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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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This report is dedicated to the late Linn Hoover. An editorial written by Dr. Hoover, a member of this committee, in February 1985 focuses on international geoscience cooperation and is pertinent to this report. His editorial is given in Appendix A.

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PREFACE

During the past decade increasing concern has been expressed over the deteriorating position of U.S. geoscientists in international activities, such as the inadequacy of U.S. support for the International Geological Correlation Program (IGCP). Our competitive position has been steadily eroded through declining U.S. activities at the same time that other countries (e.g., France, Federal Republic of Germany, the United Kingdom, Japan, and the USSR) are mounting vigorous international programs with broad government support.

H. D. Hedberg, originator of the IGCP, and W. G. Ernst, then chairman of the Geology Section of the National Academy of Sciences, requested an evaluation of the situation. Initial response involved a workshop on U.S. participation in International Cooperation in Science and Technology.

A more complete response assigned the study of the international situation to the Geological Sciences Board, now the Board on Earth Sciences. The board in turn established the Committee on Global and International Geology and charged it to report on all aspects of American participation in international geologic activities--academic, governmental, and industrial--and to recommend how current involvement could be improved and strengthened.* The full committee met three times and consulted with numerous other geoscientists in gathering the data for its report and recommendations.

This report primarily addresses decision-makers in governmental and nongovernmental organizations. Support of the Board on Earth Sciences and this committee by the following federal agencies is gratefully acknowledged: National Science Foundation, U.S. Geological Survey, Department of Energy, National Oceanographic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), Nuclear Regulatory Commission, and U.S. Army Corps of Engineers.

*The full charge to the committee is given in Appendix B.

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EXECUTIVE SUMMARY

This report addresses the three main aspects of international activities in the geosciences--basic research, economic applications, and the potential role of geosciences in U.S. foreign policy. Because the three are closely intertwined, the current deficiencies and the possible remedies overlap.

U.S. geoscience programs play an important role in international activities. The committee, with members drawn from industry, academia, and government, has considered the activities of American geologists and other earth scientists in international programs in relation to U.S. interests abroad, comparing them with those in the international programs of other industrialized countries. The committee concludes that (1) international geoscience needs to be strengthened to support the national interests of the United States; (2) geoscience personnel and the knowledge they possess should be more effectively used in helping to formulate foreign policy; and (3) U.S. economic and scientific interests can be strengthened by strong involvement of American geoscientists in U.S. international programs.

Geologic processes are global in scope, and many geologic phenomena that are known but imperfectly displayed in the United States must be studied in other countries in order to be understood. The principles of metallogenesis, tectonism, and crustal evolution that are applied to geologic studies in the United States are derived from observations made throughout the world. Geologic concepts tested in the United States are based on such worldwide studies of structural deformation, seismicity, volcanism, and other phenomena. The joint participation of U.S. geoscientists and their foreign colleagues in studies of geological phenomena is indispensable for the advancement and application of scientific concepts and techniques to economic and policy issues in the United States.

Cooperative geoscience programs abroad can contribute information to the important formulation and implementation of American foreign policy in many fields, including international trade and investment, access to mineral and energy raw materials, water resources development, isolation of hazardous wastes, development of seabed resources, international boundary disputes, and technical assistance programs. Such geoscience contributions must, however, be based on up-to-date knowledge of world geology, resources, programs, and data

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sources acquired by U.S. geoscientists through involvement in international programs, and interchange of ideas.

Geoscience programs conducted in cooperation with other nations can significantly benefit the U.S. economy. Current information applicable to mineral resource exploration and development is required to identify potential sources of raw materials, especially those not available in the United States. Also, U.S. industry needs the most accurate information possible about foreign resources to compete successfully in the international marketplace. Commercial and financial organizations require geologically informed analysis of optimum or potential production levels that bear on the self-sufficiency of other countries so that wise decisions can be made on trade and investments. Industry should be aware of opportunities for contractual geophysical and exploration services, potential equipment sales, and knowledge of mineral resources and reserves. Understanding of institutions, programs, and policies in other countries is vital to our national well-being.

The committee concluded that, with the exception of the petroleum industry, participation by American geoscientists in international programs has declined relative to that of many other nations over the past two decades. The federal government can use the geological sciences more effectively to support national security and resource policy interests. Thus, it is not surprising that existing U.S. programs of geoscience assistance and cooperation need strengthening, and the United States should establish a mechanism for coordinating the flow and transmission of geological and resource information from abroad to meet our scientific, economic, and political needs. Well-organized and well-supported programs in other countries, such as the Federal Republic of Germany, France, Japan, the Soviet Union, and the United Kingdom, show us that we should use the geosciences more intensively to advance our international interests.

This report not only stresses the broad relevance of international geoscience involvement to the conduct of U.S. foreign relations and the promotion of U.S. economic interests abroad but also points out specific areas where geoscientists and geoscience information could be used more effectively. The report emphasizes the importance of global geoscience research, showing how and why an enhanced international research effort is necessary, not only to reinforce our position in the world geoscience community but also to contribute more effectively to the political, economic, and social well-being of citizens of the United States.

Some specific needs and remedies are the following:

1. Foreign Policy. There is a need for a forum to increase the awareness among nongeologists of the importance of geoscience information in making decisions about foreign policy. Appropriate mechanisms are needed for identifying and monitoring such concerns as waste management, acid rain, hazard reduction, energy and mineral resources, and desertification in order to find what actions are required and practical. A vigorous program of cooperative basic

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research would help counteract any impression that the United States is interested only in developing resources and assuring their access from countries that are of strategic importance to us.

2. U.S. Economic Interests. To improve the competitive status abroad, we should (a) improve the flow and exchange of relevant geoscience information through the Science Attache and Regional Resource Officer programs; (b) reestablish (through the Agency for International Development or some other appropriate mechanism) cooperative geoscience programs with Third World and other significant countries. Such programs would involve studies in resources and hazards, other geologic investigations, training of personnel, and the publication of maps and reports.

3. Support for Basic Science. Because of the rapidly changing character of geoscience research, we should (a) increase our capacity for international consultation and exchange; (b) provide better support for current and future science and technology agreements; and (c) stimulate foreign field work by more U.S. geoscientists.

As an essential element to remedy existing deficiencies and to develop a long-term mechanism for an increased geoscience contribution to U.S. foreign policy, economic growth, and basic research, the committee recommends the establishment of an American Office of Global Geosciences whose advisory group would include both governmental and nongovernmental representation. The committee envisions this office as a small nongovernmental organization that would be financed by government and industry, and possibly private foundations as well, would serve as a clearinghouse for international geoscience information and activities, and would help coordinate projects and activities involving industry, academia, and government. It would provide long-term continuity of dynamic leadership in enhancing the cooperative role of the United States in international geoscience activities and would actively promote the participation of U.S. geoscientists in overseas research and development.

This office should be inaugurated and administered by an entity dedicated to solution of the global geoscience concerns raised in this report. Appropriate governing bodies include: (1) a consortium of federal agencies, such as Bureau of Mines (BLM), U.S. Geological Survey (USGS), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and Department of Energy (DOE); (2) a working group of solid-earth science professional societies such as American Association of Petroleum Geologists (AAPG), American Geological Union (AGU), and Geological Society of America (GSA); (3) the American Geological Institute (AGI); and (4) a board or panel of the National Research Council (NRC).

Having considered the importance of international geoscience programs in formulating and implementing foreign policy issues, and in advancing U.S. political, economic, and scientific interests abroad, the committee further recommends that funding for international geoscience activity should be increased in the overall federal budget. As an immediate action, the committee urges that new funding be

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provided for international programs already in existence, for example, in the National Science Foundation, U.S. Geological Survey, National Aeronautics and Space Administration, Department of Energy, Department of State, Bureau of Mines, and National Oceanic and Atmospheric Administration.

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1. INTRODUCTION

This report addresses all three aspects of international activities in the geosciences--basic research, economic applications, and the potential role of geosciences in fostering U.S. interests abroad. Because the three aspects are closely intertwined, the current deficiencies and the possible remedies are also intertwined.

Science is global; the laws of physics hold throughout the world. Thus scientists, especially those pursuing basic research, have a desire and a need for international communication. Because the world is their laboratory, the earth sciences, including the solid, liquid, and gaseous earth, benefit greatly from worldwide study and international communication. Of these, the study of the solid earth, the geological sciences, is in a period of rapid development occasioned by the advent of plate tectonics.

The concept of plate tectonics developed over the past 20 years has matured and has provided geologists with a credible theory and dynamic model that ties together the motions of continents, the origin of mountains and earthquakes, and the formation of many mineral deposits. To understand the components of this global model, the geologist must go where they are best displayed and communicate with colleagues from those areas.

Other geologic topics that are studied best on a global scale include volcanism, earthquakes, climatic cycles (including the glacial epochs of the recent geologic past), intercontinental correlation of geologic strata, and the action of survival processes on different landscapes under varying climatic conditions.

It was against this background that the Committee on Global and International Geology set out to investigate the perception that American participation in international geoscience activities was diminishing. It quickly became obvious that the general perception is true even though verifiable precise figures are difficult to obtain. Actual attendance at major congresses fluctuates rather widely depending on the time of year, geographic locale, and the presence or absence of other "inducements" (such as exchange rate)--and no real trend can be documented by the rough figures for attendance at general

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sessions of unions such as the IUGG and IUGS.* The decline becomes apparent when one talks to panel members for cooperative projects who have had to forego important symposia planning meetings or workshops due to lack of travel support.

Our descriptions, therefore, are anecdotal rather than quantitative, but they all point in the same direction, i.e., U.S. activities in the international aspects of the geosciences are decreasing.

The geosciences are vital to the welfare of all nations and should play an important role in a nation's economic and foreign policies. This has been recognized by many European countries, Japan, and the Soviet Union, all of whom have active programs related to the technical and material sources of the developing countries through cooperative projects, scientific exchanges, aid to their nation's private firms involved in developing markets, and more indirect means. Clearly, the United States needs to awaken to the role of the geosciences in the conduct of foreign affairs and the advancement of our economic interests overseas. It was the realization of this aspect of U.S. activity that persuaded the committee to interpret its charge broadly, and to emphasize "participation in all aspects of global and international geology."

The committee has summarized what it considers to be the major components of current civilian actions in American geoscience abroad. Discussion of activities directly related to national defense has been omitted, although the committee believes that the United States could benefit from international geoscience programs in this area too. For the sake of brevity, there is only limited discussion of the affairs of international societies because these are better known than are the activities of, for example, the regional research officers of the State Department or the compilation of data on foreign mineral deposits by the U.S. Bureau of Mines. These latter activities are summarized in the context of this report.

Finally, the committee has tried to point out in its recommendations not only the problems that need resolution but also how that resolution might be accomplished.

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*Actual numbers at IUGG have varied between 400 and 800 over the past 20 years, but the totals seem to reflect the place and time more than any other factor. Similarly IUGS (Congress) figures range between 350 and 750, the high figure coming from the very popular Copenhagen meeting in 1960.

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2. INTERNATIONAL GEOSCIENCE ACTIVITIES IN U.S. FOREIGN POLICY

BACKGROUND AND SIGNIFICANCE

International geoscience programs have made significant contributions to the formulation and implementation of foreign policy. Issues such as international trade, foreign investment, raw material inventories, mining of seabed resources, and international boundary demarcation involve geologic assessment of natural resources--energy, mineral, and water. Issues such as disposal of hazardous waste, minimizing environmental degradation, land utilization, and hazard identification and control require extensive knowledge of geologic and hydrologic processes. Policies on these and other issues of international concern must be based on adequate geologic information and expert opinion.

The United States is justifiably concerned with the adequacy and security of its supplies of energy and other mineral raw materials. Several times during this century, we have faced crises involving interruption of foreign supplies of raw materials, and our reactions were hampered by a deficiency of geological information regarding the source region or alternate source areas. Better foreign geoscience programs could improve the potential for assuring mineral and energy resources for future security of the United States. This is especially true now, when the collapse of domestic mining operations has made U.S. industry almost wholly dependent on foreign resources. An effective approach would be to strengthen developing countries through geoscience assistance programs designed to assess and stabilize their supply capability.

Despite past recommendations in this regard, the recently implemented National Materials and Minerals Policy, Research, and Development Act of 1980 (Public Law 96-479 96USC) has had no discernible effect on strengthening U.S. geoscience programs overseas and on the assessment of foreign resources. Congressional testimony on July 28, 1981, by the Deputy Assistant Secretary of the Department of the Interior (Appendix I) indicates but a small effort to assess foreign mineral resources or to stimulate their discovery and production under this act. Moreover, today's foreign assistance program virtually ignores this issue, as evidenced in the testimony of Secretary of State Schultz before the House Foreign Affairs Committee on February 9, 1984:

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> Our economic aid in FY 1985 will focus on increasing food production and reducing hunger; improving health, especially reducing infant and child mortality; slowing populations growth rates; spreading education and literacy; and improving host country financial structures.

It is remarkable that U.S. geoscience activities abroad receive relatively little support in times when the importance of science and technology in general has been recognized in American foreign policy issues. The importance of these disciplines in foreign relations was spelled out in the National Science, Engineering, and Technology Policy and Priorities Act of 1976 as follows:

> Fostering leadership in the quest for international peace and progress toward human freedom, dignity, and well-being by enlarging the contributions of American scientists and engineers to the knowledge of man and his universe, by making discoveries of basic science widely available at home and abroad, and by utilizing technology in support of United States national and foreign policy goals.

The significance of international cooperation in science and technology in relation to U.S. foreign policy was recognized in the President's message to Congress on July 11, 1983.

The extent to which some disciplines are currently involved in international relations is indicated by the more than 800 cooperative agreements in science and technology now in effect. Of these, less than 10 percent involve cooperation in the geosciences. On paper the number of geoscience cooperative agreements is slowly increasing (as shown in part by Appendix J) and includes agreements in such important areas as strategic minerals, military operations, economic assistance, seabed jurisdiction, and geologic hazards.

Unfortunately, lack of funding for U.S. participation renders most of the agreements either ineffective or totally inoperative. But with adequate funding many could yield significant benefits to us. For example, the agreement involving the U.S. Geological Survey and the Central Office of Geology of Hungary has had a wide range of benefits (see Appendix J) of far greater value than its cost. Yet this program is currently without funds. Such programs have great potential and should be more widely utilized and consistently supported.

The utilization of geoscience information and expertise in the conduct of foreign policy has been erratic and spasmodic. This is partly because there has not been a unified constituency in support of international geoscience programs within the policy-making levels of government. Many important issues could utilize geoscience input, but most of the people involved in foreign policy are unaware of this potential.

In the past, many contributions to foreign policy have been made by American geoscience programs and initiatives. For example, the long-range investigations of iron resources in Brazil, initiated in 1945 (Dorr, 1969) were part of a strategy for developing close

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political relations with countries regarded as especially important suppliers of minerals to the United States. During the 1950s and 1960s, geological and mineral projects in Turkey, Iran, and Pakistan were part of a U.S. mutual security strategy in the Central Treaty Organization (CENTO) countries, which included a CENTO Working Party on Mineral Development initiated by the Department of State (Central Treaty Organization, 1959). In 1982 and 1984, marine surveys for hydrocarbon resources in the Southwest Pacific by the U.S. Geological Survey and the University of Hawaii were carried out as part of an objective under the tripartite security agreement between Australia, New Zealand, and the United States. Many other examples of geoscience contributions to foreign policy objectives could be cited.

A modest increase in geoscience cooperation could help to counteract the impression that the U.S. government is interested in developing resources promoting economic stability only where we have immediate strategic interests.

EVOLUTION OF THE GEOSCIENCE ROLE IN MINERAL POLICY, FOREIGN POLICY, AND NATIONAL SECURITY

U.S. geoscientists have long been concerned with foreign policy issues that are related to our nation's raw material supply and its national security.

Mineral Policy

During and after World War I, the global struggle for minerals as an important factor in world politics and in American foreign relations was stressed by prominent geoscientist advisors to the U.S. government, notably Charles K. Leith, George Otis Smith, and Josiah E. Spurr. In reviewing the history of mineral policy during this period, Alfred Eckes (1979, p. 5) wrote that:

> Most important for foreign policy, the three understood that heavy mineral usage would exhaust America's rich natural endowments, and they anticipated the U.S. would become more and more dependent on foreign suppliers for high quality ores. This trend, they all emphasized, foreshadowed intense competition among industrial nations for overseas raw materials. And, based on Germany and Japan's aggressive quest for raw materials during and after World War I, the experts foresaw--accurately as it turned out--that the competition for strategic materials could thwart efforts to stabilize Europe and restore global prosperity.

