminary proposal for a Central American Geologic Map Project was completed and approved by representatives from the participating countries.

Jose Corvalan, Chairman of the Southeast Quadrant Panel, noted that many more people became involved in the panel work during the past three years. Special working groups were set up in Chile, Peru, and Ecuador. The Chilean group includes mainly representatives from the National Geologic and Mining Survey. In Peru the group includes representatives from the Institute of Geology and Mining, the petroleum industry, the Geological Society of Peru, the National Office for Evaluation of Natural Resources, and the mining industry. In Ecuador both the Division of Mines and the Division of Hydrocarbons of the Department of Energy and Mines are involved in this work as are representatives from private petroleum companies and the Central University of Ecuador. A new version of the Tectonic Map of the Southeast Quadrant was presented to the panel at its April 25-29 meeting in Puerto Ayora, Ecuador (table 7; figure 4). Plans for future maps including paleogeography and facies, Cenozoic magmatism and mineralization, and nonmetallic minerals were considered by the panel.

Figure 4. Participants in the 1986 meeting of the Southeast Quadrant Panel held in the Galapagos Islands, Ecuador.

Progress on map compilation by the Southwest Quadrant was reported by incoming Panel Chairman David Palfreyman. Review of the third color proof of the Geologic Map was completed by outgoing Panel Chairman H. F. Doutch. Progress was reported on the Mineral-Resources Map of the Southwest Quadrant.

The Pacific islands part of the map was completed, but about six months of work remained on the Australian continent. The Energy-Resources Map compilation was nearing completion, and Palfreyman estimated that at least another year would be required to finalize the Explanatory Notes manuscript. A proof of the Southwest Tectonic Map, completed prior to the meeting, was subsequently reviewed by the Southwest Panel.



Index of maps (1-8) for the 1:2,000,000-scale series.

SEATAR Transects (I-X) for 1:1,000,000-scale strip maps and sections as exhibited in Bangkok, 11/87 (Transect V at 1:2,000,000 scale).

Lambert Azimuthal Equal-Area Projection
Center point: 120° E, 15°N

Figure 5. Index to the eight 1:2,000,000-scale map sheets for the East Asia Geotectonic Map Project.

Incoming Chairman of the Northwest Quadrant Panel Eiji Inoue reported that former Panel Chairman Chikao Nishiwaki was unable to attend the meeting owing to ill health. Nishiwaki received an award from the Circum-Pacific Council honoring his long and distinguished career as well as his 13 years of leading the Panel. The first draft of the Mineral-Resources Map was completed. It includes information from both China and the USSR, but the Chinese part needed to be revised and updated upon receipt of a newly published 1:4,000,000-scale minerals map of China expected in late 1986. Contributions to the Energy-Resources Map were received from several countries, and the first draft of the map was almost completed. Further work by panel members from the Southeast Asia countries was needed before the map could be completed.

In November 1986 the Northwest Panel met at Madang, Papua New Guinea, (table 8), at which time plans for the Geotectonic Map of Southeast Asia were adopted.

Antarctica Panel Chairman Campbell Craddock was unable to attend the 1986 Panel Chairmen's meeting in Singapore. It was noted that a new proof of the Geologic Map of Antarctica was completed in mid-1986.

Summary of Actions

The Panel Chairmen decided to add the Arctic region to the Project, following Circum-Pacific Council Chairman Halbouty's suggestion. Incoming General Chairman George Gryc supported this plan for a sixth 1:10,000,000-scale regional map and agreed to convene a panel for the region. When implemented there will be at least eight additional map sheets in the Circum-Pacific Series as a result of this action.

Upon the suggestion of John A. Reinemund, the Panel Chairmen approved a trial compilation of a paleogeographic map of the Pacific Basin. The map would include four panels on a standard-size map sheet depicting present-day geology, as well as geology at the Paleogene/Neogene, the Cretaceous/Tertiary, and Jurassic/Cretaceous boundaries. George Moore volunteered to make the trial compilation and develop preliminary guidelines for the map.

Extensive discussion of a June 1985 decision by the Panel Chairmen to compile a Geologic Hazards Map of the Circum-Pacific Region was held. Interest in hazards mapping had already been shown by the Southwest Quadrant Panel. Northwest Panel Chairman Inoue expressed interest in making a trial compilation on the 1:10,000,000-scale base subject to approval by a meeting of his panel later in the year. The other Quadrant Panel Chairmen indicated interest in a Geologic Hazards Map Series, although no formal action was taken.

The Panel Chairmen approved the Northwest Quadrant Panel's plans to participate in the East Asia Map Project (EAMP). The Northwest Panel will compile a geotectonic map in cooperation with other regional geoscience organizations. Maurice J. Terman reported that the U.S. Geological Survey had completed work on the shoreline, bathymetry, and drainage for all of the eight 1:2,000,000-scale base maps for the ERAP project (figure 5). It was noted that the Committee for the Coordination of Joint Prospecting for Mineral Resources in East Asian Offshore Areas (CCOP) would conduct basin analysis studies, in part based on this map, and that the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) would do minerals assessment studies.

Figure 6. Participants in the 1987 Panel Chairmen's meeting.

Reporting on the status of the Central America Geologic Map Project, Northeast Quadrant Panel Chairman Kenneth J. Drummond said that a revised and expanded project proposal had been completed and was being considered by the planning ministries in the Central American countries prior to submission to an international funding agency. The Map Project Panel Chairmen authorized Drummond to continue support of this work through the Northeast Quadrant Panel.

1987 PANEL CHAIRMEN'S MEETING

Introduction

Michel T. Halbouty, President and Chairman of the Circum-Pacific Council, acknowledged the continuing success of the Map Project in his opening remarks at the June 15 and 16, 1987, meeting of the Circum-Pacific Map Project Panel Chairmen held at the East-West Center, University of Hawaii, Honolulu (table 9; figure 6). Halbouty noted that the idea of a map project was conceived in 1972 and that the Circum-Pacific Map Project formally began during 1974.

Project Director John A. Reinemund outlined forthcoming international meetings in which the Map Project would be expected to participate. These included September 1988 meetings of the Panel Chairmen and Circum-Pacific Council Board of Directors in Tsukuba and Tokyo, Japan, respectively; the March 1989 symposium on "middle" American geology, mineral resources, and energy resources to be held in San Jose, Costa Rica; the 28th International Geological Congress to be held in Washington, D.C., in July 1989; and the 5th Circum-Pacific Conference scheduled for Honolulu in August 1990. Reinemund noted that the 1989 symposium in Costa Rica will be an opportunity for the Central American Map Project to exhibit their map compilations, as well as an opportunity for the Map Project to demonstrate methods of compiling regional maps.

Reinemund noted with sadness the death of Chikao Nishiwaki, who served as chairman of the Northwest Quadrant Panel from the start of the Map Project until his retirement in mid-1986.

Map Project General Chairman George Gryc announced that 30 of the 50 maps programmed prior to the meeting had been published and that six more maps were in proof stage. He announced that a second edition of the Plate-Tectonic Map of the Northwest Quadrant had been printed in 1987. In reviewing headquarters activities, Gryc pointed out that four full-time and three part-time employees of the U.S. Geological Survey are assigned to work on the Map Project.

Panel Chairmen Reports

Southeast Quadrant Panel Chairman Jose Corvalan announced that 42 geologists participated in the May 12-14, 1987 meeting of the panel in Santiago, Chile (table 10, figure 7). He reported a deep interest in the Map Project in all of the South American countries and stressed the importance of holding annual meetings of the panel in the various countries. Proofs of both the Energy-Resources and Mineral-Resources Maps of his quadrant were being reviewed and corrected by the panel and the Explanatory Notes for the Energy-Resources Map were nearing completion. The chief compiler of the Energy-Resources Map, Marcelo Yrigoyen, presented a draft of a second sheet with colored cross sections and a 1:10,000,000-scale map of sedimentary basins (figure 8). Compilation of the Tectonic Map of the Southeast Quadrant will require at least another year to finalize. At the Santiago meeting three new maps were formally adopted by the panel. These include a series of paleogeographic and facies maps of the Andean chain, seven in all, at a probable scale of 1:2,000,000; a map of Cenozoic magmatism and related mineralization in the central Andean region (probable publication scale 1:5,000,000); and a nonmetallic minerals map of the Andean region (probable scale 1:10,000,000). The next panel meeting was scheduled to be held in Ecuador during March 1988.

Figure 7. May 1987 meeting of the Southeast Quadrant Panel of the Circum-Pacific Map Project in Santiago, Chile.

A 1:2,000,000-scale geologic map of southernmost South America and the Scotia Arc compiled by Ian Dalziel and presented to the panel in Santiago was favorably received and submitted to the Panel Chairman for study as a possible publication in the Circum-Pacific Map Series. The map and a plan for a 24-chapter text were later forwarded to the Circum-Pacific Council for consideration as part of the Earth Science Series.

Kenneth J. Drummond, Chairman of the Northeast Panel, reported that the Explanatory Notes for the Energy-Resources Map were published in February 1987. Notice of the map had already appeared in the AAPG Explorer in June and further announcements or reviews were expected later in 1987. Compilation of the final thematic map of the Northeast Quadrant, the Tectonic Map, was progressing satisfactorily; reviews from four critics had been received and were being incorporated into the manuscript.

A meeting of the Northeast Panel was held later in San Jose, Costa Rica, from June 30 to July 2, 1987 (table 11).

Northwest Quadrant Panel Chairman Eiji Inoue forecast completion of the final three thematic maps of this quadrant—Tectonic, Mineral-Resources, Energy-Resources—by the end of 1987, although the Energy-Resources Map might take somewhat longer to

finish. He reported that a plan for implementation of the East Asia Resources Assessment Project (ERAP) acceptable to both the Northwest Quadrant Panel and the Committee for Coordination of Joint Prospecting for Mineral Resources in East Asian Offshore Areas (CCOP) had been worked out at the November 1986 meeting in Madang, Papua New Guinea.

David Palfreyman reported that the Southwest Quadrant Panel had authorized publication of the Geologic Map following review of the latest color proof. The Explanatory Notes manuscript was complete except for a references section. The Tectonic Map was expected to be ready for final cartographic changes, following review and correction of the May 1987 second proof by Erwin Scheibner. Although further progress had not been made on the Energy-Resources Map during the year, both it and the Mineral-Resources Map were expected to be ready for cartography by year-end 1987. Preliminary consideration of a geologic hazards map and compilation guidelines had been considered by the panel (table 12). A panel meeting was tentatively planned for late 1987.

Figure 8. Southeast Quadrant Panel member Marcelo Yrigoyen examines manuscript copy of second sheet of regional cross sections accompanying Energy-Resources Map of Southeast Quadrant at 1987 panel meeting in Santiago, Chile.

Campbell Craddock, Chairman of the Antarctica Region Panel, was unable to attend the meeting. In his absence, Gryc noted that the second proof of the Geologic Map, completed in June 1986, was being corrected and revised by the panel. Gryc underscored the need to coordinate other Antarctic maps with the Southwest and Southeast Quadrant Panels. Reinemund announced that Ian Dalziel had been asked to be chief compiler of the Tectonic Map of Antarctica. He observed that the polar parts of both the Antarctic and Arctic maps of the Project will be utilized in the newly initiated Circum-Atlantic Map Project.

Guillermo P. Salas reviewed Mexico's participation in the Northeast Quadrant Panel's work, including a seminal meeting of the Panel in Mexico City during 1985 at which the first full representation of Central American and Mexican panel members was realized and the idea of a Central American Geologic Map was first considered. Salas' extensive contributions to map compilations were acknowledged by Drummond, and he was persuaded not to retire from the panel and Circum-Pacific activities by Council Chairman Michel T. Halbouty.

Summary of Actions

Kenneth J. Drummond volunteered to compile the land geology from the 1:10,000,000-scale maps onto the 1:17,000,000-scale Pacific Basin Geologic Map. (A preliminary compilation of the Southeast and Northeast Quadrant maps onto the Pacific Basin sheet was completed manually by Drummond in September 1987.) A computer printout of colored map units from the five regional Geologic Maps onto the Pacific Basin Sheet will be attempted by Frances Mills.

A sheet of cross sections and sedimentary basin outlines compiled by the Southeast Quadrant Panel to accompany the Energy-Resources Map was approved for publication by the Panel Chairmen. These supplementary data were prepared by chief compiler Marcelo Yrigoyen of Argentina with the cooperation of panel members. The other quadrant panels may attempt to develop comparable second-sheet displays to supplement their Energy-Resources Maps.

David Z. Piper, Map Project advisor for marine minerals, agreed to compile information on cobalt crusts for inclusion on the remaining 1:10,000,000-scale Mineral-Resources Map sheets (Southeast, Southwest, Northwest, Antarctic, and Arctic). The work will be done in cooperation with Frank T. Mannheim of the U.S. Geological Survey. Piper agreed to write the seafloor-minerals section for each of the Explanatory Notes.

Plans for the summary Pacific Basin Mineral-Resources Map were advanced by the offer of Guillermo P. Salas to make a trial compilation of the Mineral-Resources Maps of the Northeast and Southeast Quadrants on the 1:17,000,000-scale base.

A greatly simplified compilation of map units from the 1:10,000,000-scale Tectonic Map of the Southwest Quadrant onto the Pacific Basin sheet, both land and seafloor, completed by Erwin Scheibner, was to be copied and sent to each of the regional panels. This would serve as a compilation guide for preparation of the 1:17,000,000-scale Tectonic Map of the Pacific Basin, the final sheet in the Tectonic Series.

A proposal to produce a map showing oceanographic parameters on the 1:17,000,000-scale Pacific Basin base presented by John A. Reinemund was favorably considered by the Panel Chairmen. Feasibility studies were to be undertaken in cooperation with the National Oceanic and Atmospheric Administration (NOAA). Subsequent meetings between Map Project and NOAA representatives in September and October 1987 resulted in NOAA's agreement to prepare sketch maps to overlay the Northwest Quadrant base for review by the Northwest Quadrant Panel at their scheduled meeting in November 1987 (table 13).

David Palfreyman agreed to make a pilot geologic hazards map of part of the Southwest Quadrant region in cooperation with R. J. Blong, possibly centering initially on Indonesia. The map will be at a scale of 1:10,000,000.

A preliminary compilation and feasibility report on a paleogeographic map of the Pacific Basin by George Moore (table 14) was accepted by the Panel Chairmen. Moore will investigate alternative time slices in addition to the originally proposed 0 Ma, 24 Ma, 66 Ma, and 144 Ma datums. The maps, initially based on a computer model (Denham and Scotese, 1987), were to be distributed to the regional panels in late 1987.

Agreements for completing initial compilations of the thematic maps were as follows: the Northwest Quadrant Panel targeted their Mineral-Resources, Energy-Resources, and Tectonic Map sheets for completion during the first part of 1988; the Southeast Quadrant Panel planned to complete revisions and corrections on their Energy-Resources and Mineral-Resources Maps by the end of 1987 and the initial draft of the Tectonic Map during the first part of 1988; the Southwest Quadrant intended to complete the final two thematic maps, the Energy-Resources and Mineral-Resources Map Sheets, by the end of 1987. The Geologic Map of Antarctica was expected to be completed and printed by mid-1988.

Completion of cartography of the revised Geographic and Base Maps of the Antarctic Region was set for the end of 1987 by cartographer Frank Sidlauskas.

Future Panel Chairmen's meetings were to be held in Tsukuba, Japan, in September 1988, Washington, D.C., in July 1989; Honolulu, Hawaii, in August 1990, and in Australia in 1991. Future panel meetings were to be held as follows: Northeast Quadrant Panel - San Jose, Costa Rica, June 30-July 2, 1987, and Belmopan, Belize, May 1988; Northwest Quadrant Panel - Beijing, China, August 29, 1987, and Bangkok, Thailand, November 1987; Southwest Quadrant Panel - Gold Coast, Australia, August 1987, or SOPAC meeting, Lae, Papua New Guinea, October 1987; and Southeast Quadrant Panel - Ecuador, March 1988.

It was decided that the Map Project will convene a symposium on Circum-Pacific Energy and Mineral Resources at the International Geological Congress to be held in Washington, D.C., in July 1989. Coconveners of the symposium are George W. Moore and Jose Corvalan. Six papers were invited and one was volunteered at the Panel Chairmen's meeting (table 15).

It was decided to accept an offer to exhibit Circum-Pacific Maps by the organizing committee of the 1st Pacific Rim Congress, held on the Gold Coast, Queensland, Australia, in August 1987. An invited paper on the Circum-Pacific Map Project was presented to a plenary session of the Congress (Addicott and Gryc, 1987).

STATUS OF THE THEMATIC MAPS

Geologic Map Series

The Geologic Map of the Northeast Quadrant was published in 1983 (Drummond, 1983; Drummond and others 1983). Publication of the Geologic Map of the Southeast Quadrant followed in 1985 (Corvalan, 1985a; Corvalan and others, 1985). Final color proof of the Southwest and Northwest Quadrant Maps were complete during the last quarter of 1987 with publication targeted for early 1988 (Inoue, 1988; Palfreyman, 1988).

Southwest Quadrant Panel Chairman David Palfreyman informed the June 1987 Map Project meeting that a 1:10,000,000-scale geologic map of Antarctica had been completed by an Australia Bureau of Mineral Resources colleague and was soon to be published (Tingey, 1988). This new map was to be used in updating the geology of Wilkes Land coast of Antarctica that appears on the Southwest Quadrant Map. A preliminary copy of the map was made available to Antarctica Region Panel Chairman Campbell Craddock.

A second color proof of the Geologic Map of the Antarctica Region, completed during June 1986, was corrected and updated by Panel Chairman Campbell Craddock in December 1987. Earlier, Floyd W. McCoy made extensive revisions of seafloor-sediment mapping around the Antarctic continental margin to include new data published subsequent to his initial compilation. Publication of the Antarctic sheet, targeted for mid-1988, will complete the original series of 1:10,000,000-scale Geologic Maps.

Compilation of the newly added Arctic sheet was expected to begin in mid- to late-1988 upon completion of the base map, now in cartographic preparation, and organization of the Arctic Region Panel.

With printed or final proofs of all of the quadrant maps in hand as of late 1987, it was possible to plan the compilation of the 1:17,000,000-scale summary Geologic Map of the Pacific Basin. At the June 1987 Panel Chairmen's meeting, Kenneth J. Drummond offered to compile land geology for the Pacific Basin map. By October 1987, geologic units for the two eastern quadrants had been compiled by Drummond. Cartographer Frances Mills agreed to make a direct transfer of geologic and seafloor sediment units from the 1:10,000,000-scale maps onto the Pacific Basin sheet by computer plotting to aid in compilation. Preliminary computer-assisted plots of the Northwest and Southwest Quadrant Maps on the 1:17,000,000-scale Pacific Basin base were completed during November.

The Explanatory Notes manuscript for the Southwest Quadrant Map was completed, edited, and ready for camera-ready assembly by November 1987. Publication of these Notes was programmed for the first quarter of 1988. The Notes manuscript for the Northwest Quadrant Map was expected to have been completed by early 1988. Most of the chapters for the Explanatory Notes for the Antarctic Region Map were completed as of year-end 1987.

Energy-Resources Map Series

Northeast Quadrant Map

The first sheet in the Energy-Resources Map Series, the Northeast Quadrant (Drummond, 1986a), was printed in August 1986 and was displayed at the 4th Circum-Pacific Conference on Energy and Mineral Resources in Singapore later that month. The map was enthusiastically received by the Map Committee and in particular by Circum-Pacific Council President Michel T. Halbouty, who underscored its unique qualities, pointing out that it and the accompanying text contain a wealth of information and saying that "it has set a standard for the other quadrants to follow".

A Spanish-language translation of the Explanatory Notes for the Northeast Quadrant Map was completed by Gerardo Soto of the Escuela Centroamericana de

Geologia of the University of Costa Rica in late 1986 and the 72-page English-Spanish notes were published during the first quarter of 1987 (Drummond, 1986b).

Southeast Quadrant Map

An initial proof of the Southeast Quadrant Map was completed during the first half of 1986. A second proof including additional information was made in time for review by the Southeast Quadrant Panel at its May 1987 meeting in Santiago. Panel Chairman Jose Corvalan informed the Map Committee that significant new and unpublished information was incorporated on the map, citing an increasing interest and willingness to cooperate on the part of oil companies in South America. The map itself is similar in format to the Northeast Quadrant Map, although the geologic background has been simplified to a greater degree.

In 1986 a comprehensive series of structural-stratigraphic sections through the major sedimentary basins of South America, both productive and prospective, was compiled by Marcelo Yrigoyen onto a proposed second sheet to accompany the map. Also included on this sheet are names and outlines of the principal sedimentary basins of South America. In May 1987 the Southeast Quadrant Panel voted to recommend inclusion of this second sheet with the Southeast Quadrant Map. Both the Map Committee and the Circum-Pacific Council approved publication of this second sheet at their June 1987 meetings. It was further agreed by the Quadrant Panel Chairmen to issue similar second sheets for the other maps in this series, although some reluctance to add another sheet to the series was expressed. Drummond recommended that a second sheet for the Northeast Map not be issued until a second printing of the map was needed. George Moore urged that the price of the two-sheet Energy-Resources Map be kept the same as the other thematic maps.

Northwest Quadrant Map

Eiji Inoue informed the June 1987 Panel Chairmen's meeting that considerable revision of the background geology, sediment isopachs, and oil and gas fields had been made since the original 1984 compilation of the Energy-Resources Map of the Northwest Quadrant. Simplified columnar sections from other panel countries were to be requested. Cross sections through sedimentary basins were also being prepared, and Inoue noted that a sheet containing these sections would be quite useful. According to Inoue, certain problems in the compilation of coal-basin outlines and rank of coal, particularly for the Soviet Union, remained to be solved.

The Northwest Quadrant Panel's target for completion of the map compilation and submittal for cartography was early 1988. Inoue also said that preparation of the Explanatory Notes has progressed with lists of oil and gas field and coal fields having been completed.

Southwest Quadrant Map

Compilation of the Energy-Resources Map of the Southwest Quadrant by the end of 1987 was predicted by Panel Chairman David Palfreyman at the Panel Chairmen's meeting in Honolulu. Although little progress on the compilation was realized during late 1986 and the first part of 1987, the following components had been completed: coal basins, oil and gas fields, sedimentary basins, and sediment isopachs. Work on the Explanatory Notes had not begun, however, and a chief author had yet to be designated.

