THE CIRCUM-PACIFIC MAP PROJECT

by

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A successful international effort to summarize geological and geophysical information on the Pacific region in correlatable form, the Circum-Pacific Map Project has made remarkable progress in four years. This article traces the Project's objectives, accomplishments and future plans.

History

Extensive geological and geophysical exploration in the Pacific region during recent years has resulted in many data that are being reported in a variety of journals and on maps of various scales and projections. The need to summarize this information in correlatable form was recognized in 1972 during discussions related to the planning of the first (1974) Circum-Pacific Conference on Energy and Mineral Resources. In February of 1973, a group of interested earth scientists* meeting in Menlo Park, California, established the framework for the Circum-Pacific Map Project, and John A. Reinemund was named its General Chairman. Later, when the Circum-Pacific Council for Energy and Mineral Resources was formed, and Michel T. Halbouty was named Chairman, the Map Project became one of its activities.

Objectives

The Project's objectives are to:

- Bring together, in an integrated series of maps, the latest geological, mineral, and energy resources information available for the Pacific region;
- Illustrate the relationship of geological and tectonic features between continents and between continents and ocean basins;

- Show the relation of known resources to major geological features;
- Focus attention on the status of, and gaps in, geological knowledge of the Pacific Basin.

Organization

In order to obtain contribution from as many countries as possible and to coordinate the work of the contributors, the Pacific region was divided into five areas: the Northwest, Northeast, Southeast, and Southwest Quadrants, and Antarctica. Panels of scientists working on and usually residing within those areas (except Antarctica) were organized under the following chairmen: C. Nishiwaki (Northwest), with Shun-ichi Sano as deputy chairman; K.J. Drummond, who succeeded C.A. Burk in 1976 (Northeast); J. Corvalán (Southeast); and R.N. Richmond (Southwest). C. Craddock is chairman of the Antarctica Panel, succeeding F.A. Wade who was chairman until his death in October 1978. (The general chairman and first panel chairmen are shown in Fig. 1).

To help coordinate activities and review maps, P.W. Richards became deputy chairman of the project in 1975. Many individuals, only a few of whom are named here, have provided

Figure 1. Circum-Pacific Map Project chairmen meeting in Menlo Park, California, U.S.A. in May, 1975. Left to right: José Corvalán, Creighton A. Burk, F. Alton Wade, Chikao Nishiwaki, and John A. Reinemund. (Photo courtesy J.C. Maher, Vice-Chairman, Circum-Pacific Council for Energy and Mineral Resources)

*These included Ian R. Campbell, Kenneth H. Crandall, William H. Curry, Maurice Ewing, Lawrence W. Funkhouser, Donald A. Henricksen, Mason L. Hill, John C. Maher, John A. Reinemund, Richard P. Sheldon, Robert J. Weimer, and J. Donald Weiss.

help and advice in organizing the project, finding data, and compiling the maps.

Map Series

The project initiated plans to compile, on new base maps, geological, tectonic, energy and mineral resources maps of the five areas, and one smaller scale map of the entire region. These plans have been little changed, except for the addition of a plan to prepare geodynamics maps.

Geographic and base maps: Guided by D.M. Kinney, the project members first considered map scales and projections that would be best suited to the project's objectives. An equal-area projection and map scales of 1:10 million for the five areas and 1:20 million for the full region were finally selected. As the maps are nonconformal, considerable overlap was allowed the five maps (Fig. 2).

Figure 2. Index map showing boundaries of the Pacific quadrant maps and boundary in the Pacific Ocean of the Antarctica map. The Pacific Basin map (1:20 million) covers approximately the full area shown.

Map graticules were computer plotted by using the Cartographic Automatic Mapping (CAM) program at 1:12 million scale and were photographically enlarged to 1:10 million. Shore and drainage lines of the two western quadrants were also computer plotted. Bathymetry was compiled by hand from the latest available sources, principally the bathymetric maps of the North and South Pacific compiled in Scripps Institution of Oceanography. J. Mammereckx Winterer provided manuscript editions of the then unpublished sheets. Topography on land was largely compiled from the U.S. Army Map Service and the American Geographical Society Maps of 1:5 million scale.

Two editions of the maps at 1:10 million scale of these five areas have been published by the American Association of Petroleum Geologists (AAPG), and the two editions of the 1:20 million scale map went to press in December, 1978. One edition is a multicolour geographic map showing topographic and bathymetric contours (colour tints emphasize differences in elevation), shore and drainage lines, a 10° graticule, international boundaries, and names of land and sea-floor features. The second edition is a simplified version for use as a base map on which to compile data. It includes only shore and drainage lines, bathymetric contours, international boundaries (except on the Northwest Quadrant), and a 2° graticule.

International boundaries, some parts of which are in dispute, appear on the maps to assist users in locating features and to identify areas compiled by individual workers. The

individuals and organizations responsible for the compilations hope that the map users will recognize the purpose of showing the boundaries and attach no political significance to them.

Geographic names have been reviewed by the U.S. Board on Geographic Names and are as accepted by the Board, except for a few names that have changed since map publication and a few errors that were introduced during the compilations. Corrections have been made to names that will appear on the Pacific Basin (1:20 million scale) map.