Debate within the League of Nations regarding unequal distribution of mineral resources kept the issue in the news and generated serious concern within the United States during the years between World Wars I and II. Leith and others were involved in efforts to establish a more

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definite mineral policy in the United States through such mechanisms as the Mineral Advisory Commission established in 1928.

As World War II approached, it became clear that the German and Japanese quest for sufficiency in mineral resources was a principal factor in their growing militarism. The onset of World War II revealed the increasing vulnerability of the United States to the disruption of mineral supply. Countermeasures included the establishment of a mineral stockpile in 1939 and, in 1942, a program funded through the Board on Economic Warfare to procure mineral supplies and stimulate mineral production in Latin America. U.S. geoscientists were involved in these activities as advisors to the government, as members of mineral purchasing missions in Latin America, and as American representatives in the investigation of other sources of supply.

The U.S. concern regarding Latin American mineral production and supply resulted in the first major entry of U.S. geoscientists into the international arena through the Interdepartmental Committee on Scientific and Cultural Cooperation (ICSCC). The ICSCC was established and funded under Public Law 63, 76th Congress, May 25, 1938, and Public Law 355, 76th Congress, August 6, 1939, to coordinate specific international programs of federal agencies. Under this committee, U.S. geologists began investigations in Latin American countries to locate sources of strategic minerals. During World War II, this program was supplemented by funds from the Board on Economic Warfare and its successor, the Foreign Economic Administration. More than 60 geologists organized by the U.S. Geological Survey (USGS) conducted mineral investigations in 16 Latin American countries. In addition, American geologists were assigned to undertake terrain analyses, engineering studies, and hydrologic investigations to support actual or potential military operations in Europe, Africa, Asia, South America, and the Western Pacific. This led to the establishment of a Military Geology Branch within the USGS and a continuing, but now diminishing, program of classified geoscience studies to support strategic planning by the U.S. military.

The concern over strategic mineral supplies during World War II was, to a considerable extent, responsible for the establishment in the Department of State of the resources attache (regional resources officer) program after the war. Initially, this program consisted of a few professionals from the U.S. Bureau of Mines assigned to U.S. embassies. In 1975, the program was reorganized and enlarged, and foreign service officers were assigned to the positions of resources officers. Despite fluctuating support and frequent changes of staff, the program has generally been an effective mechanism for obtaining information regarding resources and related programs, although most resource officers are not geoscience professionals. There are currently regional resources officers in 10 U.S. embassies and designated resources reporters in 9 others. A significant aspect of this program is that it reflects a recognition within the Department of State of the importance of earth resources in the political relationship of the United States to other countries. However, the program is not adequate in scope and expertise to meet our present-day

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needs for resources information in support of our mineral policy and national security requirements.

After World War II, concern over resources led to the appointment of the President's Materials Policy (Paley) Commission under the Truman administration. The commission concluded that "the basic problem of materials policy in the field of foreign resources is to determine the methods the United States should adopt to promote the production of materials abroad and, at the same time, to help fulfill the aspirations toward general economic development of the countries which possess rich resources" (Paley Commission, 1952, p. 59). The implication was that the United States should help other countries develop their geoscience and resources institutions and programs in order to increase production of raw materials as a means of supplying their own needs as well as the needs of the United States and other consuming countries. The foreign assistance program, which was a major vehicle for providing effective help in geologic work in the 1950s and 1960s, no longer offers significant support in the geosciences.

The Korean War revived interest in the problems of raw material supply and generated new demands for a realistic national mineral policy. Steidle (1952, pp. 132-142) called for steps toward an international mineral policy, beginning with a survey of the world's mineral resources and utilizing the foreign assistance program as a contributing mechanism. A decade later, Landsberg (1964) concluded that, although the unprecedented U.S. demands for raw materials to the end of the century could be met through a variety of means, raw materials from abroad would clearly be an increasingly important factor that required greater attention by the United States. Such concerns resulted in the National and Minerals Policy Act of 1970, but this act unfortunately did not produce any significant increased effort toward international geoscience and resources programs. In fact, the effective level of such activity probably declined during the 1970s.

The mineral supply issue came to the forefront once again in the early 1980s, and resulted in the National Materials and Minerals Policy, Research, Development Act of 1980. This act recognized that "the United States is strongly interdependent with other nations through international trade in materials and other products." It called for the President to "assess the opportunities for the United States to promote cooperative multilateral and bilateral agreements for materials development in foreign nations for the purpose of increasing the reliability of materials supplies to the Nation." Unfortunately, this act, like its predecessor, has not had any appreciable impact toward strengthening U.S. geoscience and resources programs abroad.

Although various agencies are involved in geoscience activities that concern their own special interests, few of these involve investigational programs and cooperation with other countries to provide information regarding world resources needed for mineral policy and security purposes. The U.S. currently has no coordinated or overall program for the application of geoscience to our interests in economic policy or national security.

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Foreign Policy

Immediately after World War II, geoscientists were used extensively by postwar occupation forces in the reconstruction and stabilization of occupied countries. Geoscience assistance programs were undertaken by the USGS in the late 1940s and included a survey of iron ore deposits of Minas Gerais, Brazil; studies of coal resources in Greece and South Korea; and a long-range program to develop the Philippines Bureau of Mines in order to survey the mineral resources of the Philippines.

In the 1950s and 1960s, geoscience activities were a major component of the U.S. foreign assistance program, conducted successively under the Economic Cooperation Administration, Foreign Operations Administration, International Cooperation Administration, and Agency for International Development. During these decades, U.S. geoscientists aided in strengthening geoscience agencies and programs in more than 70 countries. Broad institution-building efforts, such as in Chile (Ericksen et al., 1963) and Pakistan (Khan and Reinemund, 1963), became models for assistance that led to close cooperation between American geosciences agencies and their counterparts abroad. Along with such institutional assistance, U.S. geoscientists stimulated economic growth through studies of important resources such as industrial minerals in Thailand (Jacobsen et al., 1969) and water resources in Asia, Africa, and South America (Taylor, 1976). The training of foreign geologists was an additional accomplishment.

In some countries, U.S.-funded programs contributed directly toward the implementation of foreign policy issues. For example, a major cooperative research effort on salinity and water logging in the Indus Valley of Pakistan in the 1960s was partly an outgrowth of a Presidential mission headed by Roger Revelle. Geological cooperation with Indonesia strengthened U.S. relationships with Indonesian scientists during the period of the Sukarno administration and aided in reestablishing official American programs in that country. USGS assistance in geological mapping and resources studies in Saudi Arabia, initiated in the 1950s, is one of the few surviving programs and is a significant element in U.S. relations with the Saudi Ministry of Petroleum and Mineral Resources.

The role of geology in the American foreign assistance program declined substantially in the 1970s when the Agency for International Development (AID) decided to focus on other sectors, especially agriculture. This policy has placed the United States behind other scientifically advanced countries in the size and scope of geological activities in most developing countries; it has made it difficult for those countries to gain access to U.S. geological expertise and technology; it has resulted in a loss of our contacts and influence among the geological and resource community in most developing countries; and it has decreased the opportunities for American contractors and suppliers to participate in the aid program. This low level of U.S. geoscience participation abroad still persists in most countries and has been cited in the report on Opportunities for Research in the Geological Sciences by an ad hoc committee of the

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National Research Council's Board on Earth Sciences (1983, p. 78), as follows:

> Both the Soviet Union and the People's Republic of China allocate very sizeable financial and personnel resources to huge earth sciences research programs, with the express intent of strengthening their economies and solving internal problems related to geological hazards. Countries like Poland and Czechoslovakia direct a large proportion of their geological budgets to studies in third-world countries. In contrast, the United States in recent years essentially has abdicated its former preeminent position in supplying technical assistance in the earth sciences to developing countries.

On paper, geoscience cooperation with other countries as an instrument of foreign policy has increased during the 1980s. A number of intergovernmental science and technology agreements negotiated to strengthen political relationships with other countries (such as Brazil, China, Mexico, and Venezuela) have included components of geoscience cooperation. The formal agreements were supplemented by memoranda of understanding between appropriate U.S. agencies and their counterparts. For example, the USGS has nearly 50 current agreements for scientific, cooperative, or technical assistance covering a wide range of subjects. However, no funding accompanies most of these agreements, and the level of activity has therefore been minimal. A welcome exception is the cooperative science and technology agreement with Spain, which provides funds under an agreement covering the use of military bases in that country. Cooperative agreements with Egypt, India, Morocco, Pakistan, and Yugoslavia have utilized U.S.-owned foreign currencies to meet operating costs in the respective countries, but most of these funds have been depleted.

The U.S. policies of the 1970s toward use of geological programs have continued with little change under the present administration, with two significant exceptions, one positive in part, one negative.

On the positive side is support, under the foreign assistance program, for participation in geologic and hydrologic hazard assessment, mitigation, and training. A number of regional and bilateral projects in earthquake monitoring and risk analysis have been developed, and a new program of geologic and hydrologic hazard training has been developed jointly by the USGS and the AID Office of Foreign Disaster Assistance. The elements of this program are described in Appendix L. But although this program was supported adequately for one year, when the initial training course was successfully conducted, the remaining funds were withdrawn (by AID) and the activity has been suspended, at least temporarily.

On the negative side is the decline of U.S. leadership in international applications of remote sensing. This results principally from lack of sufficient U.S. government interest and support for remote sensing applications research. The uncertain future of U.S.-owned earth resources satellites and consistent efforts by other countries to

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move into areas of research and training in remote sensing technology previously dominated by the United States also contribute to our declining influence. Also, the earth resources satellites have become the exclusive property of private industry and access to the data becomes unduly expensive or restricted.

Another factor, and perhaps the most important one of all, is the increased international geoscience activity of countries such as France, Japan, and West Germany. They have become active competitors for geoscience information, resource evaluation and development, sale of technical equipment, cooperative research programs, and training of geoscientists. Such competition has been particularly effective where American involvement has decreased because of U.S. policy decisions. Brazil is an example. Here training by U.S. geoscientists, particularly those from the USGS, helped to establish most of the Brazilian geoscience cadre during the 1950s and 1960s. This U.S. support was terminated in 1976. Since then, other countries have stepped in to take our place, and the flow of important geoscience cooperation and information between our two countries has waned.

Geoscience training and education in foreign countries should be a major goal of our international effort. Well-trained geoscientists should be encouraged to fill the important positions within their own countries. Continued cooperative programs should be maintained; otherwise our foreign competitors will have the market to themselves.

Maintaining contact with leaders of agencies concerned with the geosciences and resources abroad is of primary importance in promoting mutual understanding of policy issues, encouraging collaboration in programs of mutual interest, and stimulating exchange of information. This seems to be recognized by other industrialized countries, who have developed various mechanisms for maintaining such contacts. For example, the Bundesanstalt für Geowissenschaften und Rohstofte of the Federal Republic of Germany has established a program of annual symposiums on resource issues. The fourth of these was held in October 1985 in Hannover (Appendix M). The only comparable activity that has ever been initiated in the United States is the nongovernmental Circum-Pacific Council with its Circum-Pacific Map project and its conferences.

France set a noteworthy example of government support for international geoscience support at the 1980 International Geological Congress. At the closing ceremony of the Congress, the then president of France (Giscard d'Estaing) announced the establishment of the Center for Training and Exchanges in Geosciences (Appendix N). France committed more than $2 million toward the operation of the center in 1983. In addition, French geoscientists have just completed an extensive 3-year cooperative program with the People's Republic of China on the geology and geophysics of southern Tibet. This was the first major modern geoscience investigation into this region, and it has already made significant contributions to our understanding of the processes and evolution of collisional mountain belts. Many other such scientifically important and poorly studied areas could be the focus of intensive and well-designed cooperative programs.

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SUMMARY

Areas in which the American geosciences have in the past made significant contributions to major foreign policy issues include the following:

Strategic mineral supplies--Foreign sources of supplies to meet U.S. needs were identified.

Energy resources--Activities of the major petroleum companies were and still are major factors in our being able to assess global reserves and potential sources of fossil fuels.

Economic assistance--Mineral resources were appraised and resource institutions and programs to aid the economic growth of developing countries have been established.

Mineral operations--Geologic and hydrologic conditions that affect military operations were determined and bases for postwar reconstruction established.

Hazard assistance--Geologic and hydrologic hazards were evaluated, risks analyzed, and measures to minimize future damage defined.

Use of outer space--Peaceful applications of satellites for earth resources studies and geodynamics studies have been undertaken and contributions have been made to lunar and planetary exploration.

Scientific cooperation--Joint geoscience research and exchange activities to support U.S. policy initiatives with foreign countries were developed.

Seabed resources--Seabed resources were identified and assessed and contributions were made to the drafting of national and international jurisdiction regulations.

Through these and other contributions, U.S. geoscience demonstrated its capacity to be responsive to the needs of foreign policy in many issues. Today only the activities in petroleum approach adequacy.

Although these contributions are recognized by many involved in past foreign policy formulation, the importance of making geoscience most effective in the conduct of future foreign policy has been less well recognized in the past 10 to 15 years. World history for the first half of this century shows that the United States needs information about--and access to--mineral resources if we are to survive economically and politically as an industrialized nation.

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3. INTERNATIONAL GEOSCIENCE ACTIVITIES IN U.S. ECONOMIC INTERESTS

BACKGROUND

In the past, international activities of U.S. geoscientists in industry, academia, and government have contributed significantly to the growth of our economy. American geologists have identified and appraised foreign sources of raw materials for U.S. industries and have assisted in foreign exploration and production activities of U.S. companies. Geoscientists have stimulated American exports through the strengthening of foreign resources programs, institutions, and industries requiring U.S. goods and services and have opened channels of communication with resource agencies in host countries.

The Committee on Global and International Geology has concluded that the international role of American geosciences today is not adequate to meet present and future U.S. economic needs. For example, there is no coherent U.S. policy on either hard minerals or fossil fuels, a conclusion documented in the recently published book *International Minerals: A National Perspective* (Agnew, 1983). The U.S. economy is rapidly becoming dependent on other nations for raw materials, trade, and investment. This dependence has created a growing need for information, contacts, and cooperative arrangements developed through geoscience activity abroad. Industry alone does not and probably cannot have a coordinated sustained program to fulfill this need, most especially for the nonfuel minerals.

The need for international geoscience information and personnel has expanded into new areas such as banking. Many American banks now have their own professional staffs involved in the collection, review, and appraisal of data on mining and energy to support their investment decisions (Agnew, 1983).

The growing dependence of the U.S. economy on resources from the rest of the world is indicated by a February 1984 news release from the State Department stating that in 1982 the U.S. imported $255 billion worth of goods including a fifth of the raw materials that we consume. In a December 1983 news release, the State Department noted that U.S. exports to the less-developed countries increased a third in the past decade and now total over $83 billion; U.S. private investment in these countries has been increasing over 11 percent per year and now exceeds $50 billion; these countries provide a large proportion of our raw

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material imports including "more than half our imports of such important metals as tungsten, bauxite, tin and cobalt." Our dependence on foreign sources for a large fraction of our petroleum needs is well known and is increasing despite our best efforts to expand domestic supplies.

Faced with this growing dependence on foreign raw materials, the United States should, in its own best interests, increase its geoscience activities in the developing countries. Such an integrated effort to establish a comprehensive international geoscience program to support U.S. economic interests currently does not exist. The State Department has increased its attention to the need for information on mineral resources. A new training program has been started, and regional resource officers at our embassies are being given increased responsibilities. This is a good first step, but the program would be more effective if it included professional geologists and engineers. Moreover, the State Department cannot deal with the whole problem alone.

While the United States lacks focus in international geoscience efforts, other industrial countries have implemented and expanded their programs. The Federal Republic of Germany, France, Japan, the Soviet Union, and the United Kingdom all have large government-supported international geoscience assistance programs and are intensifying their efforts in the less-developed countries. To understand the gravity of this situation, it is important to review the evolution that has occurred in the U.S. economic position abroad as related to the role of geoscience programs.