Antarctic and Arctic Region Maps

Compilation of these maps had not begun as of the end of 1987. It is expected that the Antarctic Map will be issued first; it will follow completion of the Southwest and Southeast Quadrant Maps with which it shares an appreciable overlap area.

Pacific Basin Map

Little progress on the compilation of this map was made during 1986 and 1987. Although several ideas about the map elements were discussed at the annual meeting, the preliminary compilation guidelines prepared by Paul W. Richards, Energy-Resources Map Advisor, and Drummond in 1983 (table 16), were not modified. Considerable interest was shown in the classification of sedimentary basins and depiction of these on the map sheet. Halbouty recommended that Bill St. John be contacted and that his 1981 and 1984 publications be evaluated for possible guidelines.

Mineral-Resources Map Series

Introduction

Publication of the Mineral-Resources Map Series was initiated in late 1984 with printing of the Northeast Quadrant Map. As of late 1987, an additional map was in proof, the Southeast Quadrant Map, and the remaining maps were still being compiled by the regional panels. Two of the maps, the Northwest and Southwest Quadrant sheets, were expected to be ready for cartography about year-end 1987.

At the time of publication of the 1985 Map Project Status Report, there were certain unresolved questions about the mineral-deposit categories used on the pilot map in the Mineral-Resources Map Series (Addicott, 1985; table 17). In late 1985, Mineral-Resources Map Advisor Philip W. Guild responded to criticism of the system of classification by revising the original eight categories and adding three more (table 17).

Northeast Quadrant Map

This map was printed in late 1984 (Drummond, 1984a). The Explanatory Notes for the Northeast Quadrant Map were printed the following year (Guild and others, 1985). The Notes include both English and Spanish texts.

Southeast Quadrant Map

The first proof of the Mineral-Resources Map of the Southeast Quadrant was completed during May 1986. Subsequently, colored photocopies were mailed to panel members for review and revision. Corvalan noted that the geologic background on the Southeast Map differs from the already published Northeast Quadrant Map. Modification of the background was required to develop units that would best show the important differences between the central Andes and the northern and southern Andes. The Central Andean segment from the Gulf of Guayaquil southward to the latitude of the Chile Rise, for example, represents a back-arc environment, according to Corvalan. It is characterized by abundant and varied mineralization, whereas both to the north and to the south mineral deposits are far less abundant and the minerals represent forearc mineralization of the polymetallic type.

For the first time in the Mineral-Resources Series, cobalt crusts will be included in the seafloor-minerals element as sufficient data are now available. Chief compiler David Z. Piper announced at the 1987 Panel Chairmen's meeting that four categories of crusts would be shown: greater than 1.5 percent cobalt, 1 to 1.5 percent cobalt, 0.5 to 1

percent cobalt, and less than 0.5 percent cobalt. Economic interest, according to Piper, lies in deposits with greater than 1.5 percent cobalt.

Corvalan announced that page-size reductions of the Mineral-Resources Map would be made in order to show mineralized areas and metallogenic provinces. These will likely be included in the Explanatory Notes. Corvalan outlined four chapters for the Southeast Quadrant Notes: (1) Introduction; (2) Resources symbology; (3) Land resources, in which each unit in the geologic background will be discussed with regard to the commodities that it hosts; and (4) Seafloor minerals.

Northwest Quadrant Map

At the June 1987 Panel Chairmen's meeting Eiji Inoue declared that 80 percent of the compilation of the Northwest Quadrant Map had been completed and forecast that the map would be ready for cartography by the end of the year. A long-standing problem in obtaining current information on China and other parts of the Asian continent was solved during the year. What remained to be completed were the addition of the age of mineralization notations to deposits on the Asian continent, refinement of the background units in accordance with the final proof of the Geologic Map completed in October 1987, and coordination with the Southwest Quadrant Map in the mutually shared overlap area. Important contributions to the map were received from the Soviet Union through the cooperation of Professor E. A. Radkevich during 1986. The most recent of these was a specially prepared compilation for the area near Lake Baikal received in mid-1986.

The seafloor minerals compilation by David Z. Piper, Vincent E. McKelvey, and Theresa Swint-Iki, completed in 1984, was being updated with new information supplied by the Northwest Quadrant Panel by Piper in late 1987. Data on cobalt crusts prepared by Frank T. Mannheim will be included on this map as well as the two southern quadrant maps.

Southwest Quadrant Map

David Palfreyman, Chairman of the Southwest Quadrant Panel, informed the June 1987 Panel Chairmen's meeting that the Mineral-Resources Map compilation was nearing completion. The Australia continent was about 70 percent completed and the remainder of the map was already finalized. Mineral-deposit data for Australia were to be forwarded to state organizations for checking and approval during the last part of 1987 with reviews to have been completed by year end. Considerable work remained on the geologic background which was to have been completed once the final proof of the Geologic Map was in hand. The map manuscript was expected to be ready for cartography by the end of 1987.

Palfreyman observed that mineral deposits associated with the Precambrian of Australia are especially important and that further subdivisions of units would be necessary to adequately depict the geologic background for the map. It was further noted that large gold deposits found in Queensland and Western Australia during the past three years and other gold deposits discovered in the Southwest Pacific Islands, including two or more in Papua New Guinea, would be added to the map.

Preparation of the Explanatory Notes manuscript was underway during late 1987, and much of the information on mineral deposits were readily available to the panel.

Antarctica Region Map

No further work has been done on the Mineral-Resources Map of the Antarctic Region since the late-1983 compilation of mineral-deposit data by Philip W. Guild and Michael Lee. Compilation of the geologic background for the map presumably will begin during 1988 upon finalization of the Geologic Map from which it will be derived. Panel

Chairman Campbell Craddock previously declared that, in developing the geologic background, he would follow guidelines established by the pilot map in the series, the Northeast Quadrant Map (Addicott, 1985, p. 26).

Arctic Region Map

Plans for this map are to be made after the Arctic Region Panel is convened during 1988.

Seafloor-Minerals Element

During 1985 and 1986, as noted on a preceding page, it became apparent that there were sufficient data on cobalt crusts to now include this information on the Mineral-Resources Maps. Both Frank T. Mannheim and James R. Hein of the U.S. Geological Survey expressed interest in making these data available to the Map Project. Marine Minerals Advisor David Z. Piper received a data file of cobalt crusts from Mannheim during February 1987 that will be included on each of the remaining 1:10,000,000-scale regional maps.

Pacific Basin Map

At the June 1985 Panel Chairmen's meeting in Honolulu, a committee consisting of Chikao Nishiwaki, Guillermo P. Salas, and Philip W. Guild was appointed to advise the Panel Chairmen on compilation for the 1:17,000,000-scale Pacific Basin Mineral-Resources Map. In 1986 Salas completed a trial compilation of Mexico and Central America on the Pacific Basin base. Mineral deposits were shown as belts or areas on a tectonostratigraphic background modified from Howell and others (1985). This map was used as the basis of discussion on the Pacific Basin Minerals Map. During the 1987 Panel Chairmen's meeting, Salas agreed to extend his trial compilation to include all of the Northeast Quadrant.

Also completed during 1986 were a series of recommendations for compilation of the Pacific Basin Map (table 18) and a preliminary map, both by Guild. For his geologic background Guild simply depicted the limit of terranes accreted during the Mesozoic and Cenozoic. He said that more detail could be added if it did not obscure the mineral data. Guild recommended using a combination of mineral-deposit or district perimeters and individual symbols marking major deposits with colors to indicate different mineral families. He stressed the necessity of generalizing information on this map so as not to include excessive detail.

There was general agreement, both at the 1986 and 1987 meetings, that the background for this map should be tectonic and should also reflect the terrane concept.

It was remembered that a series of 1:17,000,000-scale maps showing mineralized belts and generalized tectonic terranes was prepared for the Northeast Quadrant by John Albers in 1983 and 1984 (Addicott, 1985, p. 40-41), but the Panel Chairmen, at their 1985 meeting, decided not to move forward with the maps at that time. A principal objection was that Albers' map was an individual effort and that Circum-Pacific maps should be the product of an international team or working group.

Tectonic Map Series

Southwest Quadrant Map

The first color proof of the Tectonic Map of the Southwest Quadrant was completed in August 1986 and reviewed during the Panel Chairmen's meeting in Singapore later that month. Additions and corrections to the proof were completed by chief compiler Erwin Scheibner and Tadashi Sato, compiler for the Southeast Asian part

of the map, in late 1986. Principal changes were in the coloration of tectonic units so as to more closely agree with conventional colors for geologic ages. It was decided to hold to the Project-developed time scale by Larson and others (1985) and to include a correlation chart of the major time scales currently in use in the Explanatory Notes for comparative purposes.

By June 1987 a second color proof of the map had been completed by cartographer Frances Mills. Final checking of the proof was completed in June 1987 following the Panel Chairmen's meeting in Honolulu. A final proof including revised linework, an updated set of magnetic lineations completed by Kensaku Tamaki in October 1987, and a revised time-space diagram was expected to have been completed during the first half of 1988 with printing to follow presumably late that year.

A manuscript copy of the Explanatory Notes for the Southwest Quadrant, made available to each of the Panel Chairmen at their June 1987 meeting by Scheibner, was expected to serve as a model for the other quadrant and region maps. Guidelines for the Map Series were completed by a committee of M. J. Terman, H. F. Doutch, E. Scheibner, and G. W. Moore (Addicott, 1985, table 19).

Northeast Quadrant Map

An initial draft of the Tectonic Map of the Northeast Quadrant was completed by Panel Chairman Kenneth J. Drummond in April 1987 with the assistance of George W. Moore, who helped to compile onshore Alaska and seafloor tectonic units. The map manuscript which Drummond considered to be 90 percent completed was sent to Gordon Ness, William R. Muehlberger, and panel members James E. Case and Allen J. Lowrie for technical review. Drummond estimated that a final draft of the map would be sent out for further review before the end of 1987 and that the map would be ready for cartography during the first quarter of 1988.

Preparation of the Explanatory Notes for this map was in progress as of late 1987. Drummond said that the target for completing a final draft of the Notes was mid-1988.

During the 1986 Panel Chairmen's meeting, Northwest Quadrant Panel member Kensaku Tamaki suggested that rift propagation, as, for example, along the Galapagos spreading system, be depicted on the Tectonic Map. The features were judged to be difficult to depict on the 1:10,000,000-scale maps by Moore who said that they might be shown by a new line symbol if they were exaggerated. Propagating rifts were not shown on the recently reprinted Plate-Tectonic Map of the Southwest Quadrant (Doutch, 1986), noted Moore. It was agreed that important details not suitable for depiction on the 1:10,000,000-scale base could be shown in the Explanatory Notes.

Southeast Quadrant Map

An initial draft of the Tectonic Map of the Southeast Quadrant was completed by Panel Chairman Jose Corvalan with the assistance of Chilean panel member Constantino Mpodozis during the first quarter of 1987. The map was reviewed by the panel members during the April 1987 panel meeting held in Santiago. Following the meeting colored photocopies of the map were sent to panel members for corrections and additions with a final draft targeted for March 1988 by Corvalan. According to Corvalan, members of the Southeast Quadrant Panel expressed the view that the map should be generalized and that a second sheet with cross sections showing the relationship between oceanic and continental crust would be a useful complement to the map.

Corvalan said that the principal tectonic events of the Andean chain were determined and then used in the compilation of seafloor tectonic units. Although three different segments of the Andean chain are recognized, there are significant tectonic events that can be identified throughout the entire length. The units are 0-2 Ma, 2-3 Ma, 3-6 Ma, 6-23 Ma, 23-29 Ma, and 29-33 Ma. Corvalan said that mapping of the Antarctic Peninsula and adjacent islands had not been received from the Antarctic Panel.

Northwest Quadrant Map

According to Deputy Panel Chairman Tamotsu Nozawa, considerable progress on compilation of the Tectonic Map of the Northwest Quadrant was realized during late 1985 and 1986. Certain problems with land units remained to be solved as of mid-1987, according to Nozawa. Among these were coordination of unit boundaries with the still unpublished Geologic Map of the Northwest Quadrant, differences in some of the tectonic units on compilations received from the Soviet Union, and finalizing the area of overlap with the Southwest Quadrant. Nozawa informed the June 1987 Panel Chairmen's meeting that a final draft of the map would be ready for cartography in early 1988. Work on the Explanatory Notes had not begun as of late 1987.

At the August 1986 Panel Chairmen's meeting, Kensaku Tamaki observed that many magnetic lineations needed to be added to the seafloor part of the Tectonic Map of the Northwest Quadrant, especially in an area east of Japan, the South China Sea, the Philippine area, and the Banda Arc. Age dating along the Hawaii-Emperor Seamount chain could also be added to the map, according to Tamaki. Additions to the seafloor part of the Tectonic Map were completed by Tamaki during October 1987, and his earlier suggestions were incorporated into the 1987 reprinting of the Northwest Plate-Tectonic Map.

Antarctic and Arctic Region Maps

In late-1987 Ian Dalziel agreed to serve as chief compiler of the Tectonic Map of Antarctica.

A schedule for compilation of the Arctic Map was expected to be made during 1988 following appointment of the regional panel.

Pacific Basin Map

During 1986 Erwin Scheibner completed a trial compilation of the Southwest Quadrant part of the 1:17,000,000-scale Tectonic Map of the Pacific Basin. Scheibner's effort was principally directed toward the seafloor tectonic units. He said that the major structural units of land areas of the Quadrant could be colored according to age of deformation and successfully shown at that scale. Intrusive bodies, however, might be too small to be shown on the 1:17,000,000-scale base. James W. Monger suggested that information from the Tectonostratigraphic Terranes Map of the Circum-Pacific Region (Howell and others, 1985) showing times of accretion be superimposed upon the Tectonic Map. He pointed out that such a map would show the evolution of lithospheric plates in a new perspective.

Although it was agreed that work on the 1:17,000,000-scale Pacific Basin Map was still at least a year or more in the future, it was decided that the cartographer should attempt to get a computer printout of the Southwest Quadrant proof onto the 1:17,000,000-scale base from which Scheibner could then make a pilot compilation of land units.

Plate-Tectonic Map Series

The Plate-Tectonic Maps have been the most popular of the Circum-Pacific series to date (table 19). A third printing of the 1:17,000,000-scale Pacific Basin Map was made in late 1985 (Drummond and others, 1985). Third revised printings of the Southwest and Northeast Quadrant Maps were completed during July 1986 (Doutch, 1986; Drummond, 1986c) and a third revised printing of the Northwest Plate-Tectonic Map was made during June 1987 (Nishiwaki, 1987). George W. Moore, principal compiler of the series, and author of the Explanatory Notes (Moore, 1982), reported that minor revisions, especially of the magnetic lineations, were made on all three quadrant maps. Areas of revision on

the Northeast Quadrant Map were mostly along the East Pacific Rise south of Mexico and the Juan de Fuca plate. On the Southwest Map, new magnetic lineations were added in the Indian Ocean between Australia and Antarctica and east of New Zealand. Other revisions to the Southwest Map were made on the Tonga and adjacent plates. A recently discovered piece of the Kula plate along the western part of the Aleutian Trench was published for the first time on the revised Northwest Map. Other revisions to magnetic lineations in the South China Sea were also included on the map. Moore noted that each revised reprinting in the Plate-Tectonic Series has included the location of epicenters of new large earthquakes of magnitude 7.5 or greater, together with the dates and magnitudes of the events.

Geodynamic Map Series

At the June 1987 Panel Chairmen's meeting George W. Moore, chief compiler of the Geodynamic Map Series, brought up the possibility of revising and reprinting the maps when the first printing became exhausted. He noted that three data sets could be significantly updated based on new information: earthquake focal mechanisms, earthquake epicenters, and state of lithospheric stress.

The Geodynamic Maps, printed during a one-year period in 1984 and 1985 (Drummond, 1984b; Corvalan, 1985b; Craddock, 1985; Doutch, 1985; Nishiwaki, 1985) included two new data sets: free-air gravity and earthquake focal mechanisms. They also included, for the first time, available determinations of lithospheric stress compiled by Mary Lou Zoback.

Conventional gravity data were used for land areas and satellite-derived gravity data for sea areas. Moore pointed out that these were the first maps to include total coverage of gravity for sea areas. He noted that the Hawaiian Islands constitute the largest gravity anomaly in the world. He also pointed out that the satellite from which gravity data were obtained functioned for only 70 days and that some of the tracks were spaced as much as 200 km apart. The contouring of gravity anomalies for the Geodynamic Map Series was done by computer by Richard H. Rapp with data generalized to one-degree squares both for sea and for land areas. Certain criticism leveled at the generalization of free-air gravity data for the North American continent was noted and it was pointed out by Moore that the gravity contouring for the continents was generalized in order to make the depiction of anomalies consistent across the entire map area. Further discussion of the gravity data set is presented in the Explanatory Notes for the series (Moore, 1985b).

Geographic and Base Map Series

Antarctica Region

At year-end 1987 work was continuing on revisions of the Geographic and Base Maps of the Antarctica Region. Production of a color proof of the Geographic Map was targeted for early 1988. Revised printings of these maps were recommended by the Panel Chairmen at their 1985 meeting and subsequently agreed to by the Circum-Pacific Council Directors. Progress on map cartography in the Reston, Virginia, cartographic office had been repeatedly delayed by new, higher priority thematic sheets in the Mineral-Resources and Energy-Resources Map Series, as well as cartographic revisions of the popular Plate-Tectonic Map Series during the past two and one-half years.

Arctic Region

Cartographic preparation of the Base and Geographic Maps of the Arctic Region began in 1988. Following adoption of the Arctic as a sixth basic region of the Circum-Pacific Map Project at the 1986 Panel Chairmen's Meeting, it was decided that the map

area should be a mirror image of the Antarctica Sheet with a map centerpoint located at latitude 70° N. so as to give the map a Pacific orientation. A mockup of the map was approved by the Panel Chairmen in June 1987. Map cartography will be completed in the Reston, Virginia, project office, under the direction of Frank Sidlauskas with a shoreline and latitude-longitude net to be compiled promptly for compilation of the thematic maps.

Geologic Hazards Map Series

The Map Committee became interested in a geologic hazards map following the compilation of historic landslides on the 1:17,000,000-scale Pacific Basin base map by Earl E. Brabb (Addicott, 1980, p. 29). A decision to make feasibility studies for such a map was made at the 1984 Panel Chairmen's meeting. As first conceived, the map would be on the Pacific Basin base and both geologic and meteorologic data were to be considered. At the 1985 Panel Chairmen's meeting it was decided to add a hazards map series to the schedule and to proceed, if possible, with a pilot map of at least part of one of the 1:10,000,000-scale regional maps. It was agreed to limit information to geologic hazards.

During the 1986 Panel Chairmen's meeting David Palfreyman discussed the kinds of data to be depicted in the Geologic Hazards Map Series, suggesting that earthquake, landslide, volcanic activity and seismic risk information be included. He noted that the Australia Bureau of Mineral Resources had expressed interest in hazards mapping of the Southwest Pacific (table 12). Jose Corvalan reported that the Southeast Quadrant Panel was interested in compiling a hazards map which would include such information as tsunamis, seismic risk, and volcanic risk. Tamotsu Nozawa noted that the Northwest Quadrant Panel discussed the problem at a mid-1986 meeting, concluding that a scale larger than 1:10,000,000 might be needed to adequately depict geologic hazards in Japan. There was keen interest in such a map, he said, but it was felt that it should not be undertaken until such time as the other thematic maps were completed. Several other ideas were expressed about ways and means of making a geologic hazards map. David Kear questioned whether small-scale maps such as the Circum-Pacific Map Project's could be sucessfully used to portray geologic hazards, because of the need for more detail. He stressed the newness of this field and the need for innovative depiction of information. Maurice J. Terman suggested that submarine geologic data such as slope stability might be included in this map series. George Moore suggested that three principal elements be included on the hazards map: volcanic centers, earthquakes, and landslides. The volcanic centers could be handled as spot data with the other two shown by gradational tones of perhaps blue and red. He noted that spot data for Holocene volcanic centers and seismicity were already available through project headquarters.

Further discussion of this map series during the 1987 Panel Chairmen's meeting brought up questions on the part of Circum-Pacific Council Directors as to whether such a series of maps might dilute the Map Project effort and detract from its principal focus on geology and resources. Upon the suggestion of Council President Michel T. Halbouty, it was decided to undertake a pilot compilation to assess the feasibility of undertaking this effort. Southwest Quadrant Panel Chairman David Palfreyman indicated that he and R. L. Blong of McQuarie University would compile a pilot map of part of the Southwest Quadrant, most likely the eastern part of Indonesia.

STATUS OF OTHER CIRCUM-PACIFIC MAPS

Oceanographic Map of the Pacific Basin

During the 1987 Panel Chairmen's meeting Map Project Director John A. Reinemund proposed that a map, or maps, showing oceanographic parameters be compiled and published by the Map Project in cooperation with the National Oceanographic and Atmospheric Administration (NOAA). Considerable interest was expressed in a map or maps that might relate oceanographic features such as the El Nino current phenomena of the eastern Pacific Ocean to climate. Reinemund offered to convene a group of NOAA and U.S. Geological Survey specialists to investigate the possibility of mapping oceanographic parameters on the 1:17,000,000-scale Pacific Basin base later in the year. It was specified that the work would unduly burden the Map Project, if undertaken alone, and that NOAA should be approached on the basis of their doing the basic compilation.

Subsequently, meetings between the Map Project, NOAA, Circum-Pacific Council, and U.S. Geological Survey representatives were held in Reston, Virginia, in September and October 1987 to explore the feasibility of mapping oceanographic parameters. NOAA participants in the first meeting provided a series of data sets, all available in digital format, that could be included on a hazards map (table 20). It was later decided at an October 7, 1987, joint planning meeting that two experimental compilations on the Northwest Quadrant base would be prepared for display and discussion at the November 1987 meeting of the Northwest Quadrant Panel in Bangkok. One map would depict phenomena such as maximum limit of sea ice, typhoon frequency, average direction of typhoons, tracks of several major typhoons, average tracks of winter low-pressure systems, and maximum tidal ranges. These data would be accompanied by the Holocene volcanic center and earthquake epicenter data already published on the Plate-Tectonic Map of the Northwest Quadrant (Nishiwaki, 1987). The second map would show oceanographic data possibly related to seafloor sedimentation such as mean direction of surface currents and mean surface temperature—possibly with index maps to show seasonal change, seasonal temperature, and salinity gradients in selected areas, and major ocean current systems. The data were to be supplied through N. L. Stubblefield of NOAA and compiled by the Reston, Virginia, cartographic office of the Map Project.