Geological Map: Guidelines for construction of the geological maps were established early on as follows:

- Include only geological units that are required as background for the energy and mineral resources maps.
- Emphasize geological-stratigraphic similarities between different quadrants, and principally emphasize significant unconformities that have a bearing on the distribution of energy and mineral resources.
- Alter map-unit boundaries from quadrant to quadrant as needed, but keep colours of approximately correlative units the same from map to map.

Colours represent geological ages, whereas patterns (in black) depict rock types. Geological units are mapped from land to sea floor where data are adequate. Areas covered by water have a light-gray print to distinguish them from land. Geology of the land areas has been compiled, and work is progressing on compiling the geology of the sea floor.

Tectonic maps: In addition to structure, major stratigraphic units, and rock types, the tectonic maps will portray volcanism, seismicity (epicenters), thickness of relatively undeformed sedimentary strata on land, and, in oceanic areas, magnetic lineations, age of basement, and thickness of sediments above basement. They will identify the deformed rocks according to the age of the tectonism. The somewhat more subjective nature of the tectonic map has made it the most difficult of the series for which to establish compilation guidelines.

Geodynamic maps: As work on the project advanced, it became evident that many types of geophysical data could not be included in the map series as planned, and geodynamics maps were added. These will illustrate the crustal dynamics of the Pacific region by showing gravity and crustal-thickness contours, earthquake foci, volcanoes, heat flow, and faults. Faults will be identified as active or inactive, depending on available information. Other data are available, but the cartographic ability to represent the many data will probably determine what is shown.

Hydrocarbon resources maps: Data on hydrocarbons--oil, gas, heavy oil sands, oil shale, and coal--are being compiled on a background of geology and structure. The coal is classified as anthracite, bituminous, sub-bituminous, and lignite. Economic data will be summarized in tabular form. Deposits of radioactive minerals are shown on the mineral resources maps, and geothermal areas may be shown on the geodynamics maps. Thus, most geologically related sources of energy will be included.

Mineral resources maps: These, like the hydrocarbon resources maps, are to have a background map derived from the geological and tectonic maps. Mineral deposits are indicated by coloured symbols that show the locations of principal metals or mineral commodities present and geological type (as, for example, vein, stratabound), and the relative size of the deposit. One map showing known mineral and hydrocarbon occurrences will be prepared for Antarctica.

Figure 3. Computer plots by M.E. Paidakovich of mineral localities in southwestern Canada and the adjacent U.S. (international boundary at 49° N latitude). Small, medium and large deposits are represented by three sizes of symbols.

Because a great amount of mineral information would be gathered for the maps, it was decided that the data would be digitized. P.W. Guild, working with other project members, devised a computer coding form, and stocks of the form were provided to each panel.

K.M. Dawson has coded the data from western Canada in the Northeast Quadrant. These and most others from the quadrant have been digitized by M.E. Paidakovich and have been plotted on the quadrant base map. When data from the Pacific region have been gathered and filed, the data bank will be a valuable source of information for researchers. The distribution and size of selected mineral deposits (for example, porphyry copper) of designated areas can be plotted on any of several map projections and scales. (Four examples are shown in Fig. 3.)

Pacific Basin map: The final map of the Project's series will illustrate, in a still to be determined format, the relation of geological resources to the geology and tectonics of the region. It will be, in essence, a synthesis, at one-half scale, of the approximately 20 thematic maps that will precede it.

Relation to Other International Projects

The Map Project maintains liaison with other international programs and projects that have related interests. These organizations, which contribute to the Project by advice and consultation or by providing the results of their studies, include the Commission for the Geological Map of the World (CGMW), United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), ESCAP's Committee for

Co-ordination of Joint Prospecting for Mineral Resources in Offshore Areas (CCOP), ESCAP's Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC), the International Programme of Ocean Drilling (IPOD), the International Geological Correlation Programme (IGCP), and Studies in East Asia Tectonics and Resources (SEATAR), which is a cooperative project of the Intergovernmental Oceanographic Commission (IOC), the International Decade of Ocean Exploration (IDOE), and CCOP.

Conclusion

The Circum-Pacific Map Project is a volunteer effort involving about 100 men and women whose time and expenses are contributed by the companies, institutions, or agencies that employ them. The advantages and disadvantages of such a system are obvious: although a great many people contribute, they can do so only part of the time.

Coordinating the map compilations is also made difficult by the great distances separating members of the panels, as well as by the even longer distances separating panel chairmen. Members of the Antarctica Panel, for example, live in five countries, while the panel chairmen live in four widely separated countries. Each chairman, consequently, bears the considerable responsibility for bringing the compilations from his panel together in an internally consistent format that is also compatible with maps of the adjacent areas. The chairmen meet annually and when opportunities arise during other meetings to coordinate their work.

Despite these difficulties, the geographical and base maps of 1:10 million scale have been published, and compilation of the thematic maps is progressing well. At its conclusion, the Circum-Pacific Map Project will have brought together the results of many diverse studies having the common objective of a better understanding of the geological evolution and economic development of the Pacific Basin.

ABOUT THE AUTHOR: Chief of the U.S. Geological Survey's Circum-Pacific Map Compilation Project since 1975, Dr. Paul W. Richards was Chief of the Branch of Regional Geology in Kentucky for nine years and has, since 1958 undertaken several mapping projects on behalf of the USGS in India, Turkey and Indonesia.