EVOLUTION OF GEOSCIENCE ACTIVITIES ABROAD IN RELATION TO U.S. ECONOMIC INTERESTS

A quarter of a century ago, the U.S. economic position in relation to the rest of the world began to undergo a significant change. Before the 1960s, American industry had a relatively uncomplicated status in the foreign arena. Our oil and mining companies had ready access to foreign resources, exploration and development by U.S. companies abroad were welcomed on favorable and nonrestrictive terms by developing countries, and competition for leases from other industrialized countries was minimal. U.S. service and supply contractors were preeminent, and American equipment and expertise dominated foreign markets. U.S. geoscience programs circled the globe, primarily through extensive U.S. government foreign assistance projects, and critical information regarding foreign resources, programs, and institutions required by American companies and investors was readily available.

Since 1960, our economic position abroad has changed considerably, not only because of greater U.S. dependence on foreign raw materials and markets, but also because of increased competition from other industrialized countries, rising costs, greater risks of achieving successful foreign raw material exploration and production, increased demands and astuteness of producing countries, and broader diversification of the U.S. worldwide economic interests.

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The evolution of American economic interests and geoscience activities abroad may be reviewed through six subject areas: energy and mineral resources, seabed resources, polar studies, geologic hazards and the environment, remote sensing, and contractural services and equipment.

Energy and Mineral Resources

The growing dependence of the United States on foreign sources of raw materials is certainly a matter of concern for national security and foreign policy. It is also especially important because of its impact on the American economy. U.S. petroleum and mining companies must continually seek raw materials abroad and purchase materials from foreign suppliers. This is due both to higher production costs and declining reserves in the United States and to the attempt to assure adequate long-range supplies. In order to secure supplies of overseas resources, U.S. industry needs comprehensive information concerning known and potential undiscovered resources, alternative sources of a particular commodity, leasing and investment opportunities, and resource institutions in order to compete successfully. The problem is far bigger than any company; hence the government should take steps to assure our competitiveness and the security of an adequate supply of all necessary minerals.

As already stated, U.S. economic interests abroad flourished for about 15 to 20 years after World War II. Petroleum exploration and development progressed rapidly in Venezuela, Nigeria, and Indonesia. The huge oil resources of Saudi Arabia were tapped by U.S. companies and led to the formation of the Arabian-American Oil Company (ARAMCO).

The history of ARAMCO is both a chronicle of successful application of the geosciences and an illustration of the evolution of circumstances that can and do dramatically affect U.S. economic interests. After the 1932 discovery of oil in Bahrain, the Standard Oil Company of California became interested in the oil potential of adjacent unexplored Saudi Arabia and in 1933 negotiated a concession. California Arabian Standard Oil Company was formed to manage the exploration activities.

Shortly thereafter, Texaco, with established eastern hemisphere marketing operations, became a partner in the Bahrain and Arabian undertaking, resulting in the organization of Caltex Petroleum. The Saudi Arabian operation was renamed Arabian American Oil Company (ARAMCO) in 1944. As the magnitude of Saudi Arabian reserves became apparent, Exxon and Mobil, with their sizable additional marketing facilities, became partners in 1948.

ARAMCO held 100 percent ownership of the oil within the concession and paid a per ton extraction royalty until 1950, when Saudi Arabia decreed an income tax levy. This basic arrangement continued into the 1970s, modified by numerous renegotiations regarding the profits division between ARAMCO and the government of Saudia Arabia, resulting

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in an overall increase in the latter's share of the company.

In 1973, the government of Saudi Arabia obtained a 25 percent participation in ARAMCO's crude oil concession and production assets. Then in 1974, Saudi Arabia acquired a 60 percent participation position, and in 1976, agreement was reached for the government to take over essentially 100 percent of ARAMCO's operation. The ARAMCO shareholders, Chevron, Texaco, Exxon, and Mobil, continue to provide various professional/technical services to ARAMCO, while ultimate approval of ARAMCO's business programs and budgets resides with the Saudi Arabian government.

The history of expropriations, renegotiations, policy changes, and related problems that have affected U.S. mining and petroleum companies, especially in the developed countries, has been extensively documented. Many of the problems were a result of a wave of nationalism, coupled with misunderstanding of the local procedures to be followed in resource exploration and production. In some countries, this nationalistic policy has subsided. New concessionary arrangements have been negotiated, and opportunities exist for more. The committee believes that the general retrenchment of official U.S. geoscience activities abroad removes a viable vehicle that could improve our overseas image and provide new cooperative arrangements beneficial to private industry.

Of particular concern is the current low level of U.S. government-supported activity in the exploration and assessment of resources of developing countries, where scientific and technical assistance is urgently needed to maintain and increase the raw material production. Private investment in mining within the less industrialized but developed countries has risen, as shown by the International Economic Studies Institute (1976, p. 22) statistics, but activity in the less-developed countries has been smaller and erratic (Korsten, 1983, p. 78). A major raw-material-consuming nation such as the United States cannot afford to neglect the strengthening of the developing country resource industries as potential sources of supply and as potential markets. These countries should not feel that the United States is interested in their well-being only to the extent that American interests are threatened. The International Economic Studies Institute therefore recommended that we give higher priority to resource objectives in our bilateral relations with other countries overall and improved cooperation on resources matters. Fundamental changes in institutions, procedures, and policies will have to be made in less-developed countries through government-sponsored assistance programs in order to improve investment opportunities for private capital. In a recent address, the U.S. Deputy Assistant Secretary of State for International Resources and Food Policy stated that:

> the best way for us to demonstrate our concern that this economic interdependence in minerals trade remains beneficial to all parties is to take every opportunity to strengthen and solidify our ties with producing countries, to encourage them to invest in and develop resources for the future, and help

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them search for new sources of supply and ways of maximizing existing resources.

In the field of nonfuel minerals, U.S. geoscientists were active abroad during the 1950s and 1960s and identified and assessed many important foreign mineral resources, e.g., iron and manganese in Brazil; chromite, copper, and nickel in the Philippines; and potash in Thailand. Most of these efforts were carried out under the foreign assistance program. Major mineral districts and sedimentary basins were mapped and evaluated for raw materials. Such activity, together with the development of counterpart resource institutions and programs in host nations, benefited the American economy in terms of identifying sources of raw materials, leasing and investment opportunities, and needs for contractual services. Through the publication of maps and reports by organizations such as the U.S. Bureau of Mines, U.S. Bureau of Reclamation, and U.S. Geological Survey (1968, 1976), U.S. companies and investors obtained substantial information regarding opportunities abroad. Moreover, the strengthening of geoscience programs in the host countries improved their capacity to trade with the United States through mutually beneficial joint ventures.

The National Commission on Materials Policy (1973, Chapter 9, pp. 11-15) pointed out the need for encouraging U.S. investment abroad in the extractive industries through creation of investment climates attractive to the investor and acceptable to the host country. The commission urged that this be achieved in part through intergovernmental cooperative arrangements. One of the most direct ways to achieve these objectives is through government-sponsored geoscience cooperation and resource assistance programs. Similarly, the International Economic Studies Institute (1976, p. v) recommended that the United States should "seek closer cooperation on raw materials matters." The National Materials and Minerals Policy, Research, and Development Act of 1980 directs the President to "promote cooperative research and development programs with other nations for the equitable and frugal use of materials and energy." An adequate response to these directives should involve a well-integrated and comprehensive international geoscience program.

By way of contrast, other industrialized countries have major programs already in place. The growing international competition from these countries, which was reviewed by the National Commission on Materials Policy (1973, Chapter 9, pp. 15-18), has, in recent years, been strengthened through geoscience initiatives. The Federal Republic of Germany has a well-financed, worldwide resource research and assessment program carried out by the Bundesanstalt für Geowissenschaften und Rohstofte (BRG). France has a similar program integrating mining and technological operations, through the Bureau de Recherches Geologique et Miniere (BRGM), and recently initiated the Center for International Geological Exchanges (CIFEG). Japan has a joint industry/government Institute for International Resources Development, which deals with foreign mineral and petroleum development agencies, expanding technical cooperation based on untied loans (Kuroda, 1985), and strengthening human resources, e.g., training

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(Arita, 1985). The Soviet Union and the United Kingdom also have major programs, and Canada, Norway, and Sweden are rapidly expanding their international geoscience cooperation.

One of the most important requirements for U.S. industry and investment abroad is geological and resource information. Although a considerable amount of such information is available, especially in libraries of the USGS and in the Library of Congress and through foreign mineral statistics published by the U.S. Bureau of Mines, no comprehensive effort has been made to collect, catalogue, and maintain the maps, published reports, and unpublished documents that can provide up-to-date information about known and potential resources. Of special concern is the deficiency of available maps of many areas of the world and the lack of a library for a vast number of valuable but unpublished documents that flow from international commissions, workshops, and organizational activities. Even those foreign maps and unpublished reports that may exist in the United States are difficult to identify, locate, and obtain. The United States needs a more comprehensive, centralized, and readily accessible library and information system for foreign maps and documents, along with an integrated data center dedicated to international geoscience activities. Landsat data that can partially fill this gap have become too expensive for many potential users.

Many new data about geology and resources in other countries could be obtained and made available for U.S. industry and research if the United States could respond to requests from developing countries for help in compiling, citing, and publishing information and manuscript maps in the fields of resource agencies abroad. Such requests have been received by the State Department, the USGS, and the U.S. Bureau of Mines from more than 20 countries in recent years, including Peru, Bolivia, Thailand, the Philippines, and several African countries. But, except in a few instances, the funds and capacity for such assistance have been too restricted.

The United States should assist in compiling, processing, and publishing the vast amount of unpublished material that has accumulated in geological and resources agencies in many developing countries. The value of such a cooperative effort has already been demonstrated by the Circum-Pacific Map Project. This project, initiated in 1972 as an activity of the Circum-Pacific Council on Energy and Mineral Resources, has involved scientists and organizations from over 30 countries. It is engaged in compiling and publishing a series of 47 geologic, tectonic, and resources maps at scales of 1:20,000,000 to 1:30,000,000 covering the Pacific Basin and surrounding continental areas (Reinemund et al., 1982; Reinemund, 1984). In 1984 the Circum-Pacific Council became affiliated with the American Association of Petroleum Geologists as its only international section. Along with other activities of the council, the map project represents one of the largest and most significant international geoscience initiatives in the past decade. It has contributed markedly to the availability of information on geology and resources of the Pacific region. Although it is a nongovernmental initiative, it has received extensive cooperation and some key funding from several government agencies, notably the USGS and

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the Department of Energy. This is an excellent example of a situation in which a small but necessary expenditure of government money and cooperation has contributed to the success of a major international geoscience initiative. (It is interesting to note that the success of the Circum-Pacific Map Project has led to widespread discussion on having a similar project in the Atlantic region, and the International Union of Geological Sciences is currently working on plans for such a project.)

Although the activities of the Circum-Pacific Council are limited to the Circum-Pacific region, its efforts are exceedingly valuable to the United States. It constitutes a most significant and fundamental international geoscience effort for all of the Pacific-rim countries, including the United States. While the Council is not heavily funded, it has accomplished its many objectives, and has successfully addressed cooperative projects that are essential for definitive resource assessment between many of the circum-Pacific countries.

Seabed Resources

The Circum-Pacific Map Project is currently publishing a new map of the distribution and metal contents of seabed manganese nodule concentrations in the Pacific Basin. This compilation, along with the ongoing studies of seabed sulfide deposits in the eastern Pacific (Rowland et al., 1983) and cobalt crusts in the central Pacific (Clark et al., 1984), are indicative of the growing interest in seabed resources.

International geoscience research of the ocean basins has been led by the United States through projects such as the International Decade of Ocean Exploration and the Deep Sea Drilling Program. These efforts will continue through the Ocean Drilling Program and geophysical research projects now being developed. From an economic viewpoint, the extent and evolution of U.S. interests have been described by Flipse (1982) through his explanation of the background for the Deep Seabed Hard Mineral Resources Act (Public Law 96-238) and the subsequent U.S. refusal to sign the United Nations Law of the Sea Treaty (Brown, 1983). The recent proclamation by President Reagan of the Exclusive Economic Zone has tripled the area of U.S. jurisdiction over offshore resources, which should expand plans to assess American seabed resources.

Past ocean drilling and geophysical research programs, together with offshore surveys by oil and mining companies, might indicate that U.S. geoscience efforts related to seabed resources are fully adequate. There are, however, three major problems. First, much of the accumulated data have not been adequately synthesized, compiled, and interpreted as related to resource assessment. Scientists have been more interested in making overall interpretations, in testing fundamental concepts, and in obtaining more data to test these concepts than in detailed analysis of available data. Second, more detailed studies of selected areas are needed both within the U.S. economic zone and in other areas of potential interest to U.S. companies to provide

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a base for resource assessments. Third, more cooperative research programs are needed to develop better relationships with other countries and to aid in evaluating and developing their resources. The program of studies in East Asian Tectonics and Resources (SEATAR) carried out jointly by the Coordinating Committee for Joint Prospecting for Mineral Resources in Asian Offshore Areas (1980) and the intergovernmental Oceanographic Commission with help from the National Science Foundation could serve as a model for this type of effort.

Although the United States is the major power in seabed research, extensive and well-directed programs are being carried out by the Federal Republic of Germany, France, Japan, and the Soviet Union. Most of their activities are more directly related to their particular resource interests than are U.S. government-sponsored activities. For this reason, the United States should maintain an aggressive international seabed resource-oriented geoscience program, fully utilizing the data already available, and should seek closer involvement of other countries.

Polar Studies

Arctic exploration and possible development of resources in the polar regions are receiving increasing attention. In the Antarctic, there is an even greater need for intensive geoscience programs because of the larger areas and multinational interests involved. The United States has continued a long-range program of topographic mapping of Antarctica for many years, which has included resource, stratigraphic, structural, paleomagnetic, and geophysical studies. Offshore surveys have been sporadic and limited to specific areas of interest, relying in large part on cooperative arrangements with other nations. The Antarctic cruise of the U.S. Geological Survey's S.P. Lee in 1984, which was supported also by the Circum-Pacific Council, is a step in the right direction.

In view of increasing economic interests in the Antarctic region, an expansion of U.S. geoscience activity, especially offshore, is recommended. The USGS (1978) has issued an assessment of Antarctica resources and is compiling geological, geophysical, and resources information on the region through the Circum-Pacific Council's Map Project. The more information that is compiled and evaluated, the better the decisions that will be made regarding alternative regimes for mineral resources development. This information is important for the renegotiation of the Antarctic Treaty.

Geologic Hazards and the Environment

Natural catastrophes affect economies and the capacity for production and trade. These effects of geologic and hydrologic hazards--earthquakes, volcanic eruptions, landslides, subsidence, and floods--are costly to the U.S. economy both at home and abroad.

International geoscience programs for the study and mitigation of

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such phenomena are therefore relevant to U.S. economic interests as well as to science. Such programs commonly involve the study of processes that are active in the United States but are better displayed abroad.

This is a bright spot in our foreign program. Geological hazard phenomena have received considerable attention under the U.S. Foreign Assistance Program. The Office of Foreign Disaster Assistance (OFDA) of the Agency for International Development has sponsored hazard-response and risk-analysis projects, especially in connection with volcanism and earthquake activity. That office is currently sponsoring regional earthquake studies in Southeast Asia and in the Andean countries and volcanic hazard studies in several nations. And sponsored by OFDA, the USGS has recently initiated a training program primarily for individuals and agencies responsible for planning and managing hazard investigations and disaster-response programs in developing countries.

Under a joint USGS/NSF cooperative program with the State Seismological Bureau of China, U.S.-made earthquake monitoring equipment is being installed in China. Data from subsequent studies utilizing these detection devices are expected ultimately to improve the understanding of earthquake mechanisms along the U.S. Pacific Coast. Similarly, American equipment is being installed in Indonesia as part of a volcano-monitoring program.

The potential economic benefits to the United States of international geoscience programs dealing with hazards and environment can be significant but are difficult to quantify, especially the intangible benefits of goodwill that would result in expanded U.S. trade and investments. The American commitment to overseas hazard program funding may be adequate in relation to our overseas economic interests. Nevertheless, there is need for improved coordination, staffing, and continuity of the U.S. international program involving disaster-response and environmental degradation studies.