Pacific Basin Paleogeographic Map

At the 1986 Panel Chairmen's meeting John A. Reinemund proposed that a paleogeographic map of the Pacific Basin be considered for inclusion as a special map in the Circum-Pacific Series. George W. Moore volunteered to make a trial compilation utilizing a series of four maps at a scale of 1:34,000,000. The four maps were to portray the Jurassic-Cretaceous boundary (144 Ma), the Cretaceous-Tertiary boundary (66 Ma), the Paleogene-Neogene boundary (24 Ma), and present day (0 Ma). They were to be arranged to fill a standard-size map sheet (approximately 137 by 112 cm).

Moore presented trial maps and a set of suggested compilation guidelines (table 14) to the Panel Chairmen at their June 1987 meeting in Honolulu. Moore used an interactive computer-graphics program developed by Denham and Scotese (1987) to produce the four maps. With this program the plate-tectonic situation of the Earth can be printed out at any instant in time from 600 Ma to the present and with any map center point. Moore suggested that paleotectonic mapping be used for land areas with colors to indicate age of deformation and age of emplacement of igneous rock. Seafloor tectonic units selected to show the evolution of seafloor spreading would be in lighter colored tones. Patterned overprints in black over the land units would be used to show origin such as magmatic arc, submarine fans, ocean floor, or continental. Moore recommended showing plate and terrane boundaries, as in the Plate-Tectonic Map Series, using colors to represent the age of last interplate movement.

Maurice J. Terman questioned the selection of the time slices, suggesting that some other boundaries of greater tectonic significance might be selected. Both Corvalan and Drummond also indicated interest in looking into at least some alternative time breaks for the maps.

On the basis of the trial maps and suggested guidelines prepared by Moore, the Panel Chairmen agreed that a paleogeographic map sheet should be undertaken by the project. Moore agreed to compile seafloor areas of the maps and any other parts that the regional panels requested him to do, recommending that a rough draft be readied for the September 1988 Panel Chairmen's meeting. He also volunteered to supply base maps for the compilation to the panel chairmen during the last half of 1987.

Tsunami Map

By agreement with the National Geophysical Data Center of NOAA, a map showing tsunamis in the Pacific Basin from 1900 to 1983 was compiled and published by NOAA in cooperation with the Circum-Pacific Council for Energy and Mineral Resources in 1984 (Lockridge and Smith, 1984). Although printed on the 1:17,000,000-scale Circum-Pacific base map, the map is not a part of the Circum-Pacific Map Series.

Tectonostratigraphic Terranes Map

A preliminary map showing tectonostratigraphic terranes, prepared through the cooperation of an international team of tectonic specialists, was printed in the Circum-Pacific Series in 1985 (Howell and others, 1985). The map was prepared largely outside of the regional compilation program of the Map Project. It was an outgrowth of one of a continuing series of terrane conferences sponsored by the Circum-Pacific Council for Energy and Mineral Resources (Howell and others, 1984).

Manganese Nodule, Seafloor Sediment, and Sedimentation-Rate Map

Also in 1985, a map showing the distribution of manganese nodules on the Pacific Ocean floor, together with seafloor sediments and sedimentation rates, was printed in the Circum-Pacific Series (Piper and others, 1985). Two map elements were derived from the 1:10,000,000-scale map series: manganese nodule distribution and seafloor sediments. Manganese-nodule distribution was taken from the Mineral-Resources Map Series and seafloor-sediment distribution from the Geologic Map Series. Sedimentation-rate data and mapping were compiled expressly for this map by Theresa Swint-Iki and Piper. The Manganese Nodule Map was brought out in advance of publication of all of the Mineral-Resources Map sheets, because it was possible to compile the seafloor-minerals element far in advance of the more complicated land-minerals element for the series.

REGIONAL MAPS

Introduction

Beginning in 1982, the Map Committee and the Circum-Pacific Council decided to explore the possibility of compiling detailed regional maps at scales of 1:1,000,000 or 1:2,000,000. Interest in supplementing the larger-scale Circum-Pacific thematic maps grew out of a suggestion by Council Chairman Michel T. Halbouty that the Map Project undertake compilation of more detailed geologic and resource maps of developing countries such as those of Southeast Asia. This led to the formation of an East Asia Map Project (EAMP) being organized jointly with the Coordinating Committee for Exploration for Mineral Resources in East Asian Offshore Areas (CCOP), within the framework of the Northwest Quadrant Panel of the Map Project, and including participation of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (Addicott, 1985, p. 42-46). The EAMP is closely coordinated with a sedimentary-basin analysis program conducted by CCOP with the cooperation of the International Union of Geological Sciences (IUGS).

During their 1985 meeting, the other quadrant panels came up with preliminary proposals for more detailed thematic mapping within their regions as a consequence, in part, of the impending completion of basic compilation of the then programmed 1:10,000,000-scale Circum-Pacific Map Series.

East Asia Map Project

After several years of planning and organizational activity the East Asia Map Project was tentatively approved by the Coordinating Committee for Exploration for Mineral Resources in East Asian Offshore Areas (CCOP) at their 1985 annual meeting. In 1986 the geotectonic map compilation part of the program was formally authorized by the Circum-Pacific Council for Energy and Mineral Resources. The programmed map products of the first phase of the East Asia Map Project, are a geographic map series, a geotectonic map, a sedimentary-basin map, a mineral-resources map, and a geologic-hazards map. Each map will consist of eight individual sheets (figure 5). Work on the geotectonic map is planned to function within the general framework of the Circum-Pacific Map Project and its Northwest Quadrant Panel with regard to map review, cartography, and publication.

A series of eight 1:2,000,000-scale base maps is being prepared for the program through the cooperation of the Office of International Geology of the U.S. Geological Survey (figure 5). The geotectonic map is being assembled by a team of compilers representing countries within these map boundaries under the direction of the Northwest Quadrant Panel and general compiler Tadashi Sato (table 21). The sedimentary basin map is being compiled by CCOP with the cooperation of the Association of Southeast Asian Nations Council on Petroleum (ASCOPE), and the mineral resources map is to be compiled by the Mineral Resources Section of the Natural Resources Division of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

The East Asia geotectonic map is expected to provide a framework for resources and hazards studies of Southeast Asia, especially as regards the second phase of a CCOP Resources Assessment Program. A five-year plan for compilation of the East Asia geotectonic map (table 22) was presented to the 1987 Panel Chairmen's meeting by Northwest Quadrant Panel Chairman Eiji Inoue. Compilation is programmed to be completed during 1991 with publication to follow in 1992. The map will be compiled according to guidelines developed for the Tectonic Map of the Circum-Pacific Region, according to Inoue (table 23).

A project-review committee, chaired by Arthur Saldivar-Sali of the Philippines was named by the Circum-Pacific Council to review the plans for the compilation of the various maps of the East Asia Map Project and to report back to the CPCEMR (table 24).

A progress report detailing major developments on the East Asia geotectonic map as of late 1987 prepared by Inoue is included herein (table 25).

Central America Map

At the February 1985 meeting of the Northeast Quadrant Panel in Mexico City, the Central American panel members proposed that a detailed geologic map of Central America be compiled under the aegis of the Circum-Pacific Map Project (table 26). The proposal was formally adopted by the panel and approved by both the Circum-Pacific Map Committee and the Circum-Pacific Council for Energy and Mineral Resources at their 1986 meetings. In 1987 the Central American working group ratified an agreement to proceed with compilation of an initial series of four maps at a publication scale of 1:1,000,000 (table 27). The maps are: Base Map, Geodynamic Map, and Geologic Map. Other thematic maps are expected to be added as the program develops.

Country working groups for Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama have been formed, and a project proposal calling for a five-year program of compilation of the Geologic Map of Central America has been developed (table 28). The project leader is Sergio Paniagua of the University of Costa Rica. Base-map preparation is being carried out under the direction of Fernando Rudin of the Costa Rican Geographic Institute.

At the June 30 to July 2, 1987, working-group meeting in San Jose, Costa Rica, it was decided to include a geodynamic map in the program and to schedule its compilation to be completed well in advance of the geologic map owing to the ready availability of major data sets such as seismicity, volcanism, and lithospheric stress. Preliminary country compilations for the geologic map are expected to be ready for a poster session at the Energy and Mineral Potential of "Middle" America Symposium sponsored by the Circum-Pacific Council, which will be held in San Jose in 1989. Xinia Bolanos of Costa Rica offered to coordinate the compilation of an index map and listing of available geologic mapping in Central America. Further details are included in the meeting summary (table 11).

Southeast Quadrant Maps

After two years of study, the Southeast Quadrant Panel of the Map Project formally adopted plans for three second-phase maps of the Andean region of South America at the May 1987 meeting in Santiago, Chile (table 10, figure 7). The maps will address the following topics: paleogeography and facies, late Cenozoic magmatism and mineralization, and nonmetallic minerals.

The principal activity will be a series of paleogeographic and facies maps. Seven maps are envisioned including two for the Cenozoic, three for the Mesozoic, and two for the Paleozoic. It was decided to form working groups for each country and to then concentrate on maps of the Mesozoic as initial products. Coordination with the Commission for the Geologic Map of the World (CGMW) and International Geological Correlation Programme (IGCP) was recommended by panel members Nelly Pimentel and John Davidson. The final scale of the maps is expected to be 1:2,000,000 or 1:2,500,000.

Also of considerable interest to the panel is the map of late Cenozoic magmatism and associated mineralization. It was noted that the principal area of interest for this

compilation would be the central part of the Andean chain. Jose Corvalan suggested that the initial compilation should be at a scale of 1:1,000,000 with 1:5,000,000 possibly serving as the publication scale.

Finally, it was agreed that a nonmetallic minerals map would be a useful additional second-phase product. An example of an already published map showing some 17 kinds of nonmetallic minerals for a part of the Andean chain was presented by Anibal Gajardo of Chile. It was decided that the final publication scale of this map should be 1:10,000,000. Corvalan suggested that a chief compiler for this would be designated following expected approval of this and the other second-phase maps by the Circum-Pacific Map Committee in mid-1987.

Southwest Quadrant Maps

In 1985 former Panel Chairman H. F. Doutch proposed to a joint meeting of his panel with the Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) held in the Solomon Islands that detailed maps of the boundary between the Pacific and Australia-India plates be compiled. The proposal called for including geologic, geophysical, and resource data on a series of 1:2,000,000-scale maps. Further discussion and action on the proposal, which was favorably received by country representatives at the 1985 meeting, has not been possible as the Southwest Quadrant Panel did not meet in 1986 or 1987. Interest in this work is nevertheless high, according to Panel Chairman David Palfreyman.

MAP SALES REPORT

Map sales during the 12-month period ending June 30, 1986, were especially strong and with few exceptions sales in each map category were lower during the 1986-1987 year (table 19). Reporting to the August 1986 meeting of the Map Commitee, American Association of Petroleum Geologists Marketing Services Manager Douglas White pointed out that membership mailings to the AAPG and to the Geological Society of America (GSA) had doubtlessly influenced the upswing in map sales in 1985 and 1986. He also attributed the increase to AAPG-sponsored exhibits of the maps at the GSA, AAPG, and two American Geophysical Union meetings during the 1985-1986 year (figure 9). White observed that sales activity usually picks up upon completion of the final map in a thematic series and he said that it is most effective to publicize the maps at that point because purchasers are especially interested in obtaining complete sets of maps.

It was noted that Circum-Pacific Maps can now be purchased directly through book agents in Australia, Great Britain, and Canada, in addition to the AAPG Bookstore in the United States. Addresses for these distributors are: Australia Mineral Foundation, Conyngham Street, Glenside, South Australia 5065; Petroconsultants (CES) Ltd., 36 Upper Brook Street, London W1Y 1PE, England; Canadian Society of Petroleum Geologists #505, 206 7th Avenue S.W., Calgary, Alberta T2P 0W7, Canada; and AAPG Bookstore, P.O. Box 979, Tulsa, Oklahoma 74101, U.S.A.

Figure 9. Circum-Pacific Map Project exhibit at Symposium on Andean geology, minerals, and energy resources held in Santiago, Chile, December 1985.

References Cited

Addicott, W. O., 1980, Status of the Circum-Pacific Map Project: U.S. Geological Survey Open-File Report 80-1059, 77 p.

——, 1985, Scope and status of Circum-Pacific Map Project: U.S. Geological Survey Open-File Report 85-267, 120 p.

Addicott, W. O., and Gryc, G., 1987, The Circum-Pacific Map Project: status update 1987: Australia Institute of Mining and Metallurgy, Pacific Rim Congress, Gold Coast, Australia, 1987: Proceedings, p. 503-507.

Anonymous, 1986, Mapping the vast Pacific: Earth Science, Fall 1986, p. 20-21.

Corvalán D., J., 1985a, Geologic Map of the Circum-Pacific Region, Southeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

——, 1985b, Geodynamic Map of the Circum-Pacific Region, Southeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Corvalán D., J., McCoy, F. W., Moore, G. W., Swint-Iki, T. R., and Addicott, W. O., 1985, Explanatory notes for the Geologic Map of the Circum-Pacific Region, Southeast Quadrant: Tulsa, Oklahoma, American Association of Petroleum Geologists, 36 p.

Craddock, C., 1985, Geodynamic Map of the Circum-Pacific Region, Antarctica Sheet: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:10,000,000.

Denham, C. R., and Scotese, C. R., 1987, Terra mobilis: a plate-tectonic program for the Macintosh: Austin, Texas, Geoimages, version 1.1, 3 disks, 26 p.

Doutch, H. F., 1985, Geodynamic Map of the Circum-Pacific Region, Southwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

——, 1986, Plate-Tectonic Map of the Circum-Pacific Region, Southwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Drummond, K. J., 1983, Geologic Map of the Circum-Pacific Region, Northeast Quadrant: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:10,000,000.

——, 1984a, Geodynamic Map of the Circum-Pacific Region, Northeast Quadrant: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:10,000,000.

——, 1984b, Mineral-Resources Map of the Circum-Pacific Region, Northeast Quadrant: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:10,000,000.

——, 1986a, Energy-Resources Map of the Circum-Pacific region, Northeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

——, 1986b, Explanatory Notes for the Energy-Resources Map of the Circum-Pacific Region, Northeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, 72 p. (1987).

Drummond, K. J., 1986c, Plate-Tectonic Map of the Circum-Pacific Region, Northeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Drummond, K. J., McCoy, F. W., Moore, G. W., Swint-Iki, T. R., and Addicott, W. O., 1983, Explanatory notes for the Geologic Map of the Circum-Pacific Region, Northeast Quadrant: Tulsa, Oklahoma, American Association of Petroleum Geologists, 36 p.

Drummond, K. J., Nishiwaki, C., Corvalan D., J., Doutch, H. F., and Craddock C., 1985, Plate-Tectonic Map of the Circum-Pacific region, Pacific Basin sheet: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:17,000,000.

Guild, P. W., Lee, M. P., McKelvey, V. E., Piper, D. Z., Swint-Iki, T. R., and Addicott, W. O., 1985, Explanatory notes for the Mineral-Resources Map of the Circum-Pacific region, Northeast Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Halbouty, M. T., 1970, World's giant oil and gas field, geologic factors affecting their formation and basin classification, *in* Halbouty, M. T., ed., Geology of giant petroleum fields: American Association of Petroleum Geologists Memoir 14, p. 502-555.

Halbouty, M. T., Maher, J. C., and Lian, H. M., eds., 1976, Circum-Pacific energy and mineral resources, papers from the Circum-Pacific Energy and Mineral Resources Conference held August 26-30, 1974, in Honolulu, Hawaii: Tulsa, Oklahoma, American Association of Petroleum Geologists, 608 p.

Hein, J., Morgenson, L. A., Clague, D. A., and Koski, R. A., 1987, Cobalt-rich ferromanganese crusts from the Exclusive Economic Zone of the United States and nodules from the oceanic Pacific, *in* Scholl, D. W., Grantz, A., and Vedder, J. G., eds., Geology and resource potential of the continental margins of western North America and adjacent ocean basins: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Sciences Series, v. 7 (in press).

Howell, D. G., Jones, D. L., Cox, A., and Nur, A., 1984, Proceedings of the Circum-Pacific Terrane Conference: Stanford University Publications in Geological Sciences, v. 28, 248 p.

Howell, D. G., Schermer, E. R., Jones, D. L., Ben-Avraham, Z., and Scheibner, E., 1985, Preliminary tectonostratigraphic terrane map of the Circum-Pacific region: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:17,000,000.

Inoue, E., 1987, Geologic Map of the Circum-Pacific Region, Northwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Larsen, R. L., Golovchenko, X., and Pitman, W. C., III, 1985, Geomagnetic polarity time scale, Drummond, K. J., and others, Plate-Tectonic Map of the Circum-Pacific region, Pacific Basin sheet: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:17,000,000.

Lockridge, P. A., and Smith, R. H., 1984, Tsunamis in the Pacific Basin 1900-1983: Boulder, Colorado, National Geophysical Data Center and World Data Center A for Solid Earth Geophysics, scale 1:17,000,000.

Mannheim, F., 1986, Marine cobalt resources: Science, v. 232, 2 May 1986, p. 600-608.

Moore, G. W., 1982, Explanatory notes for the Plate-Tectonic Map of the Circum-Pacific region: Tulsa, Oklahoma, American Association of Petroleum Geologists, 14 p.

——, 1985a, Explanatory notes for the Plate-Tectonic Map of the Circum-Pacific Region: Chengdu, China, Southwest Geological Sciences, no. 2, p. 10-27 (in Chinese).

——, 1985b, Explanatory notes for the Geodynamic Map of the Circum-Pacific region: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, 12 p.

Nishiwaki, C., 1985, Geodynamic Map of the Circum-Pacific region, Northwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

——, 1987, Plate-Tectonic Map of the Circum-Pacific region, Northwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Palfreyman, W. D., 1988, Geologic Map of the Circum-Pacific region, Southwest Quadrant: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000 (in press).

Piper, D. Z., Swint-Iki, T. R., McCoy, F. W., and Sullivan, L. G., 1985, Manganese Nodule, Seafloor Sediment, and Sedimentation Rates of the Circum-Pacific region: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:17,000,000.

St. John, B., 1981, Sedimentary basins of the world: Tulsa, Oklahoma, American Association of Petroleum Geologists, scale 1:40,000, 24 p.
——, 1984, Sedimentary provinces of the world: Tulsa, Oklahoma, American Association of Petroleum Geologist, map scale 1:40,000, 36 p.
Tingey, Robert, 1988, Schematic geological map of Antarctica: Canberra, Australia Bureau of Mineral Resources, scale 1:10,000,000 (in press).

Table 1. Acronyms used in this report.

AAPG	American Association of Petroleum Geologists
AGID	Association of Geoscientists for Inernational Development
APEA	Australian Petroleum Exploration Association
ARCO	Atlantic Richfield Oil Company
ASCOPE	ASEAN Council on Petroleum
ASEAN	Association of Southeast Asian Nations
BGR	Federal Republic of Germany Bundestalt fur Geowissenschaften und Rohstoffe
BMR	Australia Bureau of Mineral Resources
CCOP	ESCAP Committee for Coordination of Joint Prospecting for Mineral Resources in East Asian Offshore Areas
CCOP/SOPAC	ESCAP Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas
CERESIS	Centro Regional de Seismologia para America del Sur/Regional Center for Seismology of South America
CGMW	IUGS Commission for the Geological Map of the World
COGEODATA	IUGS Committee on Storage, Automatic Processing, and Retrieval of Geological Data
COP/CNEXO	Centre Oceanologique du Pacifique/Center National pour l'Exploration des Oceans
CPCEMR	Circum-Pacific Council for Energy and Mineral Resources
CPMP	Circum-Pacific Map Project
DSDP	Deep Sea Drilling Project
EAMP	East Asia Map Project
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
GAPA	Geological and Geophysical Atlas of the Pacific and Atlantic Oceans
GEBCO	General Bathymetric Chart of the Oceans
GSA	Geological Society of America

GSC	Geological Survey of Canada
GSJ	Geological Survey of Japan
ICL	International Committee on the Lithosphere
IDOE	International Decade of Ocean Exploration
IGC	International Geological Congress
IGCP	International Geological Correlation Program
IHO	International Hydrographic Organization
INETER	Instituto Nicaraguense de Estudios Territoriales
IOC	Intergovernmental Oceanographic Commission
IPA	Indonesian Petroleum Association
IPOD	International Program for Ocean Drilling
IUGS	International Union of Geological Sciences
JAPEX	Japan Petroleum Exploration Company
NASA	U.S. National Aeronautic and Space Administration
NOAA	National Oceanic and Atmospheric Administration
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre Mer
PAIGH	Pan American Institute for Geography and History
PSA	Pacific Science Association
RECOPE	Refinadora Costarricense de Petroleo
SCAR	Scientific Committee for Antarctic Research
SCOR	Scientific Committee on Ocean Research
SEAPEX	Southeast Asia Petroleum Exploration Society
SEATAR	Studies of East Asia Tectonics and Resources (CCOP/IOC)
SEPM	Society of Economic Paleontologists and Mineralogists
SUNY	State University of New York
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNEP	United Nations Environmental Programme

USGS	United States Geological Survey
VSEGEI	U.S.S.R. All-Union Geological Institute
WGGM	Northwest Quadrant Panel, Working Group Geotectonic Map
WGRA	ESCAP Working Group on Resources Assessment

Table 2. Published Circum-Pacific Maps.

1977 - Northeast Geographic Map
Northwest Geographic Map
Northeast Base Map
Northwest Base Map

1978 - Southwest Geographic Map
Southeast Geographic Map
Antarctica Geographic Map
Southwest Base Map
Southeast Base Map
Antarctica Base Map
Pacific Basin Geographic Map
Pacific Basin Base Map

1981 - Northeast Plate-Tectonic Map (revised and reprinted 1982, 1986)
Northwest Plate-Tectonic Map (revised and reprinted 1982, 1987)
Southeast Plate-Tectonic Map (revised and reprinted 1982)
Southwest Plate-Tectonic Map (revised and reprinted 1982, 1986)
Antarctica Plate-Tectonic Map (revised and reprinted 1983)

1982 - Pacific Basin Plate-Tectonic Map (revised and reprinted 1983, 1985)

1983 - Northeast Geologic Map

1984 - Northeast Geodynamic Map
Northeast Mineral-Resources Map

1985 - Southeast Geodynamic Map
Southwest Geodynamic Map
Tectonostratigraphic Terranes Map
Pacific Basin Manganese Nodule/Sediment Map
Northwest Geodynamic Map
Antarctica Geodynamic Map
Pacific Basin Geodynamic Map
Southeast Geologic Map

1986 - Northeast Energy-Resources Map

1988 - Northwest Geologic Map
Southwest Geologic Map
Antarctica Geologic Map

Table 3. Officers and directors of the Circum-Pacific Council for Energy and Mineral Resources.

Officers

Michel T. Halbouty	President and Chairman of the Board of Directors
J. Erick Mack, Jr.	First Vice-President
Timothy C. Lauer	Second Vice-President
Mary Stewart	Secretary
H. Gary Greene	Treasurer
Anthony P. Hatch	Chairman, Public Affairs

Executive Director

John A. Reinemund	United States

Directors

Ismet Akil	Indonesia
Nikita A. Bogdanov	USSR
Raphael Bueno S.	Colombia
Maria Theresa Canas P.	Chile
George Gryc	United States
David Kear	New Zealand
Harold M. Lian	United States
Tamotsu Nozawa	Japan
Roye W. R. Rutland	Australia
Guillermo P. Salas	Mexico
Arthur Saldivar-Sali	Philippines
John H. Silcox	United States
Carlos del Solar	Peru
V. G. Swindon	Australia
Dirk Tempelman-Kluit	Canada
Zhai Guangming	People's Republic of China

Table 4. Members of the Circum-Pacific regional panels and map consultants.

Northwest Quadrant Panel

Chairman: Eiji Inoue	Japan
Vice Chairman: Tamotsu Nozawa	Japan
General Compiler: Tadashi Sato	Japan

Members

Wang Daxiong	China
Dieter Rammlmair	Fed. Rep. Germany
H. M. S. Hartono	Indonesia
M. Untung	Indonesia
Tohap Simanjuntak	Indonesia
Keizo Fujii	Japan
Jiro Hirayama	Japan
Kazuo Hoshino	Japan
Masaharu Kamitani	Japan
Hajime Kurasawa	Japan
Osamu Matsubayashi	Japan
Tomoyuki Moritani	Japan
Hiroo Natori	Japan
Yoshihiko Shimazaki	Japan
Tomoaki Sumii	Japan
Kensaku Tamaki	Japan
Yoji Teraoka	Japan
Koji Wakita	Japan
Lee Won Young	Korea
Kim Dong Hak	Korea
Yin Ee Heng	Malaysia
Khoo Hang Peng	Malaysia
Greg Anderson	Papua New Guinea
Stevie Nion	Papua New Guinea
Guillermo R. Balce	Philippines
Sivavong Changkasiri	Thailand
Saengathit Chuaviroj	Thailand
Tran Van Tri	Viet Nam
Le Van Cu	Viet Nam
Nguyen Khac Vinh	Viet Nam
Maurice J. Terman	USA
Frank F. H. Wang	USA

Former Members

Li Yin-huai	China
Zhang Wen-you	China
Ismet Akil	Indonesia
Djumhani	Indonesia
Raden Hardjono	Indonesia
Fred Hehuwat	Indonesia
Noriyuki Fujii	Japan
Osamu Hirokawa	Japan
Yutaka Ikebe	Japan

Yasufumi Ishiwada	Japan
Hisao Kuwagata	Japan
Chikao Nishiwaki	Japan
Shun-ichi Sano	Japan
Masatochi Sogabe	Japan
Seiya Uyeda	Japan
Masashi Yasui	Japan
Takashi Yoshida	Japan
Chong Su Kim	Rep. of Korea
No Young Park	Rep. of Korea
Sang Ho Um	Rep. of Korea
Dominador H. Almogela	Philippines
Oscar Crispin	Philippines
Juanito C. Fernandez	Philippines
Froilan Gervasio	Philippines
Sangad Bunopas	Thailand
Phisit Dheeradilok	Thailand
Kaset Pitakpaivan	Thailand
S. Kaewbaidhoon	Thailand
Michael Churkin	USA
L. I. Krasny	USSR
Viktor B. Kurnosov	USSR
V. G. Moiseenko	USSR
M. G. Ravich	USSR
N. A. Shilo	USSR
Allen G. Hatley	SEAPEX
Richard W. Murphy	SEAPEX

Southwest Quadrant Panel

Chairman: W. D. Palfreyman	Australia

Members

R. J. Blong	Australia
J. N. Casey	Australia
D. Denham	Australia
N. Exon	Australia
D. Falvey	Australia
W. Johnson	Australia
E. Scheibner	Australia
P. Wellman	Australia
P. Rodda	Fiji
Chief Geologist	New Caledonia
D. Kear	New Zealand
M. B. Reay	New Zealand
I. Speden	New Zealand
Chief Geologist	Papua New Guinea
Chief Geologist	Solomon Islands
Chief Geologist	Tonga
Chief Geologist	Vanuatu

Former Members

Graham Maxwell	APEA
R. N. Richmond	APEA
H. F. Doutch	Australia
David Forman	Australia
Gladys Warren	Australia
A. J. Halunan	Fiji
J. Paris	New Caledonia
J. Recy	New Caledonia
H. Rotschi	New Caledonia
D. I. J. Mallick	New Hebrides
J. V. Eade	New Zealand
H. R. Katz	New Zealand
R. W. Willett	New Zealand
H. L. Davies	Papua New Guinea
K. Doble	Papua New Guinea
S. Danitofea	Solomon Islands
R. B. Thompson	Solomon Islands
Y. Morel	Tahiti
Alexander Macfarlane	Vanuatu

Antarctica Region Panel

Chairman: Campbell Craddock	USA

Members

R. L. Oliver	Australia
Oscar Gonzalez-Ferran	Chile
Janet Thomson	Great Britain
G. W. Grindley	New Zealand
Charles R. Bentley	USA
Ian Dalziel	USA
David H. Elliot	USA
Arthur B. Ford	USA
Dennis E. Hayes	USA
G. E. Grikurov	USSR

Former Members

Raymond J. Adie	Great Britain
William R. MacDonald	USA
James M. Schopf	USA
F. Alton Wade	USA
M. G. Ravich	USSR

Southeast Quadrant Panel

Chairman: Jose Corvalan	Chile

Members

Marcelo R. Yrigoyen	Argentina
Raúl Soliz	Bolivia
John Davidson	Chile
Aníbal Gajardo	Chile
Eduardo González P.	Chile
Alfredo Lahsen A.	Chile
Constantino Mpodozis	Chile
Joaquín Buenaventura	Colombia
Hermann Duque-Caro	Colombia
Fernando Etayo S.	Colombia
Giovani Rosanía	Ecuador
Horacio Rueda	Ecuador
H. G. Barsczus	France
Victor R. Eyzaguirre P.	Peru
Gregorio Flores	Peru
Alfredo Pardo	Peru
Nestor Teves	Peru
George E. Ericksen	USA
Alirio Bellizzia	Venezuela
Emilio Herrero	Venezuela
Nelly Pimentel	Venezuela

Former Members

Vincent Padula	Argentina
Juan Carlos Turner	Argentina
Carlos Salinas E.	Bolivia
Carlos Mordojovic	Chile
Jaime Cruz	Colombia
Hernán Garcés G.	Colombia
Michel Hermelin	Colombia
Rodrigo Alvarado	Ecuador
Gastón Ruales	Ecuador
Eleodoro Bellido	Peru
Alberto Giesecke	Peru
José Lizarraga	Peru
Fernando Zúniga	Peru
J. Erick Mack	USA
José Antonio Galavis	Venezuela
Enrique Lavié	Venezuela
Cecilia Martin	Venezuela

Northeast Quadrant Panel

Chairman: Kenneth J. Drummond	Canada

Members

Prasada Rao	Belize
Kenneth M. Dawson	Canada
Hubert Gabrielse	Canada
Sergio Paniagua	Costa Rica
Fernando Rudín	Costa Rica
Scott Baxter	El Salvador
Julio Salazar	El Salvador
Gabriel Dengo	Guatemala
Oscar Salazar	Guatemala
José Maria Gutierrez	Honduras
G. P. Salas	Mexico
Mauricio Darce	Nicaragua
Glen Hodgson	Nicaragua
Julio Merida	Panama
James E. Case	USA
Allen Lowrie	USA
Ray G. Martin	USA
George W. Moore	USA
Peter R. Vail	USA

Former Members

Geoffrey B. Leech	Canada
Rolando Castillo	Costa Rica
Julio Bran Valencia	El Salvador
Ricardo Burgos	El Salvador
Samuel Bonis	Guatemala
Estuarto Velasquez	Guatemala
Marco Zúniga	Honduras
John Albers	USA
Creighton Burk	USA
George Gryc	USA
Philip Guild	USA
Anton Klaver	USA
Ralph Moberly	USA
David Scholl	USA

Map Coordination Consultants

Xenia Golovchenko	Marine Magnetics
Philip W. Guild	Minerals
Floyd W. McCoy	Marine Sediments
George W. Moore	Marine Geology
David Z. Piper	Marine Minerals
Paul W. Richards	Energy
Arthur C. Tarr	Seismology
Tom Simkin	Volcanology
Richard H. Rapp	Gravity

Jacqueline Mammerickx Winterer	Bathymetry
Mary Lou Zoback	Lithospheric Stress

Map Information Consultants

Allen L. Clark	Frank Mannheim
Richard D. Brown	James Marsh
Thomas E. Chase	Frederick J. Mauk
Robert G. Coleman	Gordon H. Packham
Hugo Cortes G.	Wilbur A. Rinehart
Pow Foong-Fan	Lee Siebert
Paul J. Grim	Stuart Smith
Douglas M. Kinney	David R. Soller
Loren W. Kroenke	Theresa R. Swint-Iki
Michael Lee	Frank F. H. Wang

Special Consultants

Mikhail N. Alekseev (Geological Institute, USSR Academy of Sciences)
P. L. Blong (Australian National University)
David S. Chapman (University of Utah)
Thomas A. Davies (Ocean Drilling Program)
Edward M. Davin (International Decade of Ocean Exploration)
Olivier Dottin (Commission for the Geologic Map of the World)
David G. Howell (U.S. Geological Survey)
Charles J. Johnson (East-West Center, University of Hawaii)
L. D. Kulm (Oregon State University)
Roger L. Larson (University of Rhode Island)
Herbert W. Meyers (National Geophysical Data Center)
William Muehlberger (University of Texas at Austin)
William A. Nierenberg (Scripps Institution of Oceanography)
Dallas L. Peck (U.S. Geological Survey)
Walter C. Pitman III (Lamont-Doherty Geological Observatory)
William Stubblefield (National Oceanographic and Atmospheric Administration)
Maurice J. Terman (U.S. Geological Survey)
Lawrence W. Sullivan (Lamont-Doherty Geological Observatory)
Manik Talwani (Gulf Research and Development Company)
Anthony B. Watts (Lamont-Doherty Geological Observatory)
A. I. Zhamoida (All Union Geological Institute, USSR)

Table 5. Organizations cooperating with or providing information for the Circum-Pacific Map Project.

Governmental Agencies

Argentina Servicio Nacional Minero Geológico
Australia Bureau of Mineral Resources (BMR)
Bangladesh Geological Survey
Belize Ministry of Natural Resources
Bolivia Yacimientos Petroliferos Fiscales
Centre Océanologique du Pacifique/Centre National pour l'Exploration des Oceans (COP/CNEXO), Tahiti
Chile Empresa Nacional del Petróleo
Chile Servicio Nacional de Geologia y Minería
Colombia Instituto Nacional de Investigaciones Geológico Mineras
Cook Islands Department of Survey and Physical Planning
Costa Rica Dirección de Minas e Hidrocarburos
Ecuador Dirección General de Geología y Minería
Ecuador Dirección Nacional de Hidrocarburo
El Salvador Centro de Investigaciones Geotécnicas
El Salvador Comisión Ejecutiva Autonoma del Rio Lempa
Federal Republic of Germany Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR)
Fiji Mineral Resources Department
Geological Survey of Canada
Geological Survey of Great Britain
Geological Survey of Japan
Geological Survey of South Australia
Geological Survey of Tasmania
Geological Survey of Western Australia
Guatemala Instituto Geográfico Nacional
Guatemala Instituto Nacional de Vulcanología, Sismología, Meteorología, e Hidrología
Guatemala Ministerio de Energía y Minas
Honduras Dirección General de Minas e Hidrocarburos
Indonesia Geological Survey
Indonesia Ministry of Mines
Kiribati Ministry of Natural Resources Development
Korea Research Institute for Geosciences and Mineral Resources
Malaysia Federal Geological Survey
Mexico Consejo de Recursos Minerales
New Caledonia Bureau de Recherche Geologique et Minieres
New South Wales Geological Survey, Australia
New Zealand Geological Survey
Nicaragua Instituto de Estudios Territoriales (INETER)
Office de la Recherche Scientifique et Technique d'Outre Mer (ORSTOM) Centre, New Caledonia
Office de la Recherche Scientifique et Technique d'Outre Mer (ORSTOM), Tahiti
Panama Dirección General de Recursos Minerales
Papua New Guinea Geological Survey
Perú Oficina Nacional de Evaluacion de Recursos Naturales
Perú Ministerio de Energía y Minas
Perú Servicio de Geología y Mineria

Philippine Bureau of Mines, Department of Agricultural and Natural Resources
Servicio Geológico de Bolivia
Smithsonian Institution
Solomon Islands Ministry of Natural Resources
Thailand Department of Mineral Resources
Tonga Ministry of Lands, Surveys, and Natural Resources Department
U.S. Board of Geographic Names
U.S. Defense Mapping Agency
U.S. Department of Energy
U.S. Geological Survey (USGS)
U.S. National Aeronautic and Space Administration (NASA)
U.S. National Geophysical Data Center
U.S. National Oceanographic and Atmospheric Administration (NOAA)
U.S. Naval Oceanographic Office
U.S. Naval Ocean Research and Development Activity
USSR Academy of Sciences, Far East Center
Vanuatu Geological Survey
Venezuela Ministerio de Energia y Minas

Institutes

All-Union Geological Institute (VSEGEI), USSR
Apia Observatory, Cook Islands
Centro de Estudios Geológicos de América Central
Centro Regional de Sismología para América del Sur
Earthquake Research Institute, University of Tokyo
Far East Geological Institute, Vladivostok, USSR
Geological Institute, Academia Sinica, China
Geological Institute of Mines and Metallurgy, Peru
Geophysical and Polar Research Center, University of Wisconsin
Hawaii Institute of Oceanography
Hawaii Institute of Geophysics
Institute of Arctic Geology, Ministry of Geology of the USSR
Institute of Geological Sciences, United Kingdom
Institute of International Mineral Resources Development
Institute of the Lithosphere, USSR Academy of Sciences
Institute of Mineralogy and Ore Deposits, Aachen
Institute of Polar Studies, Ohio State University
Institut Francais de recherche pour l'exploitacion de la mer (IFREMER)
Instituto Centroamericana de Investigación y Tecnología Industrial (ICAITI)
Instituto Costarricense de Electricidad (ICE)
Instituto de Geociencía de Panamá
Instituto de Geografico Nacional de Guatemala
Instituto de Investigaciones de Chile
Instituto de Recursos Hidraulicos y Electricos de Panama
Instituto Geográfico de Costa Rica
Instituto Geográfico Nacional de Honduras
Instituto Geológico Minero y Metalurgico del Perú (INGEMNET)
Instituto Panamericano de Geografico e Historia (PAIGH)
Instituto Politecnico Nacional (México)
Korean Institute of Energy and Resources (KIER)
Lamont-Doherty Geological Observatory
National Institute of Geology and Mining, Indonesia
New Zealand Oceanographic Institute
Research Institute of Geology and Mineral Resources, Vietnam

Resource Systems Institute, East-West Center
Far East Center of the USSR Academy of Sciences
Scott Polar Research Institute, Cambridge
Scripps Institution of Oceanography
U.S. Naval Electronics Laboratory
Woods Hole Oceanographic Institute

Universities

Arizona State University
Australian National University
Colorado School of Mines
Columbia University
Cornell University
Escuela Centroamericana de Geología
Escuela Politecnica Nacional, Ecuador
Florida State University
Johns Hopkins University
Imperial College of Science and Technology
Kobe University
Kyoto University
Macquarie University, Australia
Michigan State University
Middlebury College
Ohio State University
Oregon State University
Shimane University
Stanford University
State University of New York (SUNY), Albany
Texas A and M University
Texas Technical University
Tsukuba University
Universidad Central del Ecuador
Universidad de Argentina
Universidad de Chile
Universidad de Costa Rica
Universidad Nacional Autonoma de México
Universidad Nacional de Honduras
Universidad Nacional F. Villareal (Perú)
Universidad Tecnologica de Panamá
Universidad de Panama
Universite de Paris Sud
University of Adelaide, Australia
University of Auckland, New Zealand
University of California, Santa Cruz
University of Capetown, South Africa
University of London
University of Michigan
University of Otago
University of Rhode Island
University of Queensland, Australia
University of Singapore
University of Southern Mississippi
University of Sydney
University of the South Pacific, Kiribati

University of Texas
University of Tokyo
University of Wellington
University of Western Australia
University of Wisconsin

Companies

Atlantic-Richfield Oil Company (ARCO)
Chevron Overseas Petroleum, Inc.
Compania Minería Autlan, S.A.C.V. (México)
Compania Minería Avino (México)
Compania de Minas Buenaventuras, S.A. (Perú)
Empresa Minera del Centro de Peru (CENTROMIN)
Esso Exploration, Inc.
Esso Exploradora y Productora, Argentina, Inc.
Exxon Production Research Co.
Geociencias Aplicadas, S.A.
Gulf Research and Development Company
Japan Petroleum Exploration Company (JAPEX)
Kennecott Exploration Inc.
Marathon Oil Company
Mauricio Hochschild y Cia. (Perú)
Minera Nacional, S.A. (Costa Rica)
Mobil Oil Company, Canada
Occidental Boliviana, Inc.
Occidental Petroleum, Perú
Pertamina
Petroconsultants Ltd.
Petróleos del Perú (PETROPERU)
Petróleos Mexicanos (PEMEX)
Phillips Petroleum Co.
Schlumberger Surenio S.A.
Refinadors Costarricense de Petroleo (RECOPE)
Teledyne Geotech
Union Oil Company of California

Commissions and Societies

American Association of Petroleum Geologists (AAPG)
ASEAN Council on Petroleum (ASCOPE)
Australia Mineral Foundation
Australian Petroleum Exploration Association (APEA)
Canadian Society of Petroleum Geologists
Centro Regional de Sismología para America del Sur (CERESIS)
Circum-Pacific Council for Energy and Mineral Resources
Colegio de Geología de Costa Rica
Commission for the Geological Map of the World (CGMW)
Deep Sea Drilling Project (DSDP)
General Bathymetric Chart of the Oceans (GEBCO), a project of the International Oceanographic Commission (IOC) and the International Hydrographic Organization (IHO)
Geological Society of America
Geological Society of Australia
Geological Society of Japan

Intergovernmental Oceanographic Commission (IOC) Central Editorial Board for Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
International Decade of Ocean Exploration (IDOE)
International Geodynamics Project
International Geological Correlation Programme (IGCP)
International Program for Ocean Drilling (IPOD)
International Union of Geological Sciences (IUGS)
Ocean Drilling Program (ODP)
Pacific Science Association
Scientific Committee on Oceanic Research (SCOR), International Council of Scientific Unions
Southeast Asia Petroleum Exploration Society (SEAPEX) (NW Panel membership)
United Nations Asia and Pacific Branch
United Nations Economic and Social Commission for the Pacific, Natural Resources Division (ESCAP)
United Nations Committee for Coordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP)
United Nations Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC)
United Nations Environmental Program (UNEP)
United Nations Mineral Prospecting Branch
United Nations Ocean Economics and Technology Branch
Volcanological Society of Japan

Summary:

The 214 organizations in this listing are categorized as follows:

Governmental agencies	62
Institutes	40
Universities	51
Companies	28
Commissions and societies	33
Total	214

The 49 countries, including island nations and protectorates, that have contributed to this work in one way or another include:

Argentina
Australia
Bangladesh
Belize
Bolivia
Brazil
Canada
Chile
Colombia
Cook Islands
Costa Rica
Cuba
Ecuador
El Salvador
Federal Republic of Germany
Fiji
France
French Polynesia
Guatemala
Honduras
Indonesia
Japan
Kiribati
Republic of Korea
Malaysia
Mexico
New Caledonia
New Zealand
Nicaragua
Panama
Papua New Guinea
Paraguay
People's Republic of China
Peru
Philippines
Singapore
Solomon Islands
South Africa
Thailand
Tonga
Trust Territory of the Pacific Islands (U.S.)
United Kingdom
Uruguay
USA
USSR
Vanuatu
Venezuela
Vietnam
Western Samoa

Table 6. Participants in the August 14-15, 1986, Panel Chairmen's meeting held in Singapore.

Warren O. Addicott
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

José Corvalán D.
Departamento de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Kenneth J. Drummond
Mobil Oil Company of Canada
P.O. Box 800
Calgary, Alberta
Canada T2P 2J7

Bertram Elishewitz
UNDP/ESCAP Technical Support to CCOP
c/o ESCAP
UN Building
Bangkok, Thailand

H. Gary Greene
U.S. Geological Survey
345 Middlefield Road, MS 999
Menlo Park, CA 94025, U.S.A.

George Gryc
U.S. Geological Survey
345 Middlefield Road, MS 144
Menlo Park, CA 94025, U.S.A.

Michel T. Halbouty
5100 Westheimer Road
Houston, TX 77056, U.S.A.