Remote Sensing

The United States led the world in the development and application of remote sensing technology in the late 1960s and during the 1970s. This leadership resulted in large part from the earth resources (Landsat) satellites; from a well-coordinated program of research on remote sensing applications, including lunar and planetary investigations; from experimental satellites, such as Seasat; and from establishment of a highly efficient worldwide satellite data reception, processing, distribution, and training network. The consequent growth in the recognition of the value and application of remote sensing data to geological, hydrologic, agricultural, and oceanographic research projects was phenomenal. Because remote sensing provides a synoptic mechanism for the mapping of terrains, facilitates recognition of remote or obscure structures, aids in the discovery and assessment of mineral resources, accelerates the survey of land use, and creates a data base for regional syntheses, it provides an exceptionally

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effective basis for international geoscience cooperative programs. Such projects should include research on fundamental geologic and geophysical problems, training nationals of other countries, and exposing U.S. commercial and scientific capabilities to the rest of the world.

In the 1960s, improvement in sensors and data management followed the first satellite launchings, and optical remote sensing expanded rapidly both in spectral and in spatial resolution. By the mid-1970s both passive and active microwave sensors were placed on free-flyers. Researchers interested in the applications of these new types of data, such as those from the multispectral scanner on ERTS-1, soon recognized the need for such data, and sensors and missions were designed to meet expanded research objectives. The availability of synoptic and repetitive coverage from space encouraged large segments of the scientific community into direct involvement with remote sensing both as users and as planners. Surveys, which were initially stand-alone projects, merged with the more conventional geological, geophysical, and geochemical data bases. This integration generated the need for sophisticated data management and an increased desirability for worldwide dissemination of the data. U.S. leadership was particularly visible in distributing scientific results, in assisting other countries to organize receiving stations, and in training nationals.

Today U.S. leadership in remote sensing applications is rapidly diminishing. This is partly a result of aggressive international competition from other industrialized countries, such as the French SPOT and European Space Agency ERS satellite systems, a forthcoming international Japanese resources satellite system, and the Netherlands remote sensing training programs. But in part the weakening of American research satellite programs and applications is due to our increasing emphasis on the military use of remote sensing equipment. Recent changes in the Landsat program can have a serious international impact on projects that assess hazards and disasters, crop production, precipitation, desertification, and other natural phenomena.

Costs of remote sensing data from U.S. satellites are increasing, in part because of greater competition from other countries with larger space study subsidies and in part because the United States has diverted budgetary resources from the cheaper free-flyers to the more expensive manned Shuttle missions. Decentralization of facilities for processing and training has responded to the objective of commercializing space-related activities in the manner of communications technology, but this policy has not taken into account the needs of more specialized user communities, or the goodwill created in assisting other countries on a government-to-government basis.

The decline in support for research applications, both here and abroad, is limiting the options for American researchers, restricting their advantage over other nationals in this field, and reducing the U.S. lead in training capability as well. It is also forcing a curtailment in the operations of American research institutions. Other nations will not likely adhere to an open-sky policy and to the concept of freely disseminated information, because they see a strategic and commercial value in such data. Such developments will adversely affect

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U.S. participation in international cooperative geoscience programs. These factors, combined with the lack of forceful leadership and clear objectives, are reducing the opportunities to use this technology as a basis for strengthening U.S. geoscience participation abroad.

It is particularly unfortunate that U.S. support for remote sensing applications and research is restricted and disorganized on a worldwide basis. New satellite systems now being conceived, especially in geophysics, offer extensive possibilities for international cooperation and joint research on geoscience and resources problems. Such remote sensing mapping programs, if implemented, could help alleviate the widespread nonavailability of conventional maps.

Another aspect of the decline in U.S. leadership in space is that remote sensing contractors and equipment manufacturers are finding a rapid increase in competition from other advanced countries. Thus U.S. industry is losing international markets for services and equipment to aggressive competitors from other countries.

Contractual Services and Equipment Market

One of the significant economic benefits of strong international geoscience programs is the entree created for U.S. contractual services and equipment sales. Two decades ago, contractual services, such as geophysical surveys, and most field and laboratory equipment used in foreign resource agencies and programs, were purchased largely from the United States. This is no longer true. Although this change was caused by several factors, the decline in U.S. geoscience activities abroad, especially in the American technical assistance program, has been an important contributing factor. Other industrialized countries have provided scientific advisors, funds, equipment, and services, thereby giving entree to contractors and suppliers at the expense of U.S. contractors. Although it is not possible to measure accurately the total economic loss to the United States, there is little doubt that American companies have had an increasingly difficult time competing in markets where foreign suppliers have the advantage of geoscience cooperation sponsored by their home country.

The United States needs a vital and well-integrated program to aid in promoting the use of U.S. private and/or government consultants and expertise; assisting U.S. contractors, services, and equipment operating abroad; and establishing improved linkage between U.S. business and foreign resources agencies. Other industrial nations, especially Japan, the Federal Republic of Germany, and France, are aggressively moving in this direction, realizing that geoscience programs abroad can have far-reaching economic benefits for them, as well as for host countries.

SUMMARY

Contributions to American economic interests made by U.S. geoscience activities abroad may be summarized as follows:

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- Energy, mineral, and water resources of interest to the U.S. government and investors have been assessed, and guidance given to their exploration and development.
- Seabed resources and their potential have been surveyed in selected areas.
- Data on geologic and hydrologic hazards and environmental conditions have been collected, especially data pertinent to U.S. operations in other countries.
- Information has been compiled on resource programs and agencies abroad, on potential markets for American contract services and equipment, and on competitive organizations from industrialized countries.

Existing and past U.S. geoscience activities should be viewed as bases for strengthening our geoscience programs abroad to meet a growing need in all these categories.

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4. INTERNATIONAL GEOSCIENCE ACTIVITIES IN U.S. SCIENTIFIC INTERESTS

BACKGROUND

Geoscience, more than exclusively laboratory-based sciences, depends on global investigations and international research cooperation for its continued progress. Therefore, effective study and application of geoscience requires its practitioners to travel. Geoscientists must observe and study rocks in their natural environment to fully understand their origin, composition, and geometric configurations, and from such data to understand the processes that have shaped the Earth. The more opportunities geoscientists have to examine geological phenomena in different parts of the world, the more perceptive their interpretations will be.

Modern modes of transportation and communication make it easier for the geologist to travel and to share scientific information and ideas with colleagues in other countries. But a misunderstanding of proposals for international scientific efforts and travel exists among some program administrators and funding officials. This attitude stems in part from a mistaken notion that geology is a purely descriptive science and that there is no basis for conducting field investigations abroad when much of the United States remains geologically unmapped. This conception is incorrect and is particularly harmful today.

The development of the plate tectonics model has revolutionized geoscience thinking and created a picture of the earth as a whole. No longer do geoscientists view the ocean basins as immutable and the continents as fixed.

Although plate tectonics was proposed only about 20 years ago, the concept is already accepted by most geoscientists. Briefly, plate tectonics postulates that the earth's crust is divided into discrete segments or plates that move continually. The separation of plates along mid-ocean ridges leads to the formation of new crustal material, collision at continental boundaries causes mountains to rise, and slippage along other boundaries creates earthquake-prone zones such as the San Andreas fault in California. Plate tectonics provides an explanation for such features as deep submarine trenches, similarities between rocks in northeastern North America and northwestern Europe, the wide variety of geologic terranes in Alaska, and the presence of warm-water fossils in the ancient rocks of Antarctica.

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Development of the plate tectonics concept has been described as a revolution in the earth sciences, with an effect equal to that created in biology by Darwin's theory of natural selection. The concept itself is a product of global studies by geoscientists from many countries, and the World-Wide Standard Seismic Network and the U.S.-initiated Deep Sea Drilling project have provided considerable scientific data for testing the model.

Acceptance of the plate tectonic theory does not resolve all questions regarding the composition and structure of the earth's crust. As with most scientific hypotheses, the concept reveals a new generation of unsolved geologic problems. It also demonstrates the need for global research. For example, collisional tectonics are not active in the United States today. Yet episodes of past tectonic collisions are recorded in some of our mountain chains. Geoscientists need to examine the rocks and the structures in areas where processes of collision are still active, such as in the Himalayas, in order to better interpret the sequence of tectonic events that produced some of the mountain ranges in North America in older geologic eras.

Continuing applications of the plate tectonics concept have emphasized the need for expanded U.S. participation in international geoscience programs, including on-site visits by American geoscientists to research locales in other countries.

There are other important reasons why geoscientists from the United States should take part in global investigations and international cooperative endeavors. Geology is a science that can aid in resolving some of the fundamental problems that confront human society in almost all parts of the world. The identification and assessment of mineral and energy resources; the development of early warning systems to mitigate the damaging effects of earthquakes, volcanic eruptions, and seismic sea waves; and the application of geoscience knowledge to urban land use studies are examples of ways in which the geosciences can contribute to the world's welfare. When U.S. geoscientists contribute to solving such problems in other parts of the world, they provide valuable assistance to local scientific colleagues and government officials. They also gain useful knowledge that can be applied to similar problems in the United States.

Finally, geoscience, like all fields of science, flourishes best in an environment of free and open communication. Conversations with geologists from other countries at scientific meetings, and especially on field excursions can be a source of inspiration for new research or can suggest alternative solutions to difficult scientific problems. Graduate study abroad, faculty exchanges, and the sharing of geoscience data and reports with foreign colleagues are among the ways in which the United States can maintain a mutually beneficial international flow of scientific ideas. Many mechanisms already exist to facilitate global geoscientific studies and international cooperation. The problem is to assure that such devices are well publicized and appropriately funded and that potential users are encouraged to become involved.

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EVOLUTION OF INTERNATIONAL GEOSCIENCE ACTIVITIES

In the early years of the nineteenth century, geology was still a fledgling science with only a few geologists in the United States. Most of these could best be described as natural scientists, with training in chemistry, physics, or mathematics. They had an entire continent to explore and describe. It is little wonder that they and their immediate successors were scarcely concerned with field investigations in other parts of the world or with cooperative scientific research investigations with foreign colleagues.

These conditions slowly changed. After the Civil War geoscientists became more numerous, and by the time the Geological Society of America was founded in 1888, there were perhaps 200 geologists in North America (Eckel, 1982, p. 7). Graduate education became more common, and many Americans went to Europe for advanced training. Those who traveled to Europe had opportunities to exchange information and opinions with European scientists and to study classic geologic areas in the Alps, Scandinavia, and elsewhere. They returned home to educate a generation of earth scientists, and set in motion the geologic exploration and resource development of a continent.

THE INTERNATIONAL GEOLOGICAL CONGRESS

With the growth of geological research in both America and Europe came a recognition of the need for a world standardization of rock nomenclature and map symbols, lest the science degenerate into provincial and incompatible fragments (Greene, 1982, p. 193). The time was appropriate for the creation of an international geological organization. This matter was discussed by a small international group of geoscientists chaired by the venerable American geologist, James Hall, at a meeting in Buffalo in 1876. Recognizing the need for an international geological conference to establish rules for compiling geological maps and for creating rock nomenclature and geological terms, the Buffalo group called on the Geological Society of France for assistance. The society responded by forming an organizing committee to plan an International Geological Congress to be held in conjunction with the Paris Exposition of 1878.

This first International Geological Congress (IGC) was convened on August 29, 1878, at the Trocadero Palace in Paris, with an attendance of slightly more than 300 geologists from 22 countries, including 8 from the United States. The 1878 IGC council established three commissions to recommend (1) international standards for geological maps, (2) standards for geological terms, and (3) rules for assigning names to paleontological and mineral species, and asked these commissions to submit their proposals to the next congress (Congres International de Geologie, Paris, 1878). A pattern was set that was to serve the geological profession for many years.

The congresses were held generally at 3-year intervals until the start of World War I. Then, after a lapse of nearly a decade, they

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were revived (in 1922) on a 4-year cycle, and, except for the period of World War II, they have continued to the present. The United States has hosted 2 of the 26 congresses that have been held to date--the fifth in 1891 and the sixteenth in 1933. Both of these meetings were in Washington, D.C.

It has been over 50 years since an International Geological Congress met in the United States, and, in the view of many geoscientists, we are overdue to again serve as host. An invitation has been issued by the National Academy of Sciences, and the twenty-eighth IGC will meet in Washington, D.C., in July 1989, but governmental support at a level comparable with that provided by the governments of other host countries is not yet assured.

THE INTERNATIONAL UNION OF GEOLOGICAL SCIENCES

The format and frequency of the meetings of the International Geological Congress served the world geoscience community adequately for many decades. But the congress lacked mechanisms for activities and communication between sessions. A more permanent type of organization was needed. After an unsuccessful attempt in 1952, a proposal to create what is now the International Union of Geological Sciences (IUGS) was approved by the twenty-first congress in 1960 (IUGS, 1961).

The principal objectives of IUGS are to (1) encourage and promote the study of geological problems, (2) facilitate international cooperation in geological research, and (3) collaborate with the International Geological Congress in safeguarding the long-established activities of the congress. The first of these objectives has been promoted through the work of 10 IUGS commissions and 3 committees concerned with various aspects of the geosciences. The second has been aided by programs involving its 23 affiliated scientific associations, by cooperative endeavors with other scientific unions through the auspices of the International Council of Scientific Unions (ICSU), and by working with UNESCO and other intergovernmental organizations.

In recent years, IUGS has established a Research Development Program, a series of annual seminars, and an expanded publication program to enhance the level of international cooperation in basic research and in the application of research results to the solution of certain societal problems, e.g., mineral resource identification, assessment of geological hazards, and the exchange of methods of management of geoscientific data.

As a nongovernmental international body, IUGS is represented in the United States by the National Academy of Sciences and has maintained close relations with the USGS. Its status as a nongovernmental organization has enabled IUGS to concentrate on scientific problems and largely to avoid political controversy, but it also has hindered the union in obtaining the level of funding needed to provide adequate support for its geoscientific research program.

Since its inception in 1960, U.S. geoscientists have participated

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actively in IUGS. Three have been elected as officers, and others have served as chairmen or members of various boards, commissions, and committees.

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

U.S. geoscientists have also participated extensively in the International Union of Geodesy and Geophysics (IUGG), an older sister union within the International Council of Scientific Unions (ICSU). The IUGS and IUGG have been closely associated in several programs sponsored by ICSU. Currently they are cooperating in a major international scientific program on the origin, evolution, and dynamic processes of the lithosphere, through joint membership in the Interunion Commission on the Lithosphere (ICL) organized by ICSU in 1980.

The objectives of IUGG are to promote and coordinate physical, chemical, and mathematical studies of the earth and its immediate spatial environment. IUGG is concerned with the earth's geometrical shape; gravity and magnetic fields; internal structure and seismicity; volcanism; hydrologic cycle and glaciers; oceans, atmosphere, ionosphere, and magnetosphere; solar terrestrial relations; and studies related to the moon and planets. Cooperative studies in these subjects are conducted by seven semiautonomous associations, each responsible for a specific range of studies within the overall scope of IUGG interests. U.S. geologists and geophysicists have participated most actively in the International Association on Seismology and Physics of the Earth's Interior (IASPEI), the International Association on Volcanology and Chemistry of the Earth's Interior (IAVCEI), and the International Association on Hydrological Sciences (IAHS), each of which has close working relations with affiliates of IUGS.

In the United States, adherence to IUGG has been actively maintained by the National Academy of Sciences through the American Geophysical Union, and until recently the Geophysics Research Board of the National Research Council has maintained an overview of many of the programs with which IUGG is involved.

THE IGY AND ITS SUCCESSORS

The International Geophysical Year (IGY) of 1957-1958, sponsored by the International Council of Scientific Unions (ICSU), set a new pattern of post-World War II international cooperation in earth science research. Although focused primarily on the atmospheric sciences, oceanography, and solid-earth geophysics, the IGY showed the potentials of a well-defined, time-restricted, global research program in marshaling financial, logistical, and scientific resources.

The IGY was followed by the Upper Mantle Project, 1962-1970, also sponsored by ICSU, which concentrated on the earth's crust. Then the IUGS joined with International Union of Geodesy and Geophysics (IUGG) to organize the International Geodynamics Project (1971-1979). The

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Geodynamics Project was in turn succeeded in 1980 by the decade-long International Lithosphere Program, concerned primarily with the continental crust and its mineral resources, also directed by an ICSU interunion commission. These international geoscience research programs have become a principal channel for cooperation between U.S. geoscientists and their foreign colleagues. American geoscientists have made substantial contributions to the planning and execution of the programs and have benefited from the opportunities thus provided for conducting research on a global scale and for exchanging of scientific data and concepts. However, the ICSU-sponsored research programs have been severely handicapped by inadequate financial support.