Eiji Inoue
Geological Survey of Japan
1-1-3 Higashi, Yatabe
Ibaraki 305, Japan

David Kear
34 West End
Ohope, New Zealand

Sermsakdi Kulvanich
CCOP Technical Secretariat
c/o ESCAP
UN Building
Bangkok 2, Thailand

Harold M. Lian
Union Oil Co. of California
Box 7600
Los Angeles, CA 90051, U.S.A.

Frances Mills
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

James W. Monger
Geological Survey of Canada
100 West Pender
Vancouver, B. C.
Canada V6B 1R8

George W. Moore
Department of Geology
Oregon State University
Corvallis, OR 97331, U.S.A.

Tamotsu Nozawa
3-5-7 Tsurumaki, Setagaya
Tokyo 154, Japan

A. Thomas Ovenshine
U.S. Geological Survey
12201 Sunrise Valley Dr., MS 917
Reston, VA 22092, U.S.A.

W. David Palfreyman
Bureau of Mineral Resources
Box 378
Canberra, A.C.T. 2601, Australia

John A. Reinemund
P.O. Box 890
Leesburg, VA 22075, U.S.A.

John Ringis
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

Roye Rutland
Bureau of Mineral Resources
Box 378
Canberra, A.C.T. 2601, Australia

Erwin Scheibner
Geological Survey of N.S.W.
Dept. of Mines and Energy
State Office Block
Phillip Street
Sydney, N.S.W. 2000, Australia

Kensaku Tamaki
Oceanographic Institute
University of Tokyo
1-15-1 Minamidai
Nakano-ku
Tokyo 164, Japan

Maurice J. Terman
U.S. Geological Survey
12201 Sunrise Valley Dr., MS 917
Reston, VA 22092, U.S.A.

Table 7. Summary of the Southeast Quadrant Panel Meeting, April 24-29, 1986.

The Southeast Quadrant Panel of the Circum-Pacific Map Project met in Quito, Ecuador, on April 24, and in Puerto Ayora, Ecuador, from April 25 to April 29, 1986. Principal business was to review and approve proofs or compilations of the final three thematic maps of the Southeast Quadrant Energy-Resources, Mineral-Resources, and Tectonic Maps.

The first color proof of the Energy-Resources Map, completed in time for the meeting, was reviewed and corrected. Panel members agreed to complete further revisions to the proof by the end of May. It was also agreed that information for the Explanatory Notes, generalized stratigraphic columns for major petroleum-producing basins, and revised or newly drawn cross sections would be finalized and sent to the chief compiler, Marcelo Yrigoyen, before the end of June 1986. Panel members decided to have a second sheet to accompany the Energy-Resources Map in which about 24 cross sections drawn through major basins would be included in color. It was agreed that the South American continent part of the Geologic Map of the Southeast Quadrant should be used as the index for the second sheet, the map to be centered on a full-size sheet with the sections flanking it on either side.

Panel Chairman José Corvalán furnished copies of the compilation of the Mineral-Resources Map to panel members for additions and corrections. There was extensive discussion of the reliability of deposit information, especially deposit size. It was agreed to reevaluate the existing information as a result of the discussion. Completion of the final compilation of the Mineral-Resources Map was scheduled for 1986. It was noted that a proof of the seafloor-minerals element of this map was completed during 1984.

Corvalán displayed a progress copy of the Tectonic Map of the Southeast Quadrant. Constantino Mpodozis is collaborating with Corvalán in the compilation of this map. The final compilation is scheduled to be ready for cartography during 1987.

Future plans discussed by the panel include: (1) a series of paleogeographic and facies maps of the Andean region, (2) a map showing late Cenozoic magmatism and mineralization, and (3) a nonmetallic minerals map.

Following the panel meeting, four of the participants gave a series of talks and were participants in a round-table discussion on the Circum-Pacific
Map Project at the School of Geological, Mining, and Petroleum Engineering at the Central University of Ecuador in Quito on April 30.

W. O. Addicott 06-02-86

Participants in the 3rd Meeting of the Southeast Quadrant Panel
of the Circum-Pacific Map Project
April 24-29, 1986, Quito and Puerto Ayora, Ecuador

Warren O. Addicott
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

Alirio Bellizzia
Lagoven SA Edificio Lagoven
Los Chaguaramos
Oficina A-750
Caracas, Venezuela

Rodrigo H. Campana
Dirección Nacional de Hidrocarburo
Santa Prisca no. 215
Quito, Ecuador

Robert W. Canfield
Texaco Petroleum Co.
Apartado 1006
Quito, Ecuador

José Corvalán D.
Departamento de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Hermann Duque-Caro
INGEOMINAS
Diagonal 53, no. 34-53
Bogota, Colombia

Shelby M. Eddington
Gerente General
Esso Exploration Ecuador, S.A.
P.O. Box 160 Suc. 12 de Octubre
Quito, Ecuador

Pedro G. Espin
Texaco Petroleum Co.
P.O. Box 1006
Quito, Ecuador

H. Gary Greene
U.S. Geological Survey
345 Middlefield Road, MS 999
Menlo Park, CA 94025, U.S.A.

Serge Lenoir
Schlumberger Surenco
Apartado 6814
Caracas, Venezuela

Constantino Mpodozis
Servicio Nacional de Geología y Minería
Agustinas 785/6, Piso
Casilla 10465
Santiago, Chile

Nelly Pimentel de Bellizzia
Ministerio de Energía y Minas
Division de Geología Regional
Torre Oeste, Piso 5, Parque Central
Caracas, Venezuela

Miguel E. Padilla Mera
Consorcio CEPE-Texaco
Apartado Postal 1006
Jorge Washington y Amazonas
Quito, Ecuador

Byron Pineiros, Legarda
Dirección Nacional de Hidrocarburos
Santa Prisca no. 215
Quito, Ecuador

Giovanni Rosania
Texaco Petroleum Co.
P.O. Box 1006
Quito, Ecuador

Hugo N. Reinoso
Consorcio CEPE-Texas
Apartado Postal 1006
Quito, Ecuador

Nicholas Roberts
Schlumberger Surenco
Casilla Postal 4797
Paez 768 y Veintimilla
Quito, Ecuador

Raul Solis
Occidental Boliviana Inc.
P.O. Box 593036
Miami, Florida 31539, U.S.A.

Rodrigo Tirado
Universidad Central de Ecuador
Casilla 4535A
Quito, Ecuador

Dick Van Hart
Occidental Exploration and
Petroleum Co.
P.O. Box C-095
Sucursal 15
Quito, Ecuador

Marcelo R. Yrigoyen
Esso Exploration Inc.
Carlos Della Paolera 297-5
1001 Buenos Aires, Argentina

Table 8. Report of the Northwest Quadrant Panel meeting held at Madang, Papua New Guinea, on November 7, 1986 (reprinted from Proceedings of the twenty-third session of CCOP, November 3-13, 1986, p. 78-79).

The Northwest Quadrant Panel reported to the member delegates, Technical Advisors and CCOP Secretariat on the status and future plans of the Map Project on 7 November 1986 in Madang, Papua New Guinea. At the request of the Chairman, Northwest Panel, Dr. Eiji Inoue, Mr. George Gryc, General Chairman, CPMP, conducted the meeting and Mr. H. M. S. Hartono served as rapporteur.

Mr. Gryc introduced the discussion with some general comments about the organization and operation of the CPMP and its relationship to the Circum-Pacific Council and the U.S. Geological Survey (USGS). Printed background material on these subjects was provided to the participants. A more complete history, scope and status of the CPMP is available in USGS Open-File Report 85-267, May 1985.

Of the planned 50 map sheets authorized at 1:10,000,000 and 1:17,000,000 scales, 30 have now been published, five, including Southwest Geologic, Northwest Geologic, Antarctic Geologic, Southeast Energy-Resources and Southwest Tectonic sheets are in colour proof stage, and 15 are being compiled. Colour proof of the Northwest Geologic Sheet was displayed and delivered to the Chairman, Northwest Panel, for review.

Dr. Inoue described and displayed working copies of some of the thematic material being compiled for the Northwest Energy-Resources, Mineral-Resources and Geodynamic map sheets. Each map is and will be accompanied by a complete explanation text. Dr. Inoue reported that the colour proof of the Northwest Geologic Map would be reviewed by March 1987 and the explanation would be prepared the same year.

The last item discussed was the East Asia Geotectonic Map Project, a series of maps at 1:2,000,000-scale which is planned to be undertaken by the Northwest Panel, CPMP. Mr. B. Elishewitz first discussed the relationship of this map series to the East Asia Basin Analysis Project and stressed the need for geologic maps to conduct that analysis. A more complete discussion of this analysis project is provided in CCOP ROPEA 143.

Dr. Inoue presented his concept of how the East Asia Geotectonic Map Project should be organized. It was proposed that the membership of the project be composed of scientists of the Northwest Panel or designees and that the project consist of a General Compiler, National Chief Compilers, Liaison Officer and the Northwest Panel Chairman.

The main task of the General Compiler would be to establish the general guideline of the geotectonic map which should be commonly applied to all sheets, to assist geological adjustment of overlap areas between adjoining sheets, to promote compiling work, and to plan and lead the workshop which would be convened every year throughout the project duration.

The task of the National Chief Compilers of each country would be to prepare the geotectonic map of the country along the general guideline and to organize a national working group.

The General Compiler and the National Chief Compilers would belong to the Regional Working Group, and will exchange scientific and technical information related to map compilation with other members of the RWG.

The Liaison Officer of each country will report the progress of the compilation and will indicate problems arising from compiling work, being in close contact with the national chief compiler. The Liaison Officer will also report the status of the national working group and discuss administrative matters such as schedule, publication, finance and so on at the Northwest Quadrant Panel Meeting.

The Panel Chairman, in close contact with the General Compiler, the CPMP General Chairman, the CPC Directors and the CCOP Director will arrange the schedules

of regional workshop and panel meeting, will regularly report the progress of the compiling work to the Liaison Officers, and will consider finance problem needed for activities and publication of the sheet maps.

The geotectonic maps of eight sheets are expected to be compiled in five years. The method, style and publication of the map series are not clear, at present, but will be discussed further at a planning meeting to be arranged in 1987.

Assured financial support for part of the necessary travel expenses for members to attend workshops and panel meetings and to coordinate the map compiling will be essential.

Relationship to SEATAR was discussed and coordination recommended by the Technical Advisors. The availability of digital data tapes was discussed and is to be investigated further by Mr. Gryc.

List of Participants

Wang Daxiong
Bureau of Foreign Affairs
Ministry of Geology and Mineral Resources
Xishi, Beijing, China

He Qixiang
Institute of Marine Geology
P.O. Box 18
Qingdao, China

Mr. Yang Changshu
Bureau of Marine Geological Survey
Shichau Street
Shanghai, China

H. M. S. Hartono
Marine Geological Institute
Jl. Dr. Junjunan 236
Bandung, Indonesia

J. Widartoyo
Ministry of Mines and Energy
Merdeka Selatan 18
Jakarta, Indonesia

Bona Situmorang
LEMIGAS
P.O. Box 89/JKT
Jakarta, Indonesia

Chairul Bakri
P. T. Tambang Timah (PERSERO)
Jl. Gatot Subroto
Jakarta, Indonesia

Dr. Eiji Inoue
Geological Survey of Japan
1-3 Higashi, Yatabe
Ibaraki 305, Japan

Greg Anderson
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

Hiroaki Tsuburaya
Technical Advisor
Teikoku Oil Company
Tokyo, Japan

Lee Won Young
Marine Exploration Division
Korea Institute of Energy and Resources
219-5 Garibong-dong, Guro-gu
Seoul, Korea

Yin Ee Heng
Geological Survey Malaysia
P.O. Box 11110
Kuala Lumpur, Malaysia

Leong Khee Meng
PETRONAS
P.O. Box 12444
Kuala Lumpur, Malaysia

T. Suntharalingam
Geological Survey Malaysia
P.O. Box 1015
Ipoh, Malaysia

Sukeri Bin Haji Osman
Department of Mines
Jalan Gurney
Kuala Lumpur, Malaysia

W. D. Searson
Department of Minerals and Energy
P.O. Box 352
Port Moresby, Papua New Guinea 1-

Romeo M. Luis
Bureau of Mines and Geosciences
P.O. Box 1595
Manila, Philippines

Robin Moaina
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

Rick Rogerson
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

Benjamin Talai
Geological Survey of Papua New Guinea
P.O. Box 386
Rabaul, Papua New Guinea

Ronald Gawi
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

David Holland
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

Vahu Oru
Geological Survey of Papua New Guinea
P.O. Box 778
Port Moresby, Papua New Guinea

Salvador G. Martin
Philippine Bureau of Mines and Geosciences
Pedro Gil. St.
Manila, Philippines

Mikhail N. Alekseev
Academy of Sciences of the USSR
Geological Institute
Pyzhevsky Per. 7
Moscow, 109107, USSR

Andrey A. Tchistiakov
Institute of Overseas Geology
Dimitrova 7
Moscow, USSR

Clive R. Jones
British Geological Survey
Keyworth, Nottingham
NG 12 5GG, Great Britain

Otis E. Avery
Naval Oceanographic Office
Bay St. Louis, MS 39522-5001, U.S.A.

Leong Cheng Chit
Economic Development Board
1 Maritime Sq., World Trade Center
#10-40, Singapore 0409

Prachuab Phawandon
Department of Mineral Resources
Rama VI Road
Bangkok 10400, Thailand

Akanit Suwanasing
Department of Mineral Resources
Rama VI Road
Bangkok 10400, Thailand

Marie-Anna Lebovits
French Embassy
P.O. Box 1155
Port Moresby, Papua New Guinea

Karl Hinz
Federal Institute of Geosciences and Natural Resources
Stilleweg 2, Postfatch 51-03-53
3000 Hannover 51
Federal Republic of Germany

E. Oele
Geological Survey of the Netherlands
Spaarne 17, Postbus 157
2000 AD Haarlem, Netherlands

Larry Machesky
Natural Resources Division
ESCAP
Bangkok, Thailand

Thelma Kay
Technical Cooperation Division
ESCAP
Bangkok, Thailand

Sermsakdi Kulvanich
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

J. Hirayama
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

George Gryc
U.S. Geological Survey
345 Middlefield Road, MS 144
Menlo Park, CA 94025, U.S.A.

George G. Shor
Scripps Institution of Oceanography
Mail Code A010
La Jolla, CA 92093, U.S.A.

David M. Thorup
UNDP
GPO Box 618
Bangkok, Thailand

Jan Wahlburg
UNDP
P.O. Box 1041
Port Moresby, Papua New Guinea

B. Elishewitz
c/o CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

J. A. M. Ten Cate
c/o CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

Sakda Chantanalertvilai
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

Sumalee Songsujarit
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

Chariya Srisuwan
CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

John Ringis
c/o CCOP Technical Secretariat
110/2 Sathorn Nua Road
Bangkok 10500, Thailand

Peter J. Cook
Vice Chairman (OSNLR)
IOC of UNESCO
Place de Fontenoy
Paris, France

Dennis P. Cox
U.S. Geological Survey
345 Middlefield Road,
Menlo Park, CA 94025, U.S.A.

Table 9. Participants in the 1987 Panel Chairmen's Meeting of the Circum-Pacific Map Project, Honolulu, Hawaii, June 15-17.

Warren O. Addicott
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, California 94025, U.S.A.

José Corvalán D.
Departamento de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Kenneth J. Drummond
Mobil Oil Company of Canada
Box 800
Calgary, Alberta
Canada T2P 2J7

Anne Gartner
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

H. Gary Greene
U.S. Geological Survey
345 Middlefield Road, MS 999
Menlo Park, CA 94025, U.S.A.

George Gryc
U.S. Geological Survey
345 Middlefield Road, MS 144
Menlo Park, CA 94025, U.S.A.

Michel T. Halbouty
5100 Westheimer Road
Houston, TX 77056, U.S.A.

Bruce B. Hanshaw
Secretary General
28th Internatl. Geological Congress
P.O. Box 1001
Herndon, VA 22070, U.S.A.

John A. Reinemund
P.O. Box 890
Leesburg, VA 22075, U.S.A.

Eiji Inoue
Geological Survey of Japan
1-1-3 Higashi, Yatabe
Ibaraki 305, Japan

David Kear
34 West End
Ohope, New Zealand

Timothy C. Lauer
Unocal Indonesia Inc.
Locked Bag Service #3
Orchard Point P.O.
Singapore 9123

Frances Mills
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

George W. Moore
Department of Geology
Oregon State University
Corvallis, OR 97331, U.S.A.

Tamotsu Nozawa
3-5-7 Tsurumaki, Setagaya
Tokyo, 154, Japan

W. David Palfreyman
Bureau of Mineral Resources
Box 378
Canberra, A.C.T. 2601, Australia

David Z. Piper
U.S. Geological Survey
345 Middlefield Road, MS 902
Menlo Park, CA 94025, U.S.A.

F. J. Sidlauskas
U.S. Geological Survey
12201 Sunrise Valley Dr., MS 917
Reston, VA 22092, U.S.A.

Guillermo P. Salas
Paseo de la Reforma no. 295
Desp. 1601 y 1603
Col. Cuauhtemoc Deleg., Cuauhtemoc
06500 Mexico D.F., Mexico

Arthur Saldivar-Sali
Philippine National Oil Co.
P.N.P.C. Complex, Merritt Road
Fort Bonifacio, Makati
Metro Manila, Philippines

Erwin Scheibner
Geological Survey of New South Wales
Department of Mine and Energy
State Office Block
Phillip Street
Sydney, N.S.W. 2000, Australia

John Silcox
Chevron Overseas Petroleum Inc.
P.O. Box 5046
San Ramon, CA 94583, U.S.A.

M. J. Terman
U.S. Geological Survey
12201 Sunrise Valley Dr., MS 917
Reston, Virginia 22092, U.S.A.

Table 10. Notes from the 4th meeting of the Southeast Quadrant Panel, Santiago, Chile, May 12-14, 1987

The Southeast Quadrant Panel of the Circum-Pacific Map Project met at the University of Chile May 12-14, 1987, in Santiago. Principal agenda items were consideration of the three remaining thematic maps—Energy-Resources, Mineral-Resources, and Tectonic Maps—and the adoption of plans for new and more detailed maps of the Andean Chain. Forty-one participants from seven countries participated in the three-day meeting held at the Department of Geology and Geophysics of the University of Chile (see attachment).

Panel members from Argentina, Chile, Colombia, Ecuador, Peru, and Venezuela reviewed the status of geologic mapping in their countries, noting significant recently published maps. Raúl Solis, panel member from Bolivia, was unable to attend the meeting. Maria Teresa Canas, Director of the Servicio Nacional de Geología y Minería of Chile, welcomed the panel members, outlining the work of her organization. John Reinemund, Executive Director of the Circum-Pacific Council, outlined council activities, noting that preparation of proceedings volumes, in Spanish and English, from the Andean Symposium held in Santiago in late 1985 was nearly completed. General Chairman George Gryc reviewed the status of the Circum-Pacific Map Project, including cartographic preparation of the Energy-Resources and Mineral-Resources Maps of the Southeast Quadrant. Warren Addicott, Project Advisor, noted a recent summary of the Map Project published in EARTH SCIENCE (Anonymous, 1986), and invited panel members to have it translated and published in geological newsletters in their countries.

Panel Chairman José Corvalán reviewed the 1:10,000,000-scale Geologic Map of the Southeast Quadrant, noting that some corrections as well as new geologic mapping would be incorporated in the map when a new printing is made, possibly in 1989. Corvalán advised that it would be possible to incorporate additions in the 1:17,000,000-scale Geologic Map of the Pacific Basin, also targeted for publication in 1989.

Chief compiler of the Energy-Resources Map of the Southeast Quadrant, Marcelo Yrigoyen, presented the second color proof, noting that colored photocopies had been sent to panel members for study and correction prior to the meeting. Yrigoyen presented a full-size second sheet on which 29 colored cross sections through Andean and sub-Andean basins were displayed. Color coded as to marginal forearc, intra-arc, back-arc, and intracratonic basins, the sections were drawn to a common scale and keyed to a centrally located 1:10,000,000-scale basin index map. The panel supported the inclusion of the colored sections as a second sheet to accompany the Energy-Resources Map, and Panel Chairman José Corvalán was requested to present the proposal to the Panel Chairmen's meeting in June. Copies of the cross sections were given to panel members for review and a schedule for return of information to Yrigoyen by the end of June was adopted. Specific information needed for the Explanatory Notes was requested from panel members by Yrigoyen (see attached summary). The Explanatory Notes will follow the format developed by K. J. Drummond for the Northeast Quadrant Map.

Reinemund expressed interest in a study of sub-Andean basins by the World Bank and suggested the possibility of the Southeast Quadrant Panel cooperating in this study through preparation of paleogeographic, facies, sediment thickness, and structural maps.

Corvalan reviewed progress on the Mineral-Resources Map since the April 1986 Panel Meeting in Ecuador. The map was turned in for cartography of the color proof which had not been completed but was expected to be ready before the end of May. It was noted that a simplified geologic background was developed from the Geologic Map so as to show geologic development of the three principal parts of the Andean chain. Mineral deposits necessarily had to be simplified because of the map scale. It was agreed that headquarters would express-mail colored photocopies of the proof to each panel

member as soon as the proof is completed. These will then be submitted to Corvalan for finalizing the map. For the Explanatory Notes, Corvalan asked each panel member to describe mineral deposits in their countries and submit the information to him for final assembly. Because of space considerations, information on the age of mineralization will be included in the Explanatory Notes and not on the map itself. Considerable interest was expressed in depicting mineral belts and it was decided to include these by regions or by countries in the Explanatory Notes.

A progress compilation of the Tectonic Map showing land and ocean floor units was displayed by Corvalán. Colored photocopies of the compilation were made and distributed to panel members for review and revision. A proof of the Tectonic Map of the Southwest Quadrant was displayed and formed the basis for discussion. Corvalán advised the panel that the Southeast Map would likely differ somewhat from the Southwest Tectonic Map in the kinds and numbers of tectonic units on land, although seafloor units would be essentially similar. It was agreed that copies of the explanation of the Southwest Quadrant map would be sent to each panel member for reference. A target of a fully revised map compilation for the next panel meeting was adopted.

Principal interest in second-phase mapping by the Southeast Panel was focused on a series of paleogeographic and facies maps, probably at a final scale of 1:2,000,000 or 1:2,500,000. Corvalán initially suggested a series of seven maps: two of the Cenozoic, three of the Mesozoic, and two of the Paleozoic. Coordination with the Commission for the Geological Map of the World (CGMW) was suggested by John Davidson of Chile and headquarters agreed to contact CGMW for further information. A series of International Geological Correlation Projects dealing with South American geology could be particularly helpful in compiling the suggested maps, according to Nelly Pimentel of Venezuela. It was finally decided to form working groups for each country and to then concentrate on maps of the Mesozoic as initial products.

Discussion of a map of Cenozoic magmatism and related mineralization first proposed at the 1985 meeting of the panel in Lima resulted in the formal adoption of this map at the Santiago meeting. Corvalán suggested that a scale of 1:1,000,000 would probably best serve for the basic compilation. And a scale of 1:5,000,000 was suggested by Carlos Ruiz of Chile as the publication scale. It was noted that the principal area of interest for this map would be the central Andean region.

Considerable interest was also expressed in a nonmetallic minerals map. It was felt that such a map would be particularly useful for the Andean region countries. An example of an already published map showing some 17 kinds of nonmetallic minerals for part of the Andean chain was presented by Anibal Gajardo of Chile. A publication scale of 1:10,000,000 was suggested for this map. Corvalán said that someone would be appointed to oversee compilation of this map and that he would present the idea for this map to the Panel Chairmen's and Council Directors' meetings in June for approval.

An invitation to hold the next meeting of the Panel in Lago Agrio on the Galapagos Islands, Ecuador, by Giovani Rosania was accepted and approved by the panel. The meeting was scheduled for late March 1988.

Panel members were invited to visit the new offices and facilities of the Servicio Nacional de Geología y Minería and were briefed on current projects of that office.

W. O. Addicott: 5-18-87

List of Participants

Eduardo Abad Escobar
Depto. Geociencias
Universidad de Concepción
Casilla 3-C
Concepción, Chile

Warren Addicott
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, California 94025, U.S.A.

Adela Aguilar
Minera Utah de Chile
Isidora Goyenechea 2925
Santiago, Chile

Alirio Bellizzia
M.E.M. Consejo Consultivo de Directores
Servicios Geológicos de Latinoamerica
M.E.M. Parque Central
Torre Oeste, Piso 5°
Caracas, Venezuela

Maria T. Canas P.
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

Hugo Conn
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

José Corvalán D.
Depto. de Geología y Geofisíca
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Vladimir Covacevic
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

John Davidson
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

Hermann Duque-Caro
INGEOMINAS
Diagonal 53, #34-53
Bogota, Colombia

Francisco Franquesa R.
Depto. de Geología y Geoofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

José Frutos J.
Depto. de Geociencias
Universidad de Concepción
Casilla 3-C
Concepción, Chile

Anibal Gajardo C.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Oscar Gonzalez F.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Irma Gonzalez M.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

George Gryc
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

Fernando Henriquez B.
Depto. Ing. Minas
Universidad de Santiago
Casilla 10233
Santiago, Chile

Francisco Herve A.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Hans Langerfeldt
Minera Ango América de Chile Ltda.
Clasificador 31, Correo 9
Santiago, Chile

Emilio Lorca
Instituto Hidrográfico de la Armada
Casilla 324
Valparaiso, Chile

Mario Marino
Empresa Nacional del Petróleo (ENAP)
Casilla 3556
Santiago, Chile

Ruben Martinez P.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Darling Montoya
Empresa Minera del Centro del Perú S.A.
Av. J. Prado Este 1980, 2° Piso
San Borja
Lima, Perú

Esteban Morales
Facultad de Ciencias
Universidad Católica de Valparaiso
Valparaiso, Chile

Carlos Mordojovich
Hernando de Aguirre 751
Santiago, Chile

Miguel Parada R.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Federico Peebles L.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Nelly Pimentel de Bellizzia
M.E.M. Division de Geología Regional
Torre Oeste, Piso 5, Parque Central
Caracas, Venezuela

John A. Reinemund
P.O. Box 890
Leesburg, VA 22075, U.S.A.

Carlos Roeschman
Depto. de Geociencias
Universidad de Concepción
Casilla 3-C
Concepción, Chile

Giovani Rosania S.
Texaco Petroleum Co.
P.O. Box 1006
Quito, Ecuador

Lidia Rosas T.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Carlos Ruiz F.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Jorge Skarmeta M.
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

Manuel Suarez D.
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

Irene Tapia A.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Carlos Ulriksen G.
Servicio Nacional de Geología y Minería
Av. Santa Maria 0104
Santiago, Chile

Soledad Valdivia
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Edward Valenzuela A.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Mario Vergara M.
Depto. de Geología y Geofísica
Universidad de Chile
Casilla 13518, Correo 21
Santiago, Chile

Marcelo Yrigoyen
c/o Exxon Co. International
Zavalia 2048, 5° Piso
1428 Buenos Aires, Argentina

Table 11. Notes from the joint Central American Geologic Map working group and Northeast Quadrant Panel meeting held in San Jose, Costa Rica, June 30 to July 2, 1987.

The 1987 Northeast Panel meeting, held in conjunction with the working group for the Central American Geologic Map Project, in San Jose, Costa Rica, was attended by 23 project participants representing Belize, Canada, Costa Rica, Guatemala, Honduras, El Salvador, Mexico, Nicaragua, Panama, and the United States.

This meeting was facilitated by Sergio Paniagua, Director of the School of Geology of the University of Costa Rica. Paniagua succeeded Rolando Castillo as Director and as coordinator of the Central American Geologic Map project in April 1987.

John A. Reinemund reported on the activities of the Circum-Pacific Council and outlined plans for a symposium on "Energy and Mineral Potential of Middle America", planned for March 1989 in San Jose.

Warren O. Addicott reviewed the status of the Map Project. He noted that the Explanatory Notes for the Northeast and Southeast Quadrants and the Antarctica region are being published in English and Spanish. Addicott observed that the Northeast Panel is the leader in map production with 7 maps published, including Geographic (1977), Base (1977), Plate-Tectonic (1981), Geologic (1983), Geodynamic (1984), Mineral-Resources (1984), and Energy-Resources (1986).

Panel Chairman Kenneth J. Drummond presented the Energy-Resources Map, published in August 1986, and the Explanatory Notes, printed in August 1987. He urged panel members to review the map and send in any additions or corrections.

Guillermo P. Salas reviewed his plans to make a pilot map of the mineral resources of Central America and Mexico for the 1:17,000,000-scale Pacific Basin Mineral-Resources Map. Salas will use a generalized background of tectonostratigraphic terranes. Gabriel Dengo noted that some work done by ICAITI and information to be published in the Decade of North American Geology volume on Central America might be useful.

Drummond reviewed the draft of the Tectonic Map for the Northeast Quadrant, then about 80 percent complete, and plans for a final draft by mid-1988. A preliminary copy of the Explanatory Notes was distributed. A major emphasis of the Tectonic Map is to show the contrasting oceanic and continental crustal domains. Tectonic development of the oceanic crust is shown by episodes of seafloor spreading selected to show major changes in plate kinematics. In the continental region, colored areas show the ages of deformation and metamorphism of basement rocks, emplacement of igneous rocks, and age of volcanic intrusion.

Bruno Baldis of Argentina reviewed the activities of the International Geological Correlation Programme of the International Union of Geological Sciences in the Latin American countries.

Gabriel Dengo reviewed the planning for the Geologic Map of Central America and objectives for the meeting. A summary of the 1985 proposal for the compilation of geologic information for Central America is included as table 26. The status of geologic, tectonic, and resources mapping in each of the Central American countries was reviewed by panel members.

Prasada Rao reviewed the series of 1:250,000-scale thematic maps of Belize, including geology, soils, seismic, tectonic, paleogeographic, geochemical, and oil and gas prospects.

Scott Baxter informed the meeting that there is complete topographic coverage of El Salvador at scales of 1:50,000, 1:100,000, 1:300,000, and 1:500,000. There are published geologic maps at scales of 1:100,000 (1978) and 1:500,000 (1974). There is also a 1:400,000-scale gravity map and various geophysical maps of offshore areas. Also noted were a stratigraphic lexicon and a bibliography of geology compiled in 1984 and 1985 respectively.

Jose M. Gutierrez pointed out that Honduras was completely covered by topographic maps at a scale of 1:50,000 that had been completed by his agency and various universities in the United States. There is also a 1974 geologic map of the country at 1:500,000. Currently a metallogenic map is being made in cooperation with the Bureau of Geological Research of France, and there is a 1:250,000 tectonic map of Honduras including satellite data.

In Panama Julio Merida noted there are both geologic and paleogeographic maps of the country at scales of 1:1,000,000. There are various geologic and minerals maps of selected areas at scales of 1:250,000, and the geology and geomorphology of about 60 percent of the country was mapped at a scale of 1:50,000 from 1962 to 1964.

There is a regional geologic map of Nicaragua at a scale of 1:1,000,000, according to Glen Hodgson, and there are also more than 110 geologic maps at a scale of 1:50,000. There is a geologic map of 35 percent of the country at a scale of 1:250,000. At the present time, a 1:500,000-scale geologic map of the country is being made by a series of government agencies in cooperation with the Association of Nicaraguan Geologists (ANGPA).

The most recent geologic map of Costa Rica was published in 1982 at a scale of 1:200,000. Other thematic maps of Costa Rica, reviewed by Walter Montero, include a metallogenic map at a scale of 1:500,000, published in 1978, a map of mineral resources published in 1978 at a scale of 1:750,000, and a geomorphic map at a scale of 1:200,000, published in 1980. Currently two geologic maps of Costa Rica are being compiled at a scale of 1:500,000, and geochemical maps of five 1:200,000-scale sheets are being compiled. There is a published gravity map at a scale of 1:750,000, and a Plio-Quaternary volcanism map at a scale of 1:700,000.

According to Oscar Salazar, there is a published geologic map of Guatemala at a scale of 1:500,000. Mapping at a scale of 1:250,000 is now underway and some geologic mapping at 1:50,000 exists.

John A. Reinemund summarized the status of the proposal for the Central American Geologic Map project. He observed that the proposal had been approved by the Circum-Pacific Council and had been discussed with potential funding agencies. Reinemund expressed the view that the project should be tied into the forthcoming council-sponsored symposium on energy and mineral resources of Middle America to be held in San Jose in 1989. The role of the Circum-Pacific Map Project will be to provide technical help, to organize and support working-group meetings, and to coordinate and support publication of the maps.

Reinemund suggested that the project could be divided into four parts: (1) base map, (2) thematic maps including the Geologic Map and another simpler map such as a plate-tectonic or geodynamic map that could be done before completion of the Geologic Map, (3) a correlation chart, and (4) an index of available maps and maps in progress.

Fernando Rudín of the Geographic Institute of Costa Rica summarized preparation of the base map for the project. It was agreed that his suggestion for making two sheets at a scale of 1:1,000,000 on a UTM projection should be followed. Boundaries of the northern sheet proposed by Rudin were lat 11° and 18.5° N., and long 82° and 94° W. For the southern sheet the proposed boundaries were lat 4° and 11° N., and long 77° and 90° W. Rudin agreed to produce working base maps by photographically merging the land geodetic grid and bathymetric data.

Sergio Paniagua, Coordinator of the Central American Geologic Map, reviewed the project proposal developed in 1986. The proposal included a five-year plan including two years for completion of the base map and country geologic compilations, two additional years for compilation of the regional map, and a final year for cartography and publication.

Dengo displayed an unpublished 1:1,000,000-scale geologic map compiled by ICAITI in 1974. He discussed the legend and explanation from the Case and Holcombe (1980)

1:2,500,000-scale geologic map of the Caribbean and Central America that was suggested as a guide in developing a map legend and compilation guidelines.

Addicott reviewed financial, technical support, and training needs. The Circum-Pacific Council and its Map Project would be available to help in providing technical support and in coordinating any needed consulting or training.

Dengo maintained that the Central American Geologic Map project needed to define specific objectives in framing a proposal for official approval and funding. He suggested that it would be convenient to develop a document that could be signed by country representatives in order to show that the project was of broad and well-organized scope and that it would benefit Central America as a whole and all of the participating countries. Dengo recommended that (1) the countries prepare a list of published and unpublished maps to later be compiled for publication, possibly by the Circum-Pacific Council (Xinia Bolanos of Costa Rica agreed to coordinate the compilation of a list and an index of mapping for Central America), (2) continuation of work in progress and preparation of stratigraphic tables so that correlation problems could be tackled at the next working group meeting, and (3) undertake compilation of a geodynamic map from readily available data sets for early publication.

On July 2, Dengo presented a written proposal for implementation of the Central American Geologic Map project for the approval of representatives from the Central American countries (table 27). The document expresses the interest of the working group of Central American Geologists in developing a series of maps to aid in the economic development of the Central American region. It was signed by representatives from each of the Central America countries. In a separate action, the Working Group approved compilation of a geodynamic map of Central America and Walter Montero of Costa Rica agreed to coordinate the compilation. The map is expected to include seismicity, focal mechanisms, faults and macrostructures, state of lithospheric stress, and igneous and metamorphic basement.

Reinemund reviewed the objectives and preliminary agenda for the March 1989 Middle American symposium to be cosponsored by the Circum-Pacific Council, the Costa Rican Ministry of Industry, Energy, and Mines, and the Refinadora Costarricense Petróleo (RECOPE). Included will be Central American and Caribbean countries as well as Mexico, Colombia, Venezuela, and Guyana. There will be four days of technical sessions, one day of workshops, field trips, extensive map displays including progress maps of the Central American map project, and poster sessions. He also noted the possibility of a joint meeting of the Northeast and Southeast Quadrant Panels of the Circum-Pacific Map Project in conjunction with the symposium.

An invitation for the Working Group of Central American Geologists and the Northeast Quadrant Panel of the Circum-Pacific Map Project to meet in Belize in 1988 extended by R. Prasada Rao was accepted and the meeting was scheduled for May 1988 in Belmopan. Addicott added that it might be useful to hold a future meeting of the working group in the United States, possibly in 1990.

Julio Merida suggested that a newsletter be sent to members of the working group summarizing progress and status of the project. It was agreed that a newsletter should be published three times a year.

Targets for working drafts of the thematic maps were December 1987 for the geodynamic map and March 1988 for country compilations for the geologic map.

Condensed from a meeting resume
prepared by Kenneth J. Drummond
on July 6, 1987

List of Participants

Warren O. Addicott
U.S. Geological Survey
345 Middlefield Road, MS 952
Menlo Park, CA 94025, U.S.A.

Guillermo E. Alvarado
Dept. de Geologia, Instituto
Costarricense de Electricidad (ICE)
Apartado 10032-1000
San Jose, Costa Rica

Bruno Baldis
IGCP Board
Av. Cordoba 261 (Este)
5400 San Juan, Argentina

Scott Baxter
Comisión Ejecutiva Hidroelectrica del
Río Lempa
Centro de Gobierno
San Salvador, El Salvador

Xinia Bolanos
Recope
Apartado 4351
San Jose, Costa Rica

Gabriel Dengo
Instituto Centroamericano de
Investigación y Tecnología (ICAITI)
Apartado 468
Guatemala, Guatemala

Kenneth J. Drummond
Mobil Oil Canada
P.O. Box 800
Calgary, Alberta
Canada T2P 2J7

Enid Gamboa
Dirección de Geología y Minas
Ministerio Energia y Minas
Apartado 292-2070
San Jose, Costa Rica

Ricardo Granados
Colegio de Geólogos de Costa Rica e
Instituto Costarricense de
Electricidad (ICE)
Apartado 10032-1000
San Jose, Costa Rica

José Maria Gutierrez
Dirección General de Minas e
Hidrocarburos
Apartado 981
Tegucigalpa, D.C., Honduras

Glen Hodgson
INMINE
Apartado 195
Managua, Nicaragua

Siegfried Kussmaul
Escuela de Geología, Universidad
de Costa Rica
Apartado 35
Ciudad Universitaria
San Jose, Costa Rica

Allan Lopez
Instituto Costarricense de
Electricidad (ICE)
Apartado 10032-1000
San Jose, Costa Rica

Julio Merida
Director General de Recursos
Minerales
Ministerio de Comercio e Industría
Panamá, Panamá

Marcial Montero
Minera Nacional S.A.
San Pedro
San Jose, Costa Rica

Walter Montero
Escuela Centroamericana de
Geología
Universidad de Costa Rica
Apartado 35
San Jose, Costa Rica

Sergio Paniagua
Escuela Centroamericana de
Geología
Universidad de Costa Rica
Apartado 35
Ciudad Universitaria
San Jose, Costa Rica

R. Prasada Rao
Ministry of Natural Resources
P.O. Box 157
Belmopan, Belize

John A. Reinemund
Circum-Pacific Council Executive
Director
P.O. Box 890
Leesburg, VA 22075, U.S.A.

Fernando Rudín
Instituto Geográfico Nacional
Apartado 2272
San Jose, Costa Rica

Guillermo P. Salas
Consejo de Recursos Minerales
Paseo de la Reforma
295, 7° Piso
México D.F. 6500, México

Oscar D. Salazar
Instituto Geográfico Militar
Division de Geología
Av. Las Americas 5-76
Zona 13
Guatemala, Guatemala

Gerardo Soto
Escuela de Geología
Universidad de Costa Rica
Apartado 35
San Jose, Costa Rica

Table 12. Suggestions for a geologic hazards map of the Southwest Quadrant.

(Excerpt from letter to W. David Palfreyman from R. J. Blong, Professor in Earth Sciences at Macquarie University, Australia)

1. Some thought needs to be given to the potential use of the map. I guess it is intended for use by professional geologists, perhaps with an economic bias. Does this mean the map should include meteorological hazards such as tropical cyclones/hurricanes/typhoons which might have serious effects on mining/drilling operations?

2. Which geologic hazards should be included? The following spring to mind—tsunamis, earthquakes, volcanic eruptions, landslides, floods, subsidence, expansive soils, storm surge, coastal erosion/progradation eruptions, and soil erosion. If all these hazards are to be included it would probably be best to plan for more than one map.

3. Consideration needs to be given to whether the map/s will be made to both improve and update existing sources. The latter task is more demanding but it is also more rewarding. Clearly, for many of the hazards named above information will have to be collected—it is doubtful that there are existing maps for any hazards except earthquakes and volcanic eruptions.

4. Lack of existing data for many hazards indicates that it will be necessary to fully utilize an interested and committed person from each country in the region to collect and synthesize data. These representatives should have the opportunity to meet once a year for each of the three years which such a project would take.

5. I also believe it will be necessary to appoint a research assistant for two to three years to collate data. I find it difficult to imagine that any academic or government agency or industry employee could find the time to make the project a success without such assistance.

6. The implications of the above suggestions are that large amounts of travel money will be required: (i) to bring together team members, (ii) for the coordinator/s to travel to at least some countries in the region,
   (iii) for the research assistant to work in some countries, and
   (iv) for liaison with coordinators of the other three map sheets.

7. Serious consideration should be given to whether map/s should be hazard maps or risk maps. Should the maps express frequencies and/or magnitudes of occurrences or probabilities of occurrence or damage? Should all hazards and/or risks be expressed or only those above certain magnitudes and/or frequencies?

8. I believe that production of a hazard/risk map for the quadrant is a viable proposition, although it will not be cheap. I also believe that a carefully thought out and accurate map would be of major benefit not only to the various geological industries but also to government agencies in the area, and to the insurance industry and international aid agencies.

Table 13. Notes from the 1987 Northwest Quadrant Panel meeting with CCOP, Bangkok, Thailand.

In recent years the Northwest Quadrant Panel has met with and reported on the status of activities to the delegates, Technical Advisors, and Secretariat of CCOP at their annual meetings. CCOP is a cooperating organization to the Circum-Pacific Council and cosponsors council activities, particularly those in the Northwest Quadrant of the Pacific Basin. The boundaries of this quadrant encompass all of the CCOP member countries.

The 1987 Annual Meeting of CCOP was held in Bangkok, Thailand, where CCOP headquarters are located. The Northwest Quadrant Panel was represented by Dr. Eiji Inoue, Panel Chairman, and Dr. Tadashi Sato. The Circum-Pacific Council was represented by John A. Reinemund, George Gryc, and Maurice J. Terman.

John Reinemund, Executive Director, Circum-Pacific Council, briefly described the objectives of the council and reviewed the present projects and planned future activities in the region. He described in some detail the East Asia Geotectonic Map, which is being done in cooperation with CCOP, ESCAP, and IUGS. This project is described in some detail in this report under the heading "Regional Maps". It includes four types of products:

1. Geographic Map series, scale 1:2,000,000, compiled by USGS

2. Geotectonic Map series, scale 1:2,000,000, compiled by Northwest Panel-CCOP working groups

3. Energy Map series, compiled by CCOP, WGRA

4. Mineral Map series, compiled by ESCAP, CCOP-WGRA

Publication of all of these products is being considered by the Circum-Pacific Council. John Reinemund also announced a schedule of council meetings for 1988 which include the Annual Meeting of the council with a workshop and symposium in Tsukuba and Tokyo, Japan, in September 1988 and a symposium in China on accreted terranes, also in 1988—time and place to be announced.

The Northwest Panel Chairman, Eiji Inoue, and the General Chairman, George Gryc, described the status of the Circum-Pacific Map Project, which is covered in detail in the main text of this report.

Tadashi Sato, the General Compiler, described the scope and status of the 1:2,000,000-scale geotectonic map series. Most of the National Working Groups have been established and compilation has been started. The map explanation being used follows closely that of the Southwest Tectonic Map, scale 1:10,000,000.

The national compilers will be invited to meet and join in a symposium on "Tectonics and Energy Resources in East Asia", scheduled for September 1988 in Tsukuba, Japan.

Maurice J. Terman described and discussed the proposal for a new thematic map series on natural hazards in the Pacific. This series, to be compiled in cooperation with NOAA, would include such phenomena as earthquakes, volcanoes, tsunamis, tidal runup, ice concentration, storm centers and tracks, and possible other geologic, atmospheric and ocean hazards.

Table 14. Preliminary guidelines for the Paleogeographic Map of the Circum-Pacific Region.