THE INTERNATIONAL GEOLOGICAL CORRELATION PROGRAM

The International Geological Correlation Program (IGCP) is special in that it has dual sponsorship. Begun about 15 years ago by IUGS, IGCP was originally designed to improve worldwide stratigraphic correlations. This objective was foundering from lack of money when UNESCO offered to co-sponsor the program and to provide a substantial increase in its financial support. Therefore, since 1973 IGCP has been a joint endeavor of IUGS and UNESCO, with the IUGS giving scientific direction and overview and UNESCO contributing funds and maintaining the program secretariat. The program includes many types of investigations whose scope transcends national boundaries. Unlike the Geodynamics Project or the Lithosphere Program, IGCP is an open-ended activity. The UNESCO affiliation makes possible the participation in IGCP of certain counties that tend to favor programs sponsored by intergovernmental rather than nongovernmental bodies. The participation of geoscientists from Third World countries is an important aspect of the IGCP. Some U.S. geoscientists have participated prominently in this excellent program, but current funding is inadequate.

Earth System Science

A particularly exciting new global development is the recognition of Earth System Science, closely linked to an International Council of Scientific Unions initiative on the Geosphere and Biosphere (National Research Council, 1986).

Awareness of phenomena such as the rising carbon dioxide content of the atmosphere is forcing atmospheric scientists, oceanographers, geologists, and ecologists to work together in an unprecedented way. The developing Earth System Science Program, which has been enthusiastically welcomed by many federal agencies including NSF, NASA, NOAA, and the USGS, has defined as its goal (NASA, 1986):

> To obtain a scientific understanding of the entire Earth System on a global scale by describing how its component parts

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and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all time scales.

INTERGOVERNMENTAL ACTIVITIES

International geoscience research activities are sponsored by various intergovernmental organizations, e.g., UNESCO, other United Nations bodies, and the North Atlantic Treaty Organization (NATO). The UNESCO earth-science program has been viewed by knowledgeable U.S. geoscientists as one of the better designed and more successful programs within the UNESCO science sector, although it has suffered from the pervasive UNESCO flaws of poor management, excessive administrative costs, and politicization. American geoscientists have not been prominent in UNESCO-sponsored earth-science activities, except for the IGCP. How the United States withdrawal from UNESCO will affect U.S. geoscience interests remains conjectural, but to date we have not developed a plan for alternative action.

AGENCY-SPONSORED PROGRAMS

The impetus of World War II propelled the United States into the forefront of many international activities, including the geosciences. As noted in Chapter 2, the war itself prompted activities in strategic mineral supplies by the USGS and the Bureau of Mines and in the military application of geology by the USGS. Immediately after the war, the policy of aiding less-developed countries led to a foreign assistance program, sponsored through the Department of State and carried out largely by the USGS, to help identify and develop resources both for the benefit of those countries and to ensure a better supply of raw materials to the industrialized nations. Although these programs were focused on practical goals, they had important effects on both research and education in the United States. They not only provided the United States with valuable updated geologic and mineral information from other parts of the world, they also established personal contacts for fostering mutually beneficial technical activities.

Concomitant with the foreign aid programs, a newly awakened interest in basic scientific research led to increased support for travel to international meetings, especially through the Office of Naval Research and the National Science Foundation (NSF), though by no means limited to them. In the 1960s, the NSF took the lead in developing programs such as Foreign Exchange Fellowships and Foreign Field Institutes. Direct research support was provided in some countries through the use of foreign currencies as specified in Public Law 480.

Finally, as the heads of governments became increasingly aware of the ever-growing importance of science and technology, a number of bilateral agreements were made between the United States and other countries, e.g., Japan, Yugoslavia, and most recently, China, for

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cooperative efforts in selected areas of science. In most of these cooperative efforts, the management of the U.S. portion of the research program was delegated to the NSF or to several agencies including the NSF.

THE SITUATION TODAY

Today, the geosciences and mineral development have been virtually eliminated from the American foreign aid programs; travel support to attend overseas meetings has been reduced; programs such as NSF's Foreign Exchange Fellowships and Foreign Field Institutes have been eliminated; foreign currencies available through Public Law 480 either have been spent or their use has been restricted; and funding for the bilateral cooperatives has been given no special appropriation but must compete with the regular programs of NSF or other agencies. As a result, the United States is losing some of its contacts with foreign scientists, contacts that are often the first step in developing mutually beneficial efforts in science and in commercial applications.

The committee recognizes that lack of funding is not the only problem. For reasons such as health, security, and terrorism, some U.S. geoscientists are reluctant these days to consider positions or research that involves working and living in other countries. Such a trend can slowly erode the number of geoscientists familiar with the geology of various parts of the world. As members of a prosperous and technologically advanced nation, we should assist less developed countries. This obligation is not altogether altruistic, because raising the scientific competence of other countries in the development of their natural resources will also benefit the United States.

The trend can be reversed. Young geoscientists who have interests in international work should be encouraged. For example, one reason many younger geoscientists are not pursuing foreign projects is because they have not made the critical personal contacts and are unfamiliar either with the relevant geologic problems or with the mechanisms of obtaining foreign employment. A mechanism should be established whereby interested geoscientists can be encouraged to visit foreign countries to establish contacts that would lead ultimately to scientific cooperation. Young geoscientists should be especially encouraged, because early involvement in international cooperative studies commonly sets a pattern for continued interest and study.

Above all we need a stable policy concerning international geoscience activities.

SUMMARY

It is impractical to identify all the contributions that global geological studies and international cooperation have made to the development of the United States. How would one document, for example, the exciting new scientific insights that were obtained by those U.S. geologists who traveled abroad in the nineteenth century and who were

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hosts to visits by foreign colleagues? How would one measure the cumulative benefit of attendance by American scientists at International Geological Congresses for over a century?

On a topical basis, answers are more easily found. For example, the investigation of earthquakes in the western United States and efforts to devise a reliable method of predicting them have been aided by similar studies conducted by Japanese geoscientists. U.S. geologists have obtained a better understanding of mountain-building processes from field investigations in the Alps, the Andes, and the Himalayas. The study of glaciers in Greenland and Antarctica has provided new clues for interpreting the record of glacial epochs and related climatic patterns in North America. On a more practical level, information gained by U.S. geologists from the study of copper deposits in Chile, coal deposits in Poland, petroleum deposits associated with freshwater lake beds in China, and phosphate rock in Morocco has been applied to the investigation of these mineral and energy resources within our own borders.

Participation in international scientific programs, such as the Continental Lithosphere Program and IGCP, is another method of enhancing U.S. capability. Conferences on currently important topics have the added advantage of focusing the attention of geologists from all parts of the world on specific geological problems. Periodic international meetings such as the International Geological Congress allow U.S. geologists to appraise and benefit from the work of foreign colleagues. At the same time, American geologists enhance the scientific reputation of the United States by sharing their geological knowledge and expertise with scientists from other countries.

The scientific challenge that confronts geologists of the world today is to decipher the history of the earth from its beginning to the present time. The record of earth events during this period of about 4.5 billion years is fragmentary at best. To carry out this assignment, geologists must travel to places where fragments of the record can be found and must seek the cooperation of fellow scientists in all countries. The entire world is, indeed, the geologist's laboratory. Geology is burgeoning with opportunities for both pure and applied studies, and that laboratory must be used more effectively than at any time in the past.

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5. SUMMARY OF NEEDS AND RECOMMENDATIONS

SUMMARY OF NEEDS

International geoscience activities are required and needed more than ever before to support U.S. economic interests by adequate use of geoscientists in U.S. international programs, and to advance our basic scientific knowledge. Our report emphasizes the breadth of international geoscience involvement in the advancement of American economic and societal interests.

From consultation with geoscientists from government, industry, and academia, the committee has identified many areas where U.S. geoscience personnel are inadequately utilized, geoscience information is not fully exploited, and support for basic geoscience research can be improved. Some of the important areas that should be strengthened are as follows:

1. The use of international geoscience in development and implementation of foreign policy.
    - (a) Develop procedures for routinely identifying geoscience contributions in policy issues.
    - (b) Develop mechanisms for interagency coordination, policy review, and implementation.
    - (c) Define new initiatives in foreign policy based on geoscience considerations.

Inasmuch as this application involves foreign policy, the Department of State must play a key role in these efforts. Implementation will require enhanced funding for the recruitment of geoscience professionals by the Department of State.

2. The use of international geoscience in U.S. economic interests.
    - (a) Improve competitive status abroad.
    - (b) Improve flow and exchange of relevant geoscience information by scientific attaché and regional resource officer programs. (In this connection the committee commends the Department of State's recent decision to provide more training for--and increase the responsibilities of--its regional resource officers.)

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3. Expanded international support for basic geoscience by American researchers.
   (a) Increase our capacity for geoscience consultation and assistance through scientific exchange.
   (b) Provide more adequate support for existing and future science and technology agreements.
   (c) Become further involved and provide greater support for intergovernmental organizations and international scientific organizations.
   (d) Enhance expertise in global geoscience, and stimulate international research. A number of agencies are concerned, but a revival and an expansion of NSF, NASA, and ICSU activities are obviously needed here.
4. Support for other international geoscience activities.
   (a) Develop new initiatives in Third World countries.
   (b) Facilitate publication and distribution of Third World maps, reports, and translations of geoscience data.
   (c) Develop a centralized inventory and coordination facility for:
      (i) map storage and availability inventory,
      (ii) a report library that includes, for example, papers in nonrefereed journals and open-file reports,
      (iii) data systems, including commodities and satellite information, and
      (iv) a roster of U.S. research and research workers involved in foreign projects.

Strengthening some of the above-mentioned areas at a time of severe budget constraints without seriously damaging other important programs will require careful and skillful action.

In some cases, substantial gains can be made without significant funding changes. For example, a post in a foreign country might be filled by someone with geological training rather than by a nonspecialist. An American geologist might be hired instead of a foreign geologist. A premium might be placed on foreign service as a step in a geological career in government agencies. In other cases, modest increments in funding might be used effectively and with great leverage. Finally, a small amount of money spent to bring American and foreign geoscientists together for planning sessions can stimulate substantial active bilateral or multilateral projects.

RECOMMENDATIONS

Having considered the importance of international geoscience programs in formulating and implementing some foreign policy issues, in advancing U.S. political, economic, and scientific interests abroad, and in providing information on world resources, programs, and institutions, the committee believes that support for international geoscience should be given higher priority in allocating funds and in developing and coordinating international geoscience activities of

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federal agencies. Accordingly, the committee recommends that federal funding for international geoscience activities should be increased.

The range of activities that should be strengthened and improved is so broad that no existing group or organization is equipped to advise, recommend, or implement all the necessary changes, which include strengthening geoscience assistance and cooperation; establishing and coordinating the flow of geological resource information from abroad to meet our scientific, economic, and political needs; and increasing support for basic geoscience research. We need a long-term mechanism for overseeing current and future needs.

Therefore the committee recommends the establishment of an American Office of Global Geosciences. Such an office would be a small nongovernmental organization that would be concerned with geoscience activities on an international scale, and would be supported by both public and private funds. Important activities could include the following: (1) to identify the international interests of the United States that can be fostered and maintained through geoscience activities abroad and to help implement the specific types of activity required to do so; (2) to define mechanisms to strengthen and coordinate U.S. geoscience programs abroad; (3) to plan a centralized mechanism for systematically acquiring and inventorying geological maps, reports, and raw data on foreign geology and resources; and (4) to serve as a central office for international geoscience information and contacts to advance basic research.

An office would be an efficient way to coordinate and focus efforts of the wide variety of international geoscience activities. Most important, it would provide daily attention to these matters rather than intermittent consideration by separate or ad hoc groups. Suggestions on the activities to be undertaken by the office should come, not only from the entire geoscience community, but from other interested parties as well.

The areas that are listed here as needing strengthening are regarded as only examples of some of the contemporary issues that should come under the purview of the office. The issues will change constantly. Through constant monitoring of the international geoscience scene, the office could be prepared to make recommendations before crises develop and reaction to crises would be based on sufficient background information.

The committee has determined that both governmental and nongovernmental interests abroad are so intimately involved with, and served by, international geoscience programs and activities, that support from both governmental and nongovernmental sources should be solicited in strengthening such programs and activities. Moreover the committee has had expressions of interest in support of the office from both petroleum and mining companies. To facilitate the planning of programs and activities that serve both governmental and nongovernmental groups and that will lead to support from both, the committee further recommends that the advisory group for the Office include both governmental and nongovernmental representation. Governmental agencies that would be especially concerned would include the Department of State, the Department of Interior (USGS and U.S.

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Bureau of Mines), NASA, and the NSF. The Departments of Commerce, Energy, and Defense would also be concerned.

Because of the urgency of the need to address the problems raised in the body of this report, the committee urges an immediate infusion of new funding for existing U.S. agencies concerned with the international aspects of the geosciences, especially earmarked for these functions. These agencies include the Office of International Programs and Division of Earth Sciences of the NSF, the International Mapping Office of the USGS, and the Earth Applications Section of NASA. Lesser roles involving international mineral resource evaluation and development are played by the Department of State, DOE, the Bureau of Mines, and NOAA, but these programs, too, need direct augmentation of support. When established, the Office of Global Geosciences would draw support from the above agencies as well as from industrial and private sources. Initially, the Office should be inaugurated under the jurisdiction of an organization concerned about the global geoscience problems raised in this report, and dedicated to their amelioration or solution. Appropriate alternative configurations might include (1) a consortium of federal agencies (Bureau of Mines, USGS, NSF, NASA, DOE, etc.); (2) a working group of professional earth science societies (Society of Exploration Geophysicists, AAPG, GSA, AGU); (3) the AGI; or (4) a board or panel of the NRC (Board on Earth Sciences, Board on Mineral and Energy Resources).

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APPENDIXES

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Appendix A

THE VIEW FROM THE MOSCOW MEETING

by Linn Hoover

The 27th International Geological Congress, held in the Soviet Union in August 1984, provided a clear reminder of the importance, if not the necessity, of international cooperation in research in the geological sciences. The broad scope of scientific papers, the variety of well-attended field excursions, and the exchange of scientific ideas and research results among more than 5,000 geologists from some 90 countries showed how much the geological sciences depend upon international cooperation to achieve further progress. For geology, unlike most other fields of science, the ultimate laboratory is the entire earth, and its practitioners need access to all parts of that laboratory at all times. The only way they can obtain it is through open and unfettered participation in research programs by all of the world's countries.

In recent years, the record of worldwide research cooperation has been pretty good. The pattern was established by the International Geophysical Year, which demonstrated the great advantages accruing from an international program of planned research on clearly defined topics. The IGY set an example for similarly organized programs concerned exclusively with research on solid earth problems. We recall the Upper Mantle Project and the International Geodynamics Project as forerunners of the current International Lithosphere Program, and we can point to the International Geological Correlation Program, the international phase of the Deep Sea Drilling Project, and the International Hydrological Decade as other successful ventures in international scientific cooperation.

Linn Hoover, a member of the Committee on Global and International Geology, died of a heart attack on February 8, 1985. The following article, written shortly before his death, summarizes his thoughts on the need for and value of international cooperation in the geological sciences. Originally published as an editorial in the February 1985 issue of Geology, it is reprinted here with the permission of the Geological Society of America as a tribute to Dr. Hoover's contributions to international scientific affairs.

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Whether conducted under the auspices of an international nongovernmental body, sponsored by UNESCO, or organized as an intergovernmental scientific endeavor, these programs have all been characterized by an emphasis on science and not on politics, an openness in program planning, and freedom of travel for their participants.

What is the outlook for international cooperation in geological research during the next decade? So far, it looks fairly promising, but some disturbing trends are becoming visible. One is the increasing difficulty of obtaining adequate financial support for international research programs. Costs continue to escalate, and government or private funding agencies look for ways to control this increase. The result is that, generally, international programs are drastically underfunded. Another problem is the tendency of some governments to discourage foreign scientific visitors, particularly geologists who want to "snoop around." And then we are faced with the as yet unpredictable results of the anticipated United States withdrawal from UNESCO, which could have unfavorable repercussions on a broad range of international scientific programs. The ultimate effect of these and other potential dangers depends primarily on the collective wisdom of the scientists who design and conduct international collaborative research programs and the administrators, in and out of government, whose responsibility it is to see that such programs are adequately supported and are pursued free of political interference or pressure.

We have all seen pictures of earth taken from space, and we cannot help but be impressed with the unity of the globe. Through plate tectonics, we have a better understanding of crustal dynamics and of how plate motions in one region can affect the geology of another. We know the need for basic geological research on a worldwide scale to solve problems of resource availability and mitigation of natural hazards. And through exciting new techniques of laser ranging and whole earth tomography, we are close to obtaining a fresh insight about crustal movement and related deep-earth structure. Progress in all these fields is contingent on unfettered international cooperation in geological research. We should all do our utmost to make certain that the political climate for such work remains cloudless.