Introduction

The Paleogeographic Map is intended to link together the other map series of the Circum-Pacific Map Project and to summarize the geologic relations between the continents and ocean basins during the past 144 million years—since near the beginning of the history of the present ocean basins. The sheet will contain four frames representing tectonic conditions successively at the Jurassic-Cretaceous boundary 144 million years ago (144 Ma), the Cretaceous-Tertiary boundary (66 Ma), the Paleogene-Neogene boundary (24 Ma), and the present (0 Ma). Each frame will encompass the whole Circum-Pacific Map Project region—from 90° E to 50° W—and will have a scale of 1:34,000,000. The map area, Lambert equal-area projection centered at the Equator and long 160° W, is the same as the project's 1:17,000,000 Pacific Basin sheet.

Base Maps

Both the meridians and the parallels will be labeled on the paleogeographic frames; in other words, the paleolongitude as well as the latitude (which is well determined from paleomagnetism) will be given for points on the maps. This is made possible by the known relationship between seafloor magnetic lineations and hotspots that are inferred to be fixed to the Earth's lower mantle, and by multiple determinations of past magnetic pole positions at differing ages with respect to the continents. The positioning can be done reasonably accurately for all the frames except the Jurassic-Cretaceous, which represents a time from which only a small amount of seafloor remains. Still earlier times than those on our map sheet would require even further extrapolation, and therefore uncertainty, but Jurassic evidence available from the Northwest Pacific can be used to control our Jurassic-Cretaceous frame with tolerable accuracy.

As a starting point, we will use the Terra Mobilis interactive computer graphics program (Denham and Scotese, 1987). This program, based on the University of Chicago paleogeographic atlas project, permits one to print out the plate-tectonic situation of the Earth at any time from 600 million years ago to the present. We ourselves will need to deal with smaller terranes that are not included in Terra Mobilis, and we will probably discover corrections in detail that can be used to improve future versions of the computer program.

Compilation

Circum-Pacific Map Project Panel Chairmen, and other interested people, will be provided with preliminary base maps for each of the three frames that represent times before the present. Countries and individuals may prepare copy for various parts of the four maps, with the Panel Chairmen acting as facilitators and coordinators. The copy may be compiled on any base convenient to the individual compiler. Staff at Map Project Headquarters will transfer and combine the material onto the final manuscript of the map sheet.

The Panel Chairmen will be listed in the main title of the published sheet, and specific authorship of the publication will be indicated on the sheet with institutional affiliation in three ranks—editor, principal compilers, and contributors—depending on the extent of individual contributions. The map will contain references and sufficient explanatory material to stand alone, and an Explanatory Notes will accompany it, to provide further detail.

Map Content

Land areas will consist of paleotectonic maps, and ocean areas will show seafloor crustal ages. Colors for age of deformation and age of igneous emplacement will consist of international geologic colors for the ages of the three before-the-present maps, plus Triassic, Paleozoic, and Precambrian. The seafloor will utilize the same age boundaries and the same colors in lighter tones.

Black-pattern overprints on land colors will indicate the origin, such as magmatic arc, submarine fans, ocean floor, or continental. Plate boundaries active in each of the frames would be bold, in geologic-age colors, and in three classes: subduction zones, transform faults, and spreading axes. Older faults, abandoned spreading axes, and sutures will be in colors that indicate the age of final faulting, rifting, or terrane accretion.

George W. Moore
June 12, 1987

Table 15. Invited and volunteered papers for the Map Project-sponsored symposium on Circum-Pacific Energy and Mineral Resources proposed for the 1989 International Geological Congress to be held in Washington, D.C.

Coconveners

George W. Moore
Department of Geology, Oregon State University,
Corvallis, Oregon 97331, U.S.A.

José Corvalán D.
Departamento de Geología y Geofísica, Universidad de Chile,
Santiago, Chile

Invited Papers

Tadashi Sato (Tsukuba University)
Geotectonics and mineral resources of east and southeast Asia

Erwin Scheibner (Geological Survey of New South Wales)
Tectonics and some aspects of metallogeny of the southwest Pacific

José Corvalán D. (Universidad de Chile)
Genesis of mineral deposits in South America

David Z. Piper (USGS, Menlo Park)
Marine minerals of the Pacific basin

Kenneth J. Drummond (Mobil Oil Canada)
Petroleum habitat on the Pacific rim

Marcelo Yrigoyen (Exxon, Buenos Aires)
Petroleum basins of South America

Volunteered Paper

George W. Moore (Oregon State University)
Mesozoic and Cenozoic paleogeographic development of the Pacific region

Table 16. Proposed compilation guidelines for a 1:17,000,000-scale Energy-Resources Map of the Pacific Basin.

Energy Resources

Hydrocarbons:

Oil and gas fields - represent by colored areas (green for oil and red for gas) to show location of oil and gas fields in each basin, making these as representative of the actual area as possible.

Giant fields - identify by number (as in Halbouty and others, 1970) alongside red or green colored blob (possibly using leader). Number keyed to table in explanatory booklet.

Coal - generalized from 1:10,000,000-scale map, possibly showing only coal basins or areas.

Geothermal: adapt from 1:10,000,000-scale map.

Ocean thermal gradients:

Background

Basins: indicate by outline around basin; use colored tints to show thickness.

Ocean areas: isopachs generalized from 1:10,000,000-scale map; plate boundaries and motion vectors from Plate-Tectonic Map (delete numerical values).

Sediment thickness: use color tints to indicate thickness.

Faults: except where correction is needed, take directly from Plate-Tectonic Map.

Basement rock exposed: indicate by pattern.

Extensive volcanic cover: indicate by pattern.

Areas underlain by salt domes: indicate by pattern.

Holocene volcanoes and areas of high heat flow: if space permits.

Tectonic provinces: generalize whatever appears on the Tectonic Map affecting energy resources and depict by patterns.

Explanatory Booklet

Index map for basin names (possibly at 1:40,000,000 scale).

Representative stratigraphic sections for basins containing giant fields.

Index map showing basins containing oil and gas fields of the Circum-Pacific keyed by number and tabulated showing number of giant fields (as in Halbouty and others, 1970). On map show shield areas, fold belts, oceanic plate boundaries, and fracture zones.

Compiled from outline by
P. W. Richards and notes by
K. J. Drummond, 6-18-83.

Table 17. Revised symbology for the Circum-Pacific Mineral-Resources Maps (a memorandum by P. W. Guild to the quadrant chairmen, October 7, 1985).

This memo is a followup to my memorandum and attachment of June 19, 1985, that was hastily written and distributed at Honolulu.

Objections raised by the Southwest Quadrant to the deposit categories used for the first edition of the Northeast Quadrant Mineral-Resources Map led to reconsideration of the deposit types to be distinguished and their symbology for future maps of the series. The original eight symbols required that some very disparate deposit types be "lumped," leaving their nature to be distinguished by personal, independent knowledge on the part of the map user. The revised symbology eliminates these ambiguities by adding three new categories.

The classification is primarily geometric and descriptive, not genetic, emphasizing the relationship of the ore deposit to the host rocks. Symbols are, insofar as possible, ideograms. The precise words to describe them may be modified; those given here are intended to clarify the meaning and aid the compiler in selecting the most appropriate symbol to use for a given deposit.

1. ⊖ Stratiform. Deposits more or less rigorously confined to one or more layers in stratified (sedimentary or volcanic) rocks. Some are of great lateral extent in relation to thickness. May be layered (banded). Usually syngenetic with enclosing rocks. Examples: evaporites, phosphorites, iron formations. Most "massive sulfide" deposits belong here.

2. ⊖ Stratabound. Deposits, generally of limited horizontal extent, that occur at more or less the same horizon in stratified rocks. May be partly concordant, partly discordant with enclosing rocks. Usually considered to be epigenetic. Examples: carbonate-hosted (Mississippi-Valley) base-metal deposits, sandstone ("red bed") copper deposits, uranium deposits of Colorado Plateau, Wyoming Basin, etc.

3. ⊖ Vein or shear-zone filling. Crosscutting, epigenetic deposits in any type of host rock. The major dimensions are transverse to stratification in sedimentary or volcanic hosts. Most stockworks fit here; some in igneous hosts are better equated with the irregular disseminated deposits (6.)

4. ⊖ Manto. Deposits that combine stratabound and crosscutting features. Characteristically, one or several ore horizons (of replacement origin?) are underlain and/or joined by vein or stockwork ore shoots. Examples: Leadville and Gilman, Colorado, lead-zinc-silver; Santa Eulalia, Chihuahua, lead-zinc-silver; La Encantada and others, Coahuila, fluorite.

5. ⊖ Skarn. Contact-metamorphic (tactite) deposits. Stratified, usually carbonate, rocks intruded by intermediate to acid igneous rock.

6.  "Porphyry" deposits. Irregular disseminated deposits, in or associated with intrusive igneous rocks. Parts of some have been described as stockworks. Hydrothermal alteration, including greisenization, common.

7.  Magmatic (irregular massive) deposits, includes pegmatites. Examples: podiform chromite, some magnetite and magnetite-ilmenite deposits.

8.  Magmatic cumulate deposits. Concordant in layered, generally mafic or ultramafic igneous rocks. Examples: stratiform chromite, ilmenite, platinum-group metals of Bushveld type; certain nickel-sulfide (komatite-hosted) deposits.

9.  Pipe. Essentially a two-dimensional deposit with long axis vertical (crosscutting); includes breccia pipe. Examples: diamondiferous kimberlite, diapir-related (salt dome) sulfur.

10.  Surficial chemical concentration. Includes laterite, bauxite, uraniferous calcrete, and some manganese oxide deposits. The criterion is that supergene processes were responsible for producing ore-grade material.

11.  Surficial mechanical concentration—placer deposit. Includes "fossil" black sands.

I believe that these categories will accommodate the deposit types in the region. We could add another—unknown or unspecified—a symbol without any identifying ticks, but I don't think this will be necessary. Furthermore, on the Northeast Quadrant map we have used this simple "core" for many small deposits in areas of considerable crowding or where a few larger deposits in a cluster serve to identify the type.

Your comments are invited.

Table 18. Recommendations for compilation of the 1:17,000,000-scale Pacific Basin Mineral-Resources Map by Philip W. Guild in a letter to Warren O. Addicott, July 14, 1986.

I have received the copy of Bill Salas' map from you (his direct mailing never arrived—we have problems there) and a long letter from Nish with a copy of his manuscript for a talk at the Singapore meeting. Each contains much food for thought. Additionally, I have experimented with a very rough draft of most of the Pacific border of the NE portion of the Basin map to get an idea of what may be feasible or desirable for the minerals map.

I believe the best place to begin this letter is to describe the draft map briefly. It is on transparent mylar. Shore lines, country boundaries, and major P-T elements have been copied from the Howell et al map of tectonostratigraphic terranes. I have traced only the "inboard" limit of accreted terranes, leaving a gap from northeast Mexico to Arizona (which some people would equate with the Texas Lineament). I have omitted the individual terrane boundaries and designations for the present; Bill's map shows their distribution in Mexico and Central America. I then copied Bill's mineral districts for the area south of the United States and continued into the southwest United States, transferring major deposits by latitude-longitude from the 5M Metallogenic Map with the aid of the Circum-Pacific base map that has a two-degree grid. (I mention this because the distortion in the northeastern part of the map is so severe that even approximate location by inspection is not adequate.) With this done, I could add district perimeters for deposits of the same type closely enough spaced to permit this. At this point I decided to leave in the x's marking major deposits, particularly in the larger districts such as the copper porphyries of Arizona-New Mexico-Sonora, rather than delete them and return to a simple area as Bill had done—and as I had suggested in my letter to him of February 3, 1986. What to do will be one of very many decisions that will have to be made. However, as I continued north I encountered many situations in which a simple "x" seemed better than an area symbol—e.g., Bingham and Butte, which really don't have any nearby neighbors of the same type. I crudely colored the x's and perimeters; orange for Cu, Cu Mo, and Cu Zn; blue for PbZn (Ag); yellow for Au and Ag, purple for Hg and F; red for Sn and W; etc., and added the chemical letter symbols as Bill had done.

As I progressed north I found that I was adding relatively more x's and fewer district perimeters, especially in the U.S. segment where the picture is very confused. In fact, I did not attempt to plot many of the deposits/districts in the Basin Range Province, where many deposit types and metals are intermixed. In Canada the distribution parallel to the continental margin becomes clearer again and it is possible to delineate some districts, but my present feeling is that it is possible and would be desirable to show at least the major deposits there also. In fact, with precise plotting and imaginative symbology it would probably be possible to show a considerable amount of detail for the entire map area.

However, we must keep in mind the purposes of the map (whatever they may be) and not overpower it with unneeded detail. Nish, in his letter of June 3—you have a copy of it—suggests restricting it to

Post-Mz porphyry copper
Post-Mz massive sulfide
Post-Permian Sn/W
Post-Permian ophiolitic deposits and their lateritic ore

To these might be added a few more, e.g.

Post-Pz Au and Ag
Post-Pz Pb Zn Ag
Post-Pz Fe (Cu) of igneous affiliation (chiefly skarn?)
Post-Pz Hg and F

There is much to be said for such an approach, but it would exclude large areas (much of Australia and Canada, among others) and many ore types. Note, in paricular, that Precambrian mineralization, many stratabound deposits, etc., would not be shown.

I have placed "pC" beside the principal deposits of this age in my draft; they could be distinguished by another symbol (e.g., a "+") if it is decided to include them. Also, simple symbols could designate stratabound deposits, but this would increase the complexity of the map. Again, it is necessary to define its purpose.

The question of what to show as the background for the mineral deposits must also be decided. We seem to agree that at least some accreted-terrane information and plate-tectonic features are desirable. Additionally, principal faults and suture zones (from the Geologic and Tectonic maps?) seem necessary. But the accreted-terrane picture is constantly changing (Bill has updated his area from that on the Howell map) and getting more complex (as in Figure 3 of the Explanatory Notes); furthermore, terranes accreted in pre-Phanerozoic time will eventually be added! Where to stop? As I said above, I have shown on the draft only the limit of terranes accreted in Mz-Cz time; we can add the details later if it seems to be desirable and if they do not obscure other information we need to show.

I propose, therefore, that we should analyze apparent relationships of ore types to terrane types to see what conclusions may be drawn before we attempt to draft final guidelines and legends for the map. Among these that are apparent from our experiments to date are:

1) In most areas, copper tends to be "outboard" of lead-zinc and in terranes shown as "volcanic arcs with probable post-Precambrian continentalized basement." This is true for most of the porphyry coppers of Canada and Mexico. Note, however, that most (Noble says 90 percent) of U.S. porphyry copper lies east of the limit of accreted terranes! Terranes, at least those shown on the present map, are not the entire answer.

2) Most lead-zinc lies east of the copper, much of it in the North American plate (and much of it pre-accretion in age). This has long been known and described by many. Exceptions are present.

3) Mz-Cz mineralization related to intrusive activity in the western United States extends far (100-1500 km) into the North American plate. Transverse lineaments and other complications are present (which I have not attempted to show on the draft, although the northeast-trending Colorado Mineral Belt near Denver gives a hint of a major one).

4) Volcanogenic massive sulfides, chromite, nickel-cobalt laterites, and other ocean-floor (ophiolitic s.l.) mineral deposits are in terranes of this type, as is well known. However, many of these "ophiolite" slivers are too small to show on the map, and in any case we would be adding little new insight to their distribution. Incidentally, an IGCP project is preparing maps of ophiolite-associated mineralization in far more detail than we can hope to achieve.

There are undoubtedly many other relationships to be brought out. An excellent example will be presented at the meeting in Singapore by Dr. Nishiwaki, who has

analyzed the distribution of tin and tungsten in China and Southeast Asia in terms of accreted terranes, modes of subduction, and genesis of the granitic rocks with which the metals are associated. He has added details to his illustrations—ages and types of granites, suture zones, time-dependent cross sections, etc.—that are relevant to his thesis of initial low-metal concentrations in trailing-margin continental-derived sediments that were later enriched to ore grade by anatetic magmatic processes during or following accretion. The paper is a significant contribution which demonstrates how integration of data from various specialized fields can be brought to bear on explaining possible (or probable) reasons for the great concentration of tin and tungsten ores in this part of the world.

However, a single map of the Basin can hardly serve to illustrate all the problems; too many kinds of specialized data would be needed, no doubt, of different sorts for different ore types. There is, also, the matter of who is capable of identifying and assembling all the relevant material.

I suggest that the Quadrant Chairmen be consulted on the next steps to take. I am sending my draft map under separate cover for consideration at Singapore.
I have no facilities here for copying it—and indeed it isn't in shape to warrant copying! It should be examined as an overlay to the Howell map and perhaps others to see if this approach has any merit before attempting to select the elements to show and their symbology. As only Nish will be there (of our three-man committee), and as time will undoubtedly be very short, I do not anticipate anything more than a general decision to go ahead or make a totally new start can be made there. However, in either case, additional people should be identified who will carry on the actual compilation after they have agreed on the rules. As I mentioned at the close of my letter to Bill of February 3, it takes time and usually more than one extended meeting to agree on these. I still remember the objections raised to the Northeast Quadrant map after two proofs had been made.

Have a good meeting.

Table 19. Sales of Circum-Pacific Maps from 1983 to 1987 (based on fiscal year ending June 30).

Series	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987
Geographic					
6-map set	—	67	41	145	85
Total basin	201	28	30	72	41
Northwest Quad	175	18	14	29	19
Southwest Quad	210	33	22	52	19
Northeast Quad	177	16	15	59	17
Southeast Quad	164	15	7	34	17
Antarctica	168	24	18	11	16
Base					
6-map set	—	54	34	117	57
Total basin	153	12	17	34	14
Northwest Quad	152	9	3	15	9
Southwest Quad	289	17	15	36	8
Northeast Quad	144	17	7	44	11
Southeast Quad	131	10	2	35	12
Antarctica	273	14	12	9	11
Plate-Tectonic					
6-map set	—	159	122	305	162
Total basin	652	221	89	473	126
Northwest Quad	531	41	24	48	55
Southwest Quad	521	39	61	102	132
Northeast Quad	571	84	45	153	154
Southeast Quad	475	24	18	60	42
Antarctica	475	30	24	25	25
Geodynamic					
6-map set	—	—	—	208	128
Total basin	—	—	—	146	66
Northwest Quad	—	—	—	66	33
Southwest Quad	—	—	21	76	26
Northeast Quad	—	—	34	139	46
Southeast Quad	—	—	22	82	30
Antarctica	—	—	—	47	24
Geologic					
Northeast Quad	—	115	129	244	110
Southeast Quad	—	—	—	164	83
Mineral Resources					
Northeast Quad	—	—	25	214	80
Energy Resources					
Northeast Quad	—	—	—	—	14

Other Maps					
Tectono. Terranes	—	—	145	280	149
Mang. Nodules	—	—	17	140	77

Table 20. Potential displays for a Circum-Pacific oceanographic map presented by representatives from the National Oceanographic and Atmospheric Administration (NOAA) at an ad hoc meeting held in Reston, Virginia, October 8, 1987.

A. Seasonal displays
- Tropical storm frequency
- Tropical storm tracks
- Sea surface temperatures
- Mean wind speed
- Mean surface current
- Mean atmospheric pressure
- Average ice limit
- Height of sea level
- Depth of mixed layer
- Top of the significant thermocline

B. Other than seasonal displays
- Preferred storm tracks
- Significant occurrence of tropical storms
- Tsunamis

C. Quadrant displays in addition to A and B
- Extreme tides/storm surge
- Strike frequency of major storms

D. Other possible data bases
- Visibililty
- Precipitation
- Upwelling areas
- Salinity
- Subsurface currents
- Depth of thermocline
- Thickness of mixed layer

Table 21. Compilers of the East Asia Geotectonic Map.

General compiler

Dr. Tadashi Sato	Professor University of Tsukuba Institute of Geosciences 1-1-1, Tennodai Sakura-mura, Niihari-gun Ibaraki 305, Japan	Japan

National compilers

Dr. Tohap Simanjuntak	Geological Research and Development Center, Bandung, Indonesia	China
Mr. Koji Wakita	Chief Geologist, Geological Survey of Japan 1-1-3 Higashi, Yatabe Ibaraki 305, Japan	Japan
Dr. Kim Dong Hak	Director Geology Department Korean Institute of Energy and Resources 219-5 Garibong-dong Guro-gu Seoul, Korea	Korea
Mr. Khoo Hang Peng	Head, Stratigraphy and Paleontology Unit Geological Survey Laboratory P.O. Box 1015 Ipoh, Perak, Malaysia	Malaysia
Not yet named		Papua New Guinea
Dr. Guillermo R. Balce	Deputy Director-General Bureau of Mines & Geosciences P.O. Box 1595 Manila, Philippines	Philippines
Mr. Saengathit Chuaviroj	Senior Geologist Geological Survey Division Dept. of Mineral Resources Roma VI Road Bangkok 10400, Thailand	Thailand

Dr. Tran Van Tri	Vice Director Research Institute of Geology and Mineral Resources Ho Chi Minh City Vietnam	Vietnam

Table 22. Tentative plan for implementation of the East Asia Geotectonic Map of the Northwest Quadrant Panel of the Circum-Pacific Map Project (1986).

1. East Asia Geotectonic Map - Stand and Purpose

It is proposed that the Geotectonic map be compiled as the second phase of the Northwest Quadrant Panel activity of the Circum-Pacific Map Project and at the same time as a part of the CCOP Resources Assessment Programme. The purpose of the project is to provide regional geologic background for energy and mineral resources assessment in East Asia, and also to be useful for the improvement and training of map compilation techniques.

2. Target, Map Scale, and Guideline

The target of the project would be to complete geotectonic map of East Asia which is divided into eight sheets (Figure 5) on a scale of 1:2,000,000. The base maps of Lambert Azimuthal Equal-Area Projection will be prepared by the U.S. Geological Survey by 1991.

The guidelines or regional legend of the geotectonic map should be prepared by the General Compiler on the basis of the group discussion of the first workshop. It is considered that the guideline or regional legend should be basically concordant with that of the Tectonic Map of the Northwest Quadrant on a scale of 1:10,000,000.

3. Membership

It is proposed that the membership of the project be composed of scientists of the CCOP member countries and scientists nominated by the Circum-Pacific Council (CPC) and the CCOP Project Office.

4. Organization and Operation

It is proposed that the project members be composed of a General Compiler, National Compilers, Liaison Officers, and the Panel Chairman.

The main task of the General Compiler would be to establish the general guideline of the geotectonic map which should be commonly applied to all sheets, to assist geological adjustment of overlap areas between adjoining sheets, to promote compiling work, and to plan and lead the workshop.

The task of the National Compilers of each country would be to prepare the geotectonic map of the country along the general guideline and to organize a domestic working group.

The General Compiler and the National Compilers would belong to the Regional Working Group, and will exchange scientific and technical information related to map compilation with other members of the RWG.

The Liaison Officer of each country will report the progress of the compilation and will indicate problems arisen from compiling work, being in close contact with the national chief compiler. The Liaison Officer will also report the status of the domestic working group and discuss administrative matters such as schedule, publication, finance and so on at the Northwest Quadrant Panel Meeting.

The Panel Chairman, in close contact with the General Compiler, the CPMP General Chairman, the CPC Directors and the CCOP Director, will arrange the

schedules of regional workshop and panel meeting, will regularly report the progress of the compiling work to the Liaison Officers, and will consider finance problems needed for activities and publication of the sheet maps.

5. Schedule

The geotectonic maps consisting of eight sheets are expected to be compiled in five years from 1987 to 1991 and be published in 1992. In order to accelerate the compilation work, workshop should be opened by the working group.

Besides, the general and national compilers shall frequently exchange information with each other throughout their activities of the project.

6. Finances

A significant part of necessary travel expenses for members to attend at the workshop and the panel meeting and to coordinate the map compiling will be provided by the CPC and CCOP. Other organizations will be approached if necessity arises.

Most of the operational cost of workshops will be provided by the related organization of the country in which the workshop is convened.

As provision of the above financial support is prerequisite to the implementation of this plan, the Panel Chairman will confer with these institutions and report the result to the Panel members.

7. Publication and Others

As the method, style and finance of the Geotectonic Map Series are not clear at present, these will be discussed among the CPC, the CPMP, the CCOP and the Northwest Quadrant Panel in the near future.

Table 23. Guidelines for compilation of the Geotectonic Map of East Asia (June 30, 1987).

Guidelines established by M. J. Terman, H. F. Doutch, E. Scheibner, and G. W. Moore for the compilation of Tectonic Map Series of the Circum-Pacific Map Project (Addicott, 1985, table 18) shall be used.

Principle of compilation

Tectonic information shall be as factual as possible. Hypothetical interpretations should not be used in order to minimize discrepancies between areas.

STRUCTURAL UNITS

Plate boundaries and spreading centers

Subduction zones
Transform faults
Spreading centers

Boundaries of tectonic units

Tectonic unit boundaries
Boundary between continental and oceanic crust
Inner edge of continent affected
Geosuture

Paleomagnetic data

Declination
Magnetic lineations
    Magnetic anomalies

Volcanic activities

Volcanic centers
    Active in historic time
    Active in Holocene time
    Holocene activity uncertain

Dikes

Deformational features

Faults and fracture zones
    Undifferentiated
    Normal faults
    Lateral faults

Reverse faults
High angle (reverse fault)
Low angle (thrust fault)
Concealed
Folds
Anticlinal axis
Open and gentle
Tight and closed
Synclinal axis

Other structures

Diatremes and related structures
Cryptoexplosion structure
Kimberlite pipes
Carbonatites
Lamproites
Astroblemes

Isopachs

Isopachs for continental areas
Isopachs for oceanic areas

TECTONIC CLASSIFICATION OF ROCKS

Rocks of active plate margins

Igneous rocks of arcs
Forearc sediments
Accretionary-prism rocks

Continental crust

Basement rocks
Metamorphic rocks
Intrusive igneous rocks
Deformed sedimentary and volcanic rocks
Rocks of transitional basins
Covering rocks
Continental platform strata
Continental margin deposits
Rift sequence
Drift or breakup sequence
Intraplate igneous rocks

Oceanic crust

Oceanic crustal rocks
Oceanic plateaus
Oceanic islands and seamount volcanics

LITHOLOGIC CLASSIFICATION OF ROCKS

Igneous rocks

- Intrusive
  - Felsic
  - Intermediate
  - Mafic
  - Ultramafic
  - Undifferentiated
- Extrusive
  - Felsic
  - Intermediate
  - Mafic
  - Undifferentiated

Metamorphic rocks

- Structural trends available
  - Low temperature low pressure
  - High pressure
  - High temperature
- Structural trends unavailable
  - Low temperature low pressure
  - High pressure
  - High temperature
- Undifferentiated

TIME-SPACE PLOTS

Major structural elements in vertical columns

Structural units in horizontal

EXPLANATORY NOTES

Letter symbol

Structural name and age span

Tectonic setting (interpretation) and brief description

Source of information

Table 24. Review committee for the East Asia Map.

Chairman:	Arthur Saldivar-Sali	Philippine National Oil Co. P.N.P.C. Complex Merritt Road, Fort Bonifacio Makati, Metro Manila Philippines
Members:	Ismet Akil	Jalan Pekalogan 11 Menteng, Jakarta, Pusat Indonesia
	Harold M. Lian	UNOCAL Thailand Inc. Central Plaza Office Bldg. 1693 Phaholyothin Road Bangkok, Thailand
	Maurice J. Terman	Office of Inernational Geology USGS 12202 Sunrise Valley Dr., MS 917 Reston, VA 22092, U.S.A.

Table 25. East Asia Geotectonic Map progress report by Eiji Inoue, August 29, 1987.

1. Origin of the project

The CCOP has established the East Asia Resources Assessment Program (CCOP/REG 2.1) with the support of IUGS and Circum-Pacific Council, with the approval of the Committee at its 21st and the 22nd Annual Sessions. The program includes two major projects: A) the East Asia Basin Analysis Project, and B) the East Asia Geotectonic Map Project.[1] At the 11th Session of the Northwest Quadrant Panel held at the 22nd CCOP Annual Session in China in November 1985, the relationship of the CPMP to the East Asia Basin Analysis Project was discussed and it was concluded that the role of the Northwest Quadrant Panel would be defined more fully after the CCOP Working Group on Resources Assessment (WGRA) meeting.

At the WGRA meeting held at Kuala Lumpur in April 1986, the group decided to start the East Asian Basin Analysis Project and to implement the compilation of basin identification and total sediment isopach maps on a scale of 1:2,000,000 for the CCOP area as the first phase work. It was decided, however, that the group not be responsible for the East Asia Geotectonic Map Project whose objective is to compile 8 sheets of geotectonic map on a scale of 1:2,000,000.

The group recommended that the Geotectonic Map Project should be conducted by Northwest Quadrant Panel, because the geotectonic map would be extremely important for providing interbasin basement data and for the basis of the basin maps to assist in the assessment for energy and mineral resources.

2. 1986 Panel Chairmen's meeting, Circum-Pacific Map Project and Council Directors' meeting in Singapore

During the meetings in August 1986, the East Asia Map Project, which is composed of the Geographic Map series, Geotectonic Map, Sedimentary Basin Map and Mineral Resources Map, was formally authorized by the Circum-Pacific Council Board of Directors, as a second phase activity of the CPMP (Figure 5). The East Asia Map Project is to function within the general framework of the Circum-Pacific Map Project with regard to cartographic processing, map standards, and map publication, but will require a special mechanism for coordinating the compilation and interpretation of data.

Subsequently the Northwest Quadrant Panel Chairman considered a preliminary plan (Table 22) to conduct the East Asia Geotectonic Map Project, consulting with Mr. G. Gryc, the General Chairman of the CPMP and with Mr. S. Kulvanich of the CCOP Director.

3. 12th Northwest Quadrant Panel meeting in Madang, Papua New Guinea

The meeting was held at Madang on November 7, 1986, in conjunction with the 23rd CCOP session. The outline of implementation of the East Asia Geotectonic Map Project was discussed.

The panel chairman presented his concept of how the project should be organized (Table 22).

[1] Although the East Asia Geotectonic Map Project will be undertaken separately from the Resources Assessment Program and will be one of several map series, it was subsequently included under the heading East Asia Map Project (EAMP) as previously discussed (see p. 30-31).

Concerning the organization, it was proposed that the project consists of a general compiler, national compilers, and liaison officers, and the former two compose a working group to conduct map compilation substantiation.

The method, style, and publication of the map series were not clear, and should be discussed further at a planning meeting to be arranged in 1987. It was pointed out that assured financial support for part of the necessary travel expenses for members to attend workshops and panel meetings and to coordinate the map compiling should be essential.

The report of the 12th Northwest Quadrant Panel meeting, including the discussions mentioned above, was endorsed by the CCOP Committee at the 23rd CCOP plenary session on November 10. The Committee requested the CCOP Technical Secretariat to give whatever assistance it could to this program, within its means.

4. Nomination of General and National compilers

The panel chairman nominated Prof. Dr. Tadashi Sato of Tsukuba University to be the general compiler. He is a very distinguished geologist in Japan and has engaged in the compilation of tectonic and geologic maps on a scale of 1:10,000,000 of Circum-Pacific Map series for several years.

The panel chairman also requested the representatives of the CCOP member countries to nominate their national compilers by May 15, 1987. Up to now, six national compilers have been named as shown in Table 21. It is expected that additional national compilers from China, Korea, and Papua New Guinea will be appointed.

5. Announce for initial planning meeting of Geotectonic Map Project in Beijing in August 1987

The panel chairman announced that an initial planning meeting would be held in Beijing on August 29, 1987, in conjunction with the International Symposium of Tectonic Evolution and Dynamics of Continental Lithosphere.

6. Informal meeting of the East Asia Geotectonic Map Project

The annual meetings were held at the East-West Center at the University of Hawaii in Honolulu on August 14-18, 1987. The panel chairman presented his concept related to schedule, organization and cost requirements to CPMP and CPC.

The Board of Directors approved the structure of the East Asia Map Project which includes the East Asia Geotectonic Map Project with other three project as mentioned in item 2. The board appointed a Project Review Committee (Table 24) to study plans and preparations, to determine the cost for carrying out the project, to define a coordination mechanism, and to submit recommendations to the Board.

7. Informal meeting of the East Asia Geotectonic Map Project

An informal meeting of the project was held in Jakarta on July 10, 1987, in conjunction with the GEOSEA VI session and with the meeting of CCOP Working Group on Resources Assessment (WGRA) which conducts the East Asia Basin Analysis Project.

In the informal meeting Dr. M. J. Terman of the CPMP consultant, Mr. S. Kulvanich of the CCOP Director, and Dr. J. Hirayama, acting for the panel chairman, introduced the outline of the project, distributing documents related to tentative guideline and standard legend of the Geotectonic Map to the GEOSEA and WGRA participants.

8. Initial planning meeting in Beijing on August 29

In this meeting, how to conduct the project, schedule, workshop, etc., were to have been discussed along with a draft of tentative plan presented by the panel chairman. Also tentative guidelines and a standard legend prepared by the general compiler were to be presented and discussed.

On the basis of the discussions the Panel Chairman and the general compiler will revise the guidelines and send them to the national compilers and the liaison officers for review. The results of this meeting will be reported at the 13th Northwest Quadrant Panel meeting during the 24th CCOP session in Bangkok October 28 - November 7, 1987.

Table 26. Statement and preliminary proposal for a geologic map of Central America by Gabriel Dengo, April 1985.

Geologic Map of Central America

This project was initiated by the Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI) in 1974, but could not be coordinated due to lack of funding.

During the XI Cartographic Week of Central America held in Guatemala from the 21st to the 25th of November 1983, resolution 7 "urged the member countries that the coordinate efforts for the production of a Regional Geologic Map in which information which may contribute to the determination of possible mineralized areas is depicted."

It was recommended to Ing. Fernando Rudín, Director of the Geographic Institute of Costa Rica, to search for support from IPGH and SIECA to convene a coordinating meeting. However, subsequently the Circum-Pacific Council for Energy and Mineral Resources showed interest in advancing the project and convened a meeting in Mexico City in February 1985 with the participation of Ing. Rudín and geologists from the Central American countries.

An *ad hoc* committee was formed which, with subsequent additions, is as follows:

Committee Members

F. Rudín (Costa Rica) - Cartographic Coordination
R. Castillo (Costa Rica) - Geologic Coordination
P. Rao (Belize)
R. Burgos (El Salvador)
O. Salazar (Guatemala)
C. H. Rivera (Honduras)
G. Hodgson (Nicaragua)
J. Merida (Panama)

Advisors

G. Dengo (ICAITI)
W. Addicott (United States)

Table 27. Agreement by the Working Group of Central American Geologists to produce a series of base and thematic maps of Central America.

Working Group of Central American Geologists, Northeast Quadrant Panel,
Circum-Pacific Map Project of the
Circum-Pacific Council for Energy and Mineral Resources

Considerations

1. That governments of the Central American countries through their cartographic institutions in session in Guatemala in November 1983 issued a resolution relative to the preparation of a Geologic Map of Central America and its importance for the economic development of the region.

2. That the organization charged with seeking means of contacts with specialized organizations for coordination, planning, and publication of regional geological maps requested the Circum-Pacific Council for Energy and Mineral Resources for its scientific and technical help in undertaking the program for a Geologic Map of Central America.

3. That the Working Group of Central American Geologists including participants of the various institutions has since 1985 been associated with the Northeast Panel, Circum-Pacific Map Project, for the planning and coordination of the Geological Map of the region and has been involved in technical session in 1986 and 1987, during which the plans for work on the program for a Geological Map of Central America has been prepared.

4. That the program for a Geological Map of Central America is expected to produce maps which will be very valuable and useful in reference to energy and mineral resources and other diverse types of geological studies, considering the program to prepare the following: topographic and bathymetric Base Map, Geodynamic Map, Geologic Map, and Resources maps.

Agreement

1. That through the Geographic Institute of Costa Rica, the information should be conveyed to the Geographic Institutions of the countries of the region concerning the preparation and plans for the program for the Geological Map of Central America.

2. That the Working Group provide help to the Circum-Pacific Council for Energy and Mineral Resources in their efforts to seek the funds necessary for the continuation of the program for the Geologic Map of Central America.

3. That each of the participants in the Working Group of Central American Geologists inform their institution concerning the development of plans for the Geologic Map Program with the objective of continuing to receive the institutions' help for the compilation of the information for the country in preparation for the integration of the regional map.

4. Express to the Circum-Pacific Council for Energy and Mineral Resources the interest of the Working Group in continuing to receive technical and financial help from the Council. This help is indispensible for the members of the Working Group active in

the work of compiling the various types of information in each country and coordinating their activities for the regional program.

5. Request the Circum-Pacific Council for Energy and Mineral Resources to send written communication to the Central American institutions participating in the development of the program concerning the importance of the program in reference to aspects of economic development for the region.

6. Show its appreciation to the Circum-Pacific Council for Energy and Mineral Resources for the valuable collaboration that exists presently in the accord for economic development of the region conveyed through its active participation in the work on the program for the Geologic Map of Central America.

The agreement was signed in San José, Costa Rica, on July 2, 1987, by Sergio Paniagua, Escuela Centroamericana de Geología, Costa Rica; Fernando Rudín, Instituto Geográfico Nacional, Costa Rica; Glen Hodgson, INMINE, Nicaragua; Jose M. Gutierrez, Dirección General de Minas e Hidrocarburos, Honduras; Scott Baxter, Comision Ejecutiva Hidroelectrica del Río Lempa, El Salvador; Julio Merida, Dirección General de Recursos Minerales, Panama; Enid Gamboa, Dirección de Geología y Minas, Costa Rica; Xinia Bolanos, RECOPE, Costa Rica; R. Prasada Rao, Ministry of Natural Resources, Belize; Oscar D. Salazar, Instituto Geográfico Militar, Guatemala; and Gabriel Dengo, Advisor, Instituto Centroamericano de Investigaciones Tecnología y Industría (ICAITI), Guatemala.

Table 28. Proposal for the Geologic Map of Central America presented at the Working Group Meeting in San José, Costa Rica, July 1, 1987.

Proposed Procedure

National Working Groups

1. Initial compilation

    a) Scale 1:250,000, 1:200,000, or another
    b) Local geological units

2. First reduction

    a) Scale 1:500,000
    b) Revision of units appropriate to the map scale

3. Second reduction

    a) Scale 1:1,000,000
    b) Revision of units appropriate to the map scale

Regional Working Group

1. Compilation of units of each country

2. Combining of units

    a) Comparison with existing maps
    b) Final selection of units
    c) Selection of symbols and colors
    d) Joining of maps at country boundaries

3. Compilation of the first draft of the regional map

    a) Revision by each national working group

4. Final compilation of the regional map

5. Cartography, proof and publication

Geologic Map of Central America

Base Map including topography and bathymetry

Land geology

- Geologic units
- Faults and folds
- Volcanos and calderas
- Other information

Marine geology

- Geologic units
- Tectonic aspects
- DSDP boreholes
- Other information

Geophysics

- Gravity
- Seismic epicenters

Other information

- Isopachs
- Crustal thickness

Stratigraphic table

Proposed Schedule for Compilation of the Geologic Map of Central America

First and Second Year: Country Compilation Phase

1) Central American countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) to initiate their compilations by national working groups at a suggested final scale of 1:500,000.
   Duration: 12 months.

2) Working Group meeting to be held in Costa Rica 12 months after the initiation of the country compilations.
   Duration: 4 days.

3) Analysis of conclusions and recommendations of the First Working Group Meeting by each country, completion of revision, and correction of the compilations.
   Duration: 12 months.

4) Working Group Meeting to be held at the end of stage 3 (12 months after the First Working Group Meeting), possibly in the United States.
   Duration: 4 days.

Third and Fourth Year: Regional Integration Phase

5) Synthesis of country compilations into the 1:1,000,000-scale Geologic Map of Central America (to begin upon completion of the Second Working Group Meeting).
Duration: 12 months.

6) Working Group Meeting - to be held in Costa Rica 12 months after the initiation of the regional compilation. Purpose of meeting will be to complete the regional compilation.
Duration: 4 days.

7) Completion of the regional compilation and presentation of the map by the end of the indicated period.
Duration: 12 months after the Third Working Group Meeting.

Fifth Year: Preparation, Review, and Publication

8) Map cartography, review, preparation of final report, and publication (maps at scales of 1:500,000 and 1:1,000,000).

9) Working Group Meeting - to be held toward the end of the fifth year to review, correct, and approve color proof of the map and final manuscript and illustrations for the printed report.
Duration: 4 days.

Country Working Groups

Belize

Dr. Prasada Rao, Coordinator, Ministry of Natural Resources, Belmopan
Mr. Pedro A. Cho, Ministry of Natural Resources, Belmopan
Mr. J. Herve Cornec, Ministry of Natural Resources, Belmopan
M.S. Evadney Garcia, Ministry of Natural Resources, Belmopan

Costa Rica

Prof. Serio Paniagua, Chief Coordinator of the geologic compilation, Director, Escuela Centroamericana de Geología, Universidad de Costa Rica, Ciudad Universitaria, Rodrigo Facio
Ing. Fernando Rudín, Chief Coordinator of the geographic base compilation, Instituto Geográfico, San José
Dr. Siegfried Kussmaul, Escuela Centroamericana de Geología, Ciudad Universitaria, Rodrigo Facio
M.Sc. Rodolfo Madrigal, Escuela Centroamericana de Geologia, Ciudad Universitaria, Rodrigo Facio
Br. Enid Gamboa, Dirección de Geología, Minas e Hidrocarburos (MIEM), San José
M.Sc. Allan Lopez, Instituto Costarricense de Electricidad (ICE), San José
Dr. Alfonso Monge, Minera Nacional S. A. (MINASA), San José
Lic. Ricardo Granados, Colegio de Geólogos de Costa Rica, San José
Srta. Xinia Bolanos, Refinadora Costarricense de Petróleo (RECOPE), San José

El Salvador

Ing. Julio Roberto Salazar Mena, Coordinator, Centro de Investigaciones Geotécnicas, San Salvador
Lic. Guillermo Eyes Guillen, Centro de Investigaciones Geotécnicas, San Salvador
Lic. Carlos Edmundo Aguilar, Centro de Investigaciones Geotécnicas, San Salvador
Lic. Scott Baxter, Comision Ejecutiva Autonoma del Río Lempa, San Salvador

Guatemala

Ing. Oscar Salazar, Coordinator, Division de Geología, Instituto Geográfico Militar, Guatemala
Dr. Samuel Bonis, Consultant, Guatemala
Ing. Nery Diaz, Ministerio de Energía y Minas, Guatemala
Dr. Gabriel Dengo, Instituto Centroamericano de Investigación y Tecnología Industrial, Guatemala

Honduras

Ing. Geol. Jose Maria Gutierrez, Coordinator, Dirección General de Minas e Hidrocarburos, Tegucigalpa
Ing. Geol. Carlo Hugo Rivera, Dirección General de Minas e Hidrocarburos, Tegucigalpa
Ing. Geol. Oscar Tabora, Dirección General de Minas e Hidrocarburos, Tegucigalpa
Ing. Juan Jose Guevara, Instituto Geográfico Nacional, Tegucigalpa
Ing. Constantino Ferrera, Instituto Geográfico Nacional, Tegucigalpa
Lic. Roberto Borjas
Sr. Roberto Irias

Nicaragua

Ing. Glen Hodgson, Instituto Nicaraguense de Minas e Energía (INMINE), Managua (panel member)
Mauricio Darce, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua (panel member)
Hugo Moreno, Direccion de Ciencias de la Tierra, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua
Yadira Centeno, Dirección de Ciencias de la Tierra, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua
Luis Munoz, Dirección de Ciencias de la Tierra, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua
Odel Castellon, Dirección de Ciencias de la Tierra, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua
Noel Rodriguez, Dirección de Ciencias de la Tierra, Instituto Nicaraguense de Estudios Territoriales (INETER), Managua

Panama

Lic. Julio Merida E., Coordinator, Dirección General de Recursos Minerales, Panamá
Ing. Aurelio Lopez Sour, Universidad Tecnología, Panamá
Dr. Tisla Destro, Universidad Tecnologia, Panama
Dr. Antonio Tourino, Universidad de Panama, Panama
Ing. Uriel Madrid, Instituto Recursos Hidraulicos y Electricos, Panamá
Lic. Vilma de Pinilla, Instituto de Geociencia, Panamá
Dr. Eric Gutierrez, Instituto de Geociencia, Panamá