Linn Hoover
Secretary-General, 28th
International Geological Congress
Deputy Chief, Office of
International Geology
U.S. Geological Survey, Reston, Va.

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Appendix B

CHARGE TO THE COMMITTEE ON GLOBAL AND INTERNATIONAL GEOLOGY

Geology is a global science; our understanding of the processes that operate within the earth and of the evolution of the earth must come from a study of the entire globe. This means that no one country, such as the United States, can hope to develop in geology without significant international involvement. The development of geological concepts and the contribution of geology to our society have been and will continue to be dependent upon international research, cooperation, and exchange. Plate tectonics has revolutionized the earth sciences. We now can relate such features as earthquakes and volcanism to plate boundary activity, which can only be studied on a global scale; thus our predictive capabilities and hazard planning require international cooperation. The natural resources of the earth are finite, and successful exploration, exploitation, apportionment, and predictive planning require a global data base. These are only a few of the reasons that the United States must strive for international scientific leadership in geology by academic, government, and industrial scientists. The committee will be concerned with bilateral and multilateral international cooperative research projects, field research abroad by U.S. investigators, strengthening the U.S. data base on global geology, and support of participation in international congresses, commissions, symposia, and the general affairs of international societies. The committee will examine participation by U.S. scientists in all aspects of global and international geology. The committee should make recommendations on how our involvement in global and international earth sciences can be improved or strengthened.

October 9, 1981

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Appendix C

EVOLUTION AND IMPORTANCE OF INTERNATIONAL ACTIVITIES IN THE GEOSCIENCES

A Background Paper by John C. Crowell, William E. Benson, and John A. Reinemund

GEOSCIENCE IS GLOBAL

Our home is the earth. The welfare of all, including those living in the United States, requires that we understand this home, how it evolved, where its useful resources lie, and how we can nurture it for the benefit of people living today and tomorrow. As world population increases, so does competition for resources. It is imperative that we inventory these valuable substances that are contained within the earth's crust, both in our country and over the globe as a whole. Our commercial and industrial enterprise can thrive only if we understand the location and availability of raw materials, now and through the coming decades. The appraisal and evaluation of these resources must be weighed in formulating foreign policy and in erecting a stance for U.S. industry in international commerce. For scientific, economic, and policy reasons, therefore, the United States must improve its understanding of its resource bank.

The earth is dynamic and active. Its crust is continually in slow motion, but from time to time these movements become violent, resulting in earthquakes and tsunamis, or volcanic eruptions, or floods and landslides. Knowledge to help ameliorate such hazards must come from far-flung studies across the globe, across the full width of oceans and continents, wherever geological phenomena are active, or geologic data are available.

Global research during the past few decades has brought new insight to the nature and history of our planet. The outermost shells of the hard earth beneath our feet are broken into plates that move inexorably about. Mountains rise where plates collide. So the Himalayan Range stands high where the subcontinent of India has been pushed into and beneath the continent of Asia. Mid-ocean mountain ridges follow trends where plates move apart. And where plates slide sideways past each other, their margins are splintered and broken and are marked by irregular ranges, valleys, and basins. The San Andreas fault system of California is such a margin. Insight into the way the earth is structured today and the way its huge heat machine operates came about only as the result of worldwide studies. Of principal importance in providing data has been the Deep Sea Drilling Project, funded largely by the U.S. National Science Foundation. This project through drilling

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and associated geophysical soundings proved that the ocean floors are created and move systematically. The plate tectonics concept and all its fruitful associated elucidations that go far to explain the nature of the physical world around us would not have been solidified without this worldwide research.

THE IMPORTANCE OF GEOSCIENCE ON A GLOBAL SCALE

Scientific Problems

As large as it is, the United States including Alaska does not contain active examples of all tectonic styles that are manufactured by our mobile earth. So geologists need to travel to Japan and Indonesia to observe arcs of islands surmounted by volcanoes standing offshore from major continents. Collisional tectonics are best displayed today in the Himalayas. Yet, these and other types of structures have developed and then have been partly obliterated on our continent in the geologic past. Their eroded roots, including deposits of useful rocks and minerals, show that these activities once prevailed. To understand how the deposits formed, it is best to examine places where the processes responsible are in operation today.

Geologic processes such as those involved in tectonic movements or in the formation of rocks and minerals at depth are extremely slow and operate in many different arenas. Scientists largely reconstruct processes by reasoning from their products, and many of these processes have long ceased producing at these sites for eons. Some have operated at depths of tens of kilometers over time intervals several hundreds of millions of years long. Only because the sites of these activities have been uplifted and then deeply eroded are the sites now in view. But there is a multiplicity of scenarios resulting from a multiplicity of processes operating in different intensities and in different sequences of events. Therefore the chances are highly unlikely that a complete decipherable sequence is preserved and visible at any one spot, and geologists must travel to many places to study earth problems.

Surface geologic processes that today are active from the tropics to the poles have all affected the continental United States in the geologic past. For example, in studying climates of the remote past, geologists draw inferences from soils and sediments that are the products of the processes operating elsewhere today. Deep lateritic soils are preserved within the United States. They were formed during times long past; and we can observe this type of weathering and groundwater alteration today only in the tropics, in South America, for example, and so come to a better understanding of their origin. Studies in Antarctica and Greenland reveal much concerning glacial processes that have operated similarly in the geologic past and left their mark in ancient sedimentary deposits. Although it seems remarkable, the Death Valley region of California--now one of the hottest places within the United States--has an indisputable rock record of glaciation, showing that an icy and frigid climate prevailed

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there about 600 million years ago. Geologists must examine climatic products no matter where they occur on the earth today in order to reconstruct the climates of the remote past. Through such studies, more will be learned of how the climate system works today and how it has worked in the past.

In short, the scientific challenge to the geoscientist is to elucidate the history of the earth from the time of its beginning on down to the present, and even to hazard statements concerning its future. This challenge involves gathering data wherever the data are available. The record, however, of events during the approximately 4.5 billion years of the earth's history is at best piecemeal. Much of this record has been lost through erosion, metamorphism, and reconstitution of older rocks into younger. The record even harbors clues on the history of life through geologic time, the changes in geographies such as the shapes and positions of continents and seas, and changes in the rocks at depth. Geochemical and geophysical information is especially useful in this huge task. The record is so fragmented, however, that wherever useful shreds can be scrutinized, geologists, geophysicists, and geochemists must go to the places where the pieces remain. And many times these places lie across the seas in remote regions or within the floors of distant oceans.

Societal Activities

Earthquakes and tsunamis are among the most devastating natural events. Fortunately these inflict their havoc infrequently within our homeland, but nearly every year a major earthquake takes place somewhere on our planet. To understand better the tectonic setting of these disastrous earthquakes, scientists need to go and study their consequences. Why do they occur where they do? What geological, geophysical, and geochemical events preceded them? Such information may help in forecasting them more satisfactorily in the future.

On-site experience is desirable not only to advance the science of geology but also as an aid to engineering, social science, and economics as they are applied to coping with these events. We can learn about the stability of dams, tunnels, aqueducts, highways, bridges, canals, buildings, and homes during severe ground shaking or inundation by tsunamis. How severe are the social and economic disruptions? We should be able to learn from disasters abroad so as to prepare better for our own. And in the process we may provide scientific and engineering knowledge to help our neighbors in their recovery and rebuilding.

Other kinds of natural disasters also lend themselves to analysis. Among these are volcanic eruptions, floods, landslides, sink-hole collapses, severe wave batterings, and ground subsidence due to fluid withdrawal. Observations made wherever and whenever such events occur can lead us to better understanding and to better planning.

Defense preparedness alone demands that we evaluate the results of all these natural events. Severe earthquakes at home, for example, could completely disrupt our capability to defend not only the affected

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areas but the rest of the country as well. Adequate preparedness plans must have sound geological information.

The Scientists Themselves

Science is a human activity. Geologists, geophysicists, and geochemists reap strong intellectual stimulation through discussions with their colleagues. They thrive on communication, and their productivity increases as the result of exchanges during scientific meetings. They need funding to support international travel so they can attend such meetings. In particular, field excursions to examine regions and mines and investigations in the company of local experts and foreign colleagues are especially rewarding. Work in progress and nascent concepts arrive at receptive ears long before they arrive at receptive eyes through the printed page. Such exchanges reveal very quickly whether U.S. scientists are leading or lagging. We have a feeling that they are beginning to lag.

Participation in international meetings spreads goodwill and can become an effective force in easing international strains or in understanding why they exist. At such meetings an informal scene is set to drive home the concept that science is done for the benefit of all mankind and that understanding the earth and its resources and its fragility may help harrassed societies in struggling with their economic and social problems. Communication and friendship among scientists begins to break barriers between diverse cultures, and usually an attitude of mutual helpfulness grows automatically. This helpfulness can include participating in teaching at many educational levels, helping to solve engineering geological problems, or in resource development.

Resources

Society depends on mineral and energy resources won from the crust. No longer can our nation depend on such resources coming from the rocks of our homeland alone, but we are dependent on oil, manganese, chromium, tin, aluminum, and many other materials from overseas. These deposits require study by our geoscientists from many viewpoints. First, we need to understand their extent and value and for how long they can provide their materials to support our economy. Second, study of overseas deposits will reveal much concerning the geological processes responsible for their formation. Such information may tell us what to look for elsewhere in order to find similar deposits, including those so far undiscovered within our homeland. Third, investigations of unusual crustal areas where special geochemical activities have brought about the accumulation of mineral and energy deposits will aid in understanding how these processes operate. The processes are active at many depths and are influenced by many factors such as the composition of rocks in the vicinity and of the variety of fluids percolating slowly through rock pores and

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fissures. By including the whole world as a laboratory, geologists have a chance to examine many types of crustal environments and types that have not been exposed in the rocks of the United States. As with all geologic processes, ore-forming processes have not been distributed evenly over the earth, and scientists must travel widely to study them.

Foreign Policy

Geoscientific factors have an impact on foreign policy. They do this whether the impacts are recognized or not, and it behooves the United States to evaluate them before they have critical consequences. Planning should consider worldwide resource availability and our competitive stance. Geoscientific considerations are important in regard to the Antarctic Treaty, the Law of the Sea, and the Nuclear Test Ban treaties. In addition, scientific research must precede international and national commitments pertaining to acid rain, the disposal of hazardous wastes, and the allocation of strategic minerals.

The world's people recognize that energy resources--oil, gas, coal, and uranium--are unequally distributed. At home too few realize that the United States is now a "have-not" nation and that we import a substantial amount of our oil. The future welfare of the United States leans heavily on knowing where resources are, the size of the deposits, and what they can yield both now and through the improvement of technologies. But sound policy positions depend on sound science and satisfactory inventories. One of the best ways to increase our knowledge of the world inventory of resources is to stimulate scientific exchange programs of many sorts and to participate in international scientific programs.

HISTORICAL SUMMARY OF U.S. GEOSCIENCE ACTIVITIES ABROAD

Government Programs

U.S. geologists first had a major role in U.S. government activities abroad during World War II. During the war years geologists carried out investigations of strategic minerals in many Latin American countries under a program sponsored by the Interdepartmental Committee on Scientific and Cultural Cooperation, coordinated by the Department of State and the Foreign Economic Administration. U.S. geologists participated in terrain analyses, engineering studies, and hydrologic investigations to support military operations in both Europe and the Pacific. Geologists were also used extensively in the post-war occupation forces in Japan, South Korea, and the western Pacific Islands.

In the 1950s and 1960s, geological activities were a major component of the U.S. foreign assistance program. During these decades, U.S. geologists helped to strengthen geoscience agencies and programs in more than 70 countries. Concurrently, U.S.-funded geoscience activities became a significant component of a number of

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organizations, including the U.S. Geological Survey (USGS), Bureau of Mines, National Science Foundation, and Smithsonian Institution.

In some countries geological assistance and research programs during these years contributed directly toward the implementation of foreign policy; for example, geological assistance to Indonesia, which was interrupted during the regime, was one of the first programs reactivated when a new government was installed. Also, USGS assistance in geological mapping and resources studies in Saudi Arabia, which was initiated in the 1950s, was, and continues to be, a significant element in U.S. relations with the Saudi Ministry of Petroleum and Mineral Resources.

In the 1970s, the role of geology in the U.S. foreign assistance program declined substantially, owing to an AID policy of focusing on agriculture and other sectors. This policy has placed the United States far behind other aid-giving countries in the size and scope of foreign geological activities, has made it difficult for developing countries to have access to U.S. geological expertise and technology, and has resulted in a loss of U.S. contacts and influence among the geological and resources community in most developing countries. This, in turn, has decreased the opportunities for U.S. contractors and suppliers under the AID program.

On the plus side, geological cooperation with other countries as an instrument of foreign policy initiatives became more widespread during this decade. Many intergovernmental science and technology agreements were negotiated to strengthen political relationships with other countries, including agreements with Brazil, China, Mexico, and Venezuela. These were supplemented by memoranda of understanding between U.S. agencies and their counterparts. The USGS, for example, currently has nearly 50 agreements with other countries, as shown in Appendix J. Unfortunately, no funding was specifically allocated for most of these agreements: because of this, the level of cooperative activity has been minimal and continuity has been uncertain. A happy exception to this is the cooperative science and technology agreement with Spain, which does provide funds under an agreement covering the use of military bases in that country. Cooperative agreements with Egypt, India, Morocco, Pakistan, Poland, and Yugoslavia have in the past utilized U.S.-owned foreign currencies to meet operating costs in the cooperating countries, but these funds are now exhausted or in short supply.

Through these four decades of changing policies toward geological assistance and cooperation, the United States has maintained a modest resource attache (regional resources officer) program in selected U.S. embassies. This program was an outgrowth of the strategic mineral studies abroad during World War II. Initially it consisted of a few professionals assigned to U.S. embassies from the U.S. Bureau of Mines. In 1975, it was reorganized and enlarged, and foreign service officers were assigned as resources officers. Despite fluctuating support and frequent changes of staff, the program has generally been an effective mechanism for obtaining information about resources and programs in those countries that have resources officers, although there are limitations due to the fact that these officers are not

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geoscience professionals. Currently there are regional resources officers in 10 U.S. embassies and designated resources reporters in 9 other U.S. embassies. Perhaps the most significant aspect of this program is that it reflects a recognition, within the Department of State, of the importance of earth resources--along with geological and resources programs--in U.S. political relationships to other countries. However, the program is not, and never has been, adequate in scope and expertise to meet the U.S. need for resources information in support of mineral policy and national security considerations.

Although U.S. policies of the 1970s toward use of geological programs have been continued with little change, two significant trends related to international geology have emerged. The first is positive; it involves increased support under the foreign assistance program for assistance in geologic and hydrologic hazard assessment, mitigation, and training. A number of regional and bilateral projects in earthquake monitoring and risk analysis have been developed, and a new program of geologic and hydrologic hazard training is now being developed jointly by the USGS and AID, although no funds are currently allocated to it.

In addition, the United States has participated during the 1970s and 1980s in the International Hydrological Program, an ongoing multinational attack on water development problems, involving both basic science and applied research, and has entered into a number of bilateral technical assistance programs in hydrology.

The second trend is negative and concerns the decline of U.S. leadership in international applications of remote sensing. This results from lack of sufficient official U.S. interest and support for remote sensing applications research, together with the uncertain future of U.S.-owned earth resources satellites and determined efforts by other countries to move into areas of research and training in remote sensing technology that were previously dominated by the United States. The U.S. role in remote sensing will be further weakened if the earth resources satellites are exclusively the property of private industry and access to the data becomes unduly expensive or restricted.

Petroleum Activities

During this same period (i.e., 1940-1975) the international energy sector changed substantially in its overall composition and in its relationships to the host countries in which it operates. Through the 1940s, foreign oil exploration and production were conducted by a relatively few major international companies under relatively simple concession terms that covered both exploration and production and that allowed title to the oil to reside with the operating company. The host countries received their share in the form of royalties and taxes.

During the 1950s and 1960s, a number of independent oil companies appeared on the international oil scene, resulting in brisk competition for concession areas and a greater variation in the concession terms negotiated. During the same period, a number of national oil companies were organized to represent the energy interests of various countries,

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and with different yardsticks on what concession terms were acceptable. As a result, general ground rules changed during the 1960s and 1970s to present-day terms in which most host governments stipulate a partnership or production sharing arrangement, with title to the oil produced residing with the host government.

Modern exploration agreements, particularly in developing countries, commonly require technical training of personnel of the host country in all facets of the petroleum industry, and the trend is toward a larger and larger participation of nationals in the international oil scene.

Minerals Industry Programs

U.S. investment in foreign exploration and mine development has been an important segment of our nation's industrial growth since the days of the original thirteen colonies. Dependence on foreign sources of minerals because of economic attractiveness, domestic shortages, or other more complex factors has resulted in continual involvement of U.S. private groups with a variety of countries, commodities, and overseas organizations over the past 200 years. Although some foreign programs have been precipitated by worldwide or local reactionary efforts, such as the flocking to western Australia in the 1970s nickel boom and the current keen competition for Canadian gold deposits, most exploration efforts have been designed on an individual basis, applying the unique, differential concepts that exploration groups perceive that they possess.

In the past 40 years, investment in foreign exploration and deposit development by domestic minerals organizations has varied with worldwide economical and political changes. Program emphasis has reacted to demand for particular minerals at the time and on projected requirements for specific time frames. This approach was evidenced by the exploration rush into uranium-rich provinces of Canada, Australia, and the United States in the 1950s through 1970s and the major emphasis on large-tonnage, enriched porphyry copper deposits in many regions of the world. Most of these exploration and mining efforts were based on geoscience generated to a large extent by the interested parties, as reliable available reports and maps were often inadequate.

During the past two decades, there has been an increased involvement of private financial institutions in mineral deposit development throughout the world. Escalating capital costs, cyclical metal prices, and expanded control or project development by host governments have complicated the historical position of private U.S. mining companies as the discoverers, developers, and financiers of most major ore bodies. This shift from the mining sector to financial groups has resulted in the establishment of in-house capabilities by banks to evaluate critical technical factors in proposed minerals operations and engineering projects. Funding requirements often involve multimillion dollar transfers, and consequently, financial institutions must be comfortable that justification exists for such long-term commitments.

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Geological data required to appraise an investment opportunity will vary with the project and include basic information regarding geological settings and known mineral occurrences. A thorough review of existing data and discussions with knowledgeable individuals is followed by on-site visits by technical representatives of the bank, such as geologists, engineers, and/or mineral economists. Consultants with particular expertise often supplement the bank's in-house capabilities. Many of the financing proposals involve developing Third World countries, and local geologic/mining consultants have proven to be essential contributors to project evaluations.

A growing number of U.S. financial institutions have established internal personnel capable of evaluating mineral investment projects. "Money center banks" that currently have relatively large staffs specifically committed to mineral and energy appraisals include Bank of America, Bankers Trust, Chase Manhattan, Chemical, Citibank, Continental Illinois, First Chicago, Manufacturers Hanover, and Morgan (see Appendix F).

Besides these major banks, some smaller financial institutions maintain resource-oriented staffs. The actual number of professional personnel involved in minerals/energy groups are adjusted to accommodate an individual bank's needs over a particular period of time. Changing emphasis related to specific mineral and energy commodities results in periodic shifts in staff sizes and direction, although the current trend is toward larger and more technically competent minerals/energy departments.

This growing emphasis on internal review of mineral investment proposals is not restricted to domestic financial institutions. International lending agencies such as the World Bank, Inter-American Development Banks, and Overseas Private Investment Corporation (OPIC) also employ experienced geoscientists and individuals with a mineral background on permanent and part-time bases to provide evaluation and recommendations regarding intermittent mineral development projects.

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Appendix D

A MORE GLOBAL TECH VIEW
by Eugene B. Skolnikoff

It is time we shed our parochial attitudes toward science and technology if we expect to remain the world's foremost technological nation. That seems paradoxical, but in fact, the spread of competence in science and technology now requires different attitudes toward international cooperation and interaction with others than are reflected in our current policies.

We have come to assume that the long postwar dominance of the United States in science and technology is a natural consequence of our basic intelligence, or ingenuity, or unique economic system, or other flattering characteristic. Ironically, we continue to hold that view even while in some arenas we wonder how to confront the technological competition from abroad, and particularly from Japan. Policies and programs of the government, notably those involving control of export of technology, are debated as though other nations can do little in science and technology unless they learn it from us.

In fact, the situation is different. Although the U.S. still has the broadest and deepest capability in science and technology we now face at least equal competition in most fields, and are in danger of falling behind in many. Nor is this new. The rise in competence in Europe, Japan, and the Soviet Union has been evident for years.

The U.S. is poorly placed to do what other countries have long since learned is necessary: tapping the knowledge and experience of other countries through cooperative projects, student exchanges, science attachés, and similar measures, as a complement to domestic research and development (R&D). Many countries have large cadres deployed in the U.S. and elsewhere, primarily to stay abreast of rapidly moving technical fields. Funds for travel and study abroad for scientists and engineers are assumed by other countries to be natural components of R&D policy. International industrial cooperation and interaction are actively stimulated and supported.

This article is reprinted by permission of the author from The Christian Science Monitor (March 8, 1984). Eugene B. Skolnikoff is director of the Center for International Studies and a political science professor at the Massachusetts Institute of Technology, Cambridge, Massachusetts.

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In the U.S., policies are almost reversed. Many programs for international cooperation in science and technology with industrialized nations that did exist before 1981 were canceled by this administration (in some cases raising questions of bad faith). International travel for scientists and engineers has been cut out or placed under even more scrutiny than normal in a government that tends to be prudishly skeptical of foreign travel by those not associated with a foreign affairs agency.

In broader, but related, areas the administration has advocated cuts in the Fulbright exchange program, while concern in the government for the serious deficiencies in education and research in foreign languages and international affairs continues to be negligible.

This is not only a result of Reagan administration policies, although it has made the situation measurably worse. The previous administration attempted to build more international programs in science and technology but with only limited success, and with no lasting effect on the deeper problem of attitudes in the government or the Congress.

Moreover, it is not only a problem for the government. Previous assumptions of the value of serious study and residence abroad as preparation for professional careers in science and engineering have given way to concern over early advancement, immediate economic return, and job security. Apparently there is also reduced interest in the cultural or intellectual rewards of foreign study.

Industry is often better attuned to the importance of foreign developments, but it is only the larger, experienced companies that are normally in a position to monitor and interact with foreign laboratories and industry and to realize that effective competition with equals requires more rather than less interaction. Medium-size and small companies in most fields--those that are so critical to innovation in high technology--can rarely do that on their own. Even large companies are too often naive and ill-informed about the structure and operation of the scientific and technological enterprise in other countries. The much-vaunted American business school gives surprisingly little attention to preparing business leaders for participation in an international environment.

For all the rhetoric about America's role in the world, the country is narrow in its policy for support of science and technology.

International interactions of all kinds should be a necessary part of a strong policy for science and technology, not seen either as irrelevant or as a threat. The costs of the current attitudes may not have been of great importance in the past. In the new environment of high-quality and aggressive technological competence in other nations, the costs are likely to be very high indeed.

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Appendix E

STATEMENT ON SCIENCE IN THE INTERNATIONAL SETTING AS ADOPTED BY THE NATIONAL SCIENCE BOARD AT ITS 238TH MEETING ON SEPTEMBER 16-17, 1982

The United States is at a critical point in its international scientific relationships:

- American scientists no longer lead in every field of science and U.S. industry is significantly challenged in many areas of technology.
- The global nature of many scientific problems, the resolution of which may significantly influence the future well-being of U.S. society, requires increased international cooperation and a coherent approach for successful study.
- The increased scale and complexity of many modern scientific projects requires facilities and operations whose costs strongly suggest the utility of international coordination, sharing and, in some cases, cooperative funding.
- Foreign policy considerations play an increasingly important role in the conduct of international scientific activities.
- Science and technology are becoming increasingly interdependent, and the national security implications of technology transfer have led to increased discussion of the need for additional controls on the international scientific communication process itself.

In view of the importance of these issues and their potential impact on the overall health of U.S. science, the National Science Board has addressed the broad topic of "Science in the International Setting." This statement expresses the Board's present policy and consolidates and extends a number of past Board actions on this subject.

IMPORTANCE OF INTERNATIONAL SCIENTIFIC COOPERATION

Scientific interaction at the international level is an essential element in the continued vitality of science. Historically, the Nation has profited greatly from its positive stance of encouraging outstanding scientists from throughout the world to be aware of and participate in our scientific activities and encouraging U.S.

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scientists to travel and interact closely with scientific projects in other nations.

There are certain fields in which international cooperation and access are essential to the effective conduct of research because the scientific questions being addressed are inherently global in nature. Examples include research related to climatology, oceanography, space applications, health, population and resource studies, acid rain, carbon dioxide buildup and heating of the atmosphere. Many of these issues are of serious concern to the future well-being of our citizens, as well as to those of other nations. Many disciplines, such as plant sciences, anthropology, and the geophysical sciences, require access to scientific sites in foreign areas.

The cost, scale, and complexity of scientific facilities in many disciplines, such as high energy physics and astronomy, provide strong incentives for nations to share in the planning, financing, and use of such facilities.

The value of international scientific cooperation is by no means limited to the use of large facilities. Individual scientists in specialized fields often find international collaborative efforts to be of signal importance in facilitating the advancement of their fields.

SCIENTIFIC COOPERATION WITH VARIOUS NATIONS

The objective of maintaining the vigor of the U.S. research effort requires a broad, world-wide program of cooperation with outstanding scientists in many nations.

Cooperation with the industrialized democracies, such as OECD members and our NATO allies, is clearly of great value to the economic well-being and industrial capability of our own Nation as well as theirs. These nations enjoy comparable levels of technical sophistication and the potential for sharing advanced, costly facilities. Since opportunities for interaction with these countries are readily available, the greatest latitude should be given to individual cooperation and exchanges independent of formal bilateral programs. However, the NSF should continue to participate in selected intergovernmental agreements that serve identifiable useful functions.

Developing countries, many of which have a corps of highly qualified scientists, also offer significant opportunities for scientific cooperation, including unique possibilities for access to scientifically important territories and environments. Moreover, international scientific cooperation may offer economic, diplomatic and other policy benefits going beyond the immediate needs and interests of science per se. With many of these countries, bilateral agreements, including the provision for support and maintenance of continuity, are required to ensure the success of collaborative scientific activities. Since direct contact between the involved scientists is essential to ensure the effectiveness of the programs, the U.S. should continue to encourage an emphasis in its bilateral agreements on such scientist-to-scientist cooperation.

There is also evidence of benefit for U.S. science from contacts

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with scientists from communist countries. Opportunities for individual scientific cooperation, even in the presence of strained political relationships, keep open channels for communication and can lay foundations for enhanced cooperation should conditions become more propitious in the future. Exchanges with communist countries should be conducted so that commensurate benefits flow to both sides.

The levels of scientific activity with these three classes of nations will vary in time as scientific opportunities change and in reflection of the evolution of our foreign relations. At any given time, these levels will reflect a balance between needs and opportunities for American science and the goals and requirements of foreign policy and national security.

The Board concludes that because the international dimension is intrinsic to the nature of scientific research and because of the Foundation's role in the support of the Nation's foreign policy, the Director of the Foundation must play a significant role, in collaboration with the Department of State and the Executive Office of the President, in the development and implementation of the international science policy of the United States.

The Board strongly supports the Director in that very important dimension of his responsibilities. So that the Board can take these policy considerations fully into account in its planning, the Board must keep abreast of international initiatives and U.S. foreign policy objectives that should be considered in formulating the Foundation's priorities and budget.

MODALITIES FOR FACILITATING INTERNATIONAL SCIENTIFIC COOPERATION

Agencies such as the NSF, as well as universities and nongovernmental professional scientific organizations, will each have unique and important contributions to make toward the success of cooperative international scientific activities. The Foundation, by virtue of its fundamental and broad-based scientific program, should take the initiative, in cooperation with the Department of State and other agencies as appropriate, to bring together potential international partners to accomplish the necessary planning and implementation for international sharing or collaboration in fundamental science and engineering research.

Under the auspices of the International Council of Scientific Unions, a number of multilateral scientific programs have been successfully carried out, often with the cooperation and assistance of intergovernmental organizations and member governments. The International Geophysical Year program (the 25th anniversary of which is being commemorated now) has offered a useful paradigm for subsequent efforts in the atmospheric, geophysical and ocean regimes. The foundation should use such multilateral channels when attractive opportunities arise.

The role of the National Academy of Sciences (NAS, NAE, IOM) as a congressionally chartered, yet private organization has enabled it to relate to many nongovernmental institutions throughout the United

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States in cooperating with other countries. This is a source of strength of which the Foundation should take full advantage. The National Academy has an especially significant role to play in facilitating international scientific cooperation, both by virtue of serving as the U.S. representative in connection with various nongovernmental international scientific organizations, and through bonds of cooperation with similar academies in other countries.

INTERNATIONAL SCIENTIFIC COMMUNICATION

Maintenance of a strong technological position is central to our national security and to our economic and commercial vitality. Technology leadership depends on a creative and vigorous science and engineering base which, in turn, benefits greatly from an effective international exchange of scientific and engineering information. Opportunities for exchange of novel ideas and rapid assimilation of new research results provided by contacts and conferences have long been important to the progress of science. These exchanges have served the Nation well in terms of contributing to rapid advances in basic research, innovation, application of research results, and development of state-of-the-art technology.

Foreign students, teachers, and researchers working on American campuses are also an important resource, both for our universities and ultimately for our industry's success in foreign markets. As a result of the advanced state of development of the U.S. scientific enterprise, the U.S. has been particularly efficient in absorbing, understanding, and extending new ideas from all sources, foreign and domestic; and this in itself is becoming an increasingly vital component of the success of U.S. science and its contributions to technology and industrial strength.

Advances in scientific knowledge are usually incremental and interdependent. They are facilitated by knowledge of other scientists' successes and failures, and by the criticism of one's peers--that is, by open discussion. Openness on the campuses of American colleges and universities is particularly central; for it is there that new research directions are frequently conceived, and there that the next generation of scientists is trained. Restrictions which diminish that openness are likely to have serious costs to science and, ultimately, to national security. Such costs should be carefully considered in all dimensions before implementing any actions that would compromise the traditional open environment that has served us so well in the past.

In those special instances where universities choose to undertake proprietary or classified work, they may have to accept constraints on communication.

CONCLUDING STATEMENT

The nature of science requires that its international dimension be considered an organic aspect of the scientific enterprise. This

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dimension must be actively provided for in all Foundation programs, from education and fellowships to the various disciplinary efforts in the natural sciences, social sciences, and engineering. Planning for new facilities and the setting of priorities for major scientific investigations and programs should be carried out with the full recognition of the priorities of other countries and in an environment which encourages complementarity or planned supplementation, cost sharing, and coherence of the various efforts of cooperating countries. National Science Foundation organization and management procedures should reflect these principles.

The Board will continue its analysis of the subject of "Science in the International Setting" in connection with the preparation of the Sixteenth Board Report of this same title.

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Appendix F

LETTER TO G.A. BARBER LISTING BANKS WITH INTERESTS IN FOREIGN MINERALS

July 25, 1983

Mr. G.A. Barber
Anaconda Minerals Company
Box 5300
Denver, CO 80217

Dear Art:

Responding, finally to your request for comments concerning the National Academy of Sciences Committee on United States awareness of international geological developments, I would start by saying that the so-called "money center banks" that have their own professional staffs keep fairly well up to date on international developments because so many of the new mining projects now under way are located overseas.

Tabulated below is a fairly complete list of the major, and minor, U.S. Banks which have organized minerals investment appraisal groups:

Majors	Others
Bank of America	Colorado National
Bankers Trust	Crocker
Chase Manhattan	First Bank of Minneapolis
Chemical	First City of Houston
Citibank	First Dallas
Continental Illinois	Irving Trust
First Chicago	Marine Midland
Manufacturers Hanover	Bank of New York
Morgan	Northwestern National
	Security Pacific

In addition, several international banks, such as National Westminister and Lloyds, have U.S. based mining groups. The Canadian banks are well staffed technically and only an hour away.

Chemical Bank has approximately 145 people in its Energy and Minerals Group. It is difficult to compare the size of our effort with others because many other banks are not organized on industry lines. Many use geographical or other organizational criteria and the absolute

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numbers are difficult to estimate. Consultants are routinely used by all Banks and in certain types of asset based lending outside consultants reports make up an integral part of the documentation.

In a similar vein, foreign sources are commonly used as technical sources. Chemical Bank, for instance, has Energy and Mineral people in Houston, Denver, Calgary, London, Paris, Singapore, Hong Kong, and Sydney, in addition to New York. With this network of offices we can effectively gather foreign source information.

The tremendous use in capital costs for natural resource projects has necessitated a corresponding rise in the degree of study of the various aspects of the project. Once the basics are understood, then the project review can take place. Basically, this process focuses on the net present value of the cash flow and the ability of the project to provide that cash flow.

Your final question regarding the World Bank is too far out of my world for me to give you anything meaningful. I hope these comments are helpful and don't hesitate to call if you need clarification.

Best regards.

Sincerely,

William L. Cameron

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Appendix G

MINERALS INDUSTRY STATUS REPORT

by G.A. Barber

A summary of the status of the U.S. minerals industry's background on global and international geology can be addressed in three parts:

- Minerals Industry Current International Geology Data Base
- International Geology Data Base Deficiencies
- Recommendations

MINERALS INDUSTRY CURRENT INTERNATIONAL GEOLOGY DATA BASE

Critical data regarding geology and mineral resources are acquired by the domestic minerals industry from both internal and outside sources. The term "data" refers to information including broad geologic concepts, ore deposit genesis, mineral commodity concentrations, resources, and reserves; mineral exploration; and exploration techniques. These subjects represent the principal interests of mineral exploration groups.

Internal data sources vary with the organization, and include one or more of the following:

- Exploration/Scouting Offices
- Mine Operation Staffs
- Corporate Planning Units
- Sales Offices
- Affiliated/Subsidiary Company Contacts

Sources of information outside company organizations are more extensive, and include:

- Federal, state, and local government agencies, such as U.S. Geological Survey and U.S. Bureau of Mines
- Academic institutions, through theses, research, and faculty/student consultants

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Note: Report was completed on June 24, 1983.

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- Private consultants
- Technical meetings, field trips, etc.
- Libraries
- Data banks
- Financial institutions
- Mine/Projects visits
- Foreign sources, including publications, news services, and government agencies.

Examples of available publications and the broad range of geology-related meetings are attached.

INTERNATIONAL GEOLOGY DATA BASE DEFICIENCIES

There are five principal concerns with respect to the dissemination of global/international geologic data within the U.S. minerals industry:

- Timeliness in publishing announcements/descriptions of significant world-wide geologic events, concepts, etc.
- Verification of reported data accuracy.
- Incomplete data, particularly from COMECON countries and Third World nations.
- Lack of a common depository for international data.
- Distribution of pertinent geologic data to the U.S. public, as it relates to the general welfare of the nation, either directly or through news media.

RECOMMENDATIONS

These deficiencies could be rectified by establishing a central depository and distribution center within an existing, or to-be-established, U.S. agency with responsibility for:

- Maintaining a continual exchange of pertinent geologic/mineral resource data with corresponding information sources in other countries through publications, correspondence, telex, telephone, personal visits, etc.
- Screening and appraising data.
- Promptly distributing pertinent reports to government, academic, private industry, and news media groups, with interpretive comments regarding the potential impact of particular geologic events/concepts/statistics on the U.S. public.
- Assisting in organizing reliable geologic data sources in other countries.

One of the basic problems that the U.S. minerals industry faces in contributing to a geologic data base is the perceived proprietary nature of some resource information. If a neutral depository did

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exist, arrangements could be made for appropriate screening to avoidinclusion of sensitive information which a supplier wished to withhold from general distribution. Since geology is considered to be a "pure science," most pertinent international geologic data should be available without infringing on a company's concern regarding the competitive edge.

There are a number of options as to which U.S. agency should assume this responsibility. These include the designation of a new unit within the proposed Department of International Trade and Industry which is expected to be established in the near future. The data accumulation/distribution center might be included within the existing U.S. Bureau of Mines or U.S. Geological Survey organizations. An inventory of processing capabilities in these agencies could be made immediately in preparation for recommending a depository.

The status of the geologic/mineral resource data base in the U.S. is embarrassing when one reviews publications, organizational charts, and reported capabilities of the numerous active agencies throughout the world, such as France's B.R.G.M., Atomic Energy Commission, and Uranium Research Center. Other major data sources exist in West Germany, England, Australia, and Canada. We obviously have a long way to go to catch up with these counterparts.

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Appendix H

A PARTIAL SURVEY OF PRODUCTION AND AVAILABILITY OF FOREIGN GEOSCIENCE MAPS

Compiled by D.M. Curtis

1. Who produces maps (other than agencies of foreign governments)

U.S.

U.S. or Bilateral/multilateral funding (USGS funded by other agencies):

Saudi Arabia = 77% of total USGS international funding in 1982 ($17.7 million)

Circum-Pacific Map project (non-government and multilateral)

International Stratigic Mineral Inventory

DOS Trade and Development Program--for 4 strategic minerals (Philippines, Peru, Morocco) (Maps? $$$?)

DOS/AID Technical Assistance Programs

Remote sensing for mapping: Egypt, Kenya, Bolivia

Fossil fuels and geothermal: Morocco, Bangladesh, Pakistan, Jordan, Malawi, Costa Rica, Senegal

South Pacific Hydrocarbon Resource Investigation (joint USGS/DOS/AID)

East Africa Regional Remote Sensing Center

Utilization Grants Program using Landsat data (for resource mapping, etc.): Bolivia, Chile, Philippines

NASA: satellite mapping programs in global geodynamics (gravity, magnetic maps soon)

DOD: Defense Mapping Agency (no information)

Circum-Pacific Map Project of Circum-Pacific Council for Energy and Minerals, CCOP (Coordinating Committee for Offshore Prospecting): maps published by AAPG

Other governmental and non-governmental agencies are engaged in making various types of geological maps, some of which include foreign areas

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Note: Landsat data are being used for geological mapping in many countries, such as Philippines, Egypt, Pakistan, Sudan, Swaziland, Syria, Thailand, Tunisia, Zaire. Maps for developing countries have limited availability because these countries have problems in compiling, editing, and publishing.

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Foreign (international funding and/or administration by international agency)

CGMW - Commission for Geological Map of the World (IUGS; supported by BRGM; marketed by AAPG)

ESCAP - Economic and Scientific Commission for Asia and the Pacific (UN)

SEATAR - Studies of SE Asia Tectonics and Resources (CCOP and ESCAP)

IOC - Intergovernmental Oceanographic Commission (IUGS? ICSU??) Committee for General Bathymetric Chart of the Oceans (GEBCO); Central Editorial Board oversees preparation and publication of Geological/Geophysical Atlases of the Atlantic and Pacific Oceans by USSR. Products expected beginning 1984.

IGCP - International Geological Correlation Programme (IUGS and UNESCO); currently 15 IGCP projects (worldwide) will have maps as a product. Significant among these is #32, Stratigraphic Correlations between Basins of the ESCAP Region, which has already produced 3 volumes of the ESCAP Atlas of Stratigraphy and 12 map atlas sheets of sedimentary basins of the ESCAP region.

UNESCO projects for regional development (i.e., Africa Project; possibly more)

International Association of Hydrogeologists - workshop on hydrogeological maps of SE Asia (Do they make maps or compile lists?)

ICL (Lithosphere project) will produce maps?

Oceanographic Institutions and geological institutes worldwide DSDP - IPOD

2. Where are they? - Collections

North America

U.S. Geological Survey - has extensive collections of geological maps, worldwide

Library of Congress, Geography and Map Division - has largest map collection in the world; domestic and foreign (except USSR); 3.7 million maps; 44,000 atlases; 8,000 reference works, 50,000 maps, and 800 atlases added annually; DOS foreign maps* are acquired by exchange or purchase collection includes extensive holdings of geological maps

Geological Survey of Canada

Also major university libraries, industry libraries, GSA, etc.

Overseas

BRGM (Bureau de Recherche Geologique et Minieres) Paris

IGME (Instituto Geologico y Minero de Espana) Madrid

Bundesanstalt für Geowissenschaften und Rohstofte - Germany-Hanover and/or Forschungsgemeinschaft. . . .Bonn?

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*DOS, through its Interagency Map and Publication Acquisition Program collects about 60,000 foreign maps per year - about 10% geological. These are eventually deposited in the Library of Congress.

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USSR
Institute of Geological Sciences U.K. - London
CIFEG (Center for Training and Exchanges in the Geosciences)
Paris - cartographic library has been developed as part of the center
Other national collections in industry and university libraries; and other institutes; etc.
CGMW (Commission for Geologic Map of the World) Paris, BRGM

3. Means of locating and getting access (references, data banks)
GEOREF/BRGM (automated data bases being merged)
IGME (automated data base)
Library of Congress (automated data base from 1968; older holdings readily accessed manually)
Bibliographies; directories; lists
IGCP Catalogue (of publications resulting from IGCP projects through 1979, many of which are maps; new Catalogue in preparation)
CGMW - list of available maps from BRGM or AAPG
Circum-Pacific Map Project - list of available maps from AAPG
Dederick Court & Co. - geological references (maps and bibliographies summarized through 1980)
GEOTIMES & EPISODES - listing of recently published maps
Hall Bibliographic Guides to Maps and Atlases (annual) (also includes maps in non-map sources)
Carrington & Stephenson Directory of Map Collections in U.S. and Canada
[Note: International Directory is expected in 1984]
Telberg Book Co. (foreign maps; catalogue available)

4. Examples of ongoing foreign initiatives with map products
USSR - Tectonic map of the world
Atlas of Geology/Geophysics of Atlantic and Pacific Oceans
Japan - Revolving fund for mineral exploration; now part of UNDP; mineral maps
Canada - International Development Research Center - work includes geological mapping in developing countries
UK - Institute of Geological Sciences
$5 million mapping program in Bolivia
$2 million mapping program in Pakistan
France - BRGM and IFP and French National Petroleum Co. do mapping in many parts of the world; many bilateral agreements.

Note: Board on Earth Sciences Committee on Status of Geologic Mapping in U.S. does not cover foreign map collections.

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Appendix I

STATEMENT OF WILLIAM P. PENDLEY, DEPUTY ASSISTANT SECRETARY--ENERGY AND MINERALS DEPARTMENT OF THE INTERIOR BEFORE THE COMMITTEE ON SCIENCE AND TECHNOLOGY JULY 28, 1981

Mr. Chairman and members of the committee: It is a pleasure to appear before you today to discuss the implementation of P.L. 96-479, the "National Materials and Minerals Policy, Research and Development Act of 1980." The 1980 Act sets this nation on a new and stronger course in the development of its minerals policy. Its provisions will help broaden and deepen our knowledge of minerals and materials, better coordinate mineral policy development with the organizations and agencies of the Executive Branch, and will provide greater awareness of the fundamental role minerals and materials play in the development of a vigorous economy and strong national defense. This committee should be commended for the lead role it took during the last session of Congress to make this legislation a reality. I wish to particularly compliment you, Mr. Chairman, for your perseverance and personal effort in the speedy and timely enactment of this legislation.

I think the record is clear that the 1980 Act has the strong support of this Administration. The development of a comprehensive strategic material policy is one of the chief tasks and major challenges the President has placed before his Administration. We are working hard and, I believe, successfully in carrying out the mandate of the new law. Allow me first to describe the actions we have taken within the Department of the Interior to carry out our responsibilities under the Act. Then I would like to briefly describe the coordination of other related activities called for in the law that are being carried out elsewhere in the Executive Branch.

The 1980 law requires the Secretary of the Interior to do three things: first, to improve the capacity of the Bureau of Mines to assess international minerals supplies; second, to increase the level of mining and metallurgy research by the Bureau in critical and strategic minerals; and third, to improve the availability and analysis of mineral data in Federal land use decision making. A report on our actions in carrying out these responsibilities is due to the Congress by October 21 of this year.

First, to improve the Bureau's capacity to assess international minerals supplies, we are strongly supporting the Bureau's efforts to evaluate mineral properties located throughout the world and to develop worldwide supply availability curves based on mineral property evaluations. The worldwide engineering and cost evaluations of all

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major mineral properties for the 23 most critical mineral commodities will be completed by the end of FY 1983 and worldwide supply availability curves based on these data should be completed by FY 1984. To improve the analysis of some foreign and domestic mineral data, we have proposed in the FY 1982 budget request that a mineral policy analysis office be established within the Bureau. This new office will be the focal point within the Bureau for addressing mineral policy issues and will serve as a mechanism for joint analytical efforts with other agencies. In addition, the Department initiated a review by the Office of Mineral and Policy Research Analysis regarding the various mineral data systems now in use in an attempt to ensure compatibility and utility and reduce duplication. Finally, the Bureau is now inventorying all mineral data systems within the Executive Branch, and is identifying the location, the currency, and the relevancy of the data systems for policy related analysis and decision-making. An interagency Minerals Information Coordinating Committee, chaired by the Bureau, is now carrying out this task.

To fulfill the second requirement of the Act to increase the level of research related to critical and strategic minerals, we have revised the Bureau's 1982 budget request and moved $8.3 million from environmentally oriented research to other studies more directly related to improved recovery of and substitution for critical and strategic minerals. While operating under the very tight restraints necessitated by the need to curtail Federal spending generally, this re-direction of research will enable the Bureau to perform additional research involving the recovery of cobalt, chromium, manganese, nickel, zinc, tin, and titanium from domestic resources, and involving the development of substitutes for those materials that are, for the most part, imported.

Third, to improve the availability and analysis of mineral data in Federal land use decision-making, Secretary Watt has directed the Department to take the steps necessary to improve decision-making relative to the utilization of our nation's lands. Adequate minerals information for balanced land use decisions, as essential as it is, is the most difficult part of the land planning process. The very history of mining is that new mineral deposits are often found where we had no previous hint of their existence. Discovery is often made only after repeated exploration efforts, sometimes spanning many years. While we can identify some areas of potential, we are never 100 percent sure. We simply do not know nor will we ever completely know where all of our mineral deposits lie. Neither can we easily predict the technological and economical--and sometimes political--circumstances that make mineral deposits mineable.

Ironically, because most of our knowledge on the mineral character of public lands is largely the result of exploration and mining by the private sector, the availability of new information becomes a factor of decisions that affect the private sector's accessibility to such lands.

A major step in the right direction, I believe, will be to re-examine the responsibility of government as to its management of the public lands to assure that minerals receive proper consideration. This process is now under way at Department of the Interior.

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As I hope you can detect, Mr. Chairman, the Department of the Interior has made major progress in implementing the 1980 law--particularly when one considers the start-up time involved in the change of administrations. Our work is far from complete in carrying out the letter of the new law, but I believe we have demonstrated a compliance with the spirit of that law.

In addition to these efforts within the Department and related activities mandated by the law for other agencies, the Cabinet Council of Natural Resources and the Environment has been given the responsibility for formulating a National Materials Policy by the President. In carrying out this responsibility, the Council has established a Strategic Materials Policy Working Group, I have the privilege to chair. The working group contains participants from eighteen different agencies and organizations and has divided its tasks into eight separate issue areas. One of the eight issue areas deals specifically with compliance with the provisions of the 1980 Act and coordination of the various actions called for by the law. The other seven issue areas under study by the working group, related directly to the 1980 Act, and are thus an essential part of our response.

Mr. Trimble: I am Mr. Trimble from the Department of Defense. I have a prepared statement which I would like to enter into the record. Before commencing, I would make the observation that the Department of Defense generally does not buy basic raw materials. Rather, we do buy the finished product, many of which are extremely important to the defense of the country. We have a very high regard for the criticality of this matter of the shortage of materials and minerals. To support the important objective that has been set forth to improve our posture regarding materials and minerals, the Department of Defense is enthusiastically fulfilling its responsibilities under the act of 1980.

The following are actions that we have taken or are taking. One, we have established a Department of Defense (DOD) team of senior professionals who are assigned to our industrial resources and our research and development offices to assume the responsibility of all tasks required to meet both the spirit and letter of the law. This team is working closely with the Departments of Interior, Commerce, and State, the Central Intelligence Agency, National Security Agency, and Federal Emergency Management Agency to ensure that we have a coordinated Government-wide plan for the resolution of problems relating to minerals and materials. They are also working with the White House Council on Natural Resources and Environment in an effort to develop a unified position under Public Law 96-479.

Two, we have tasked the Institute for Defense Analysis, a local not-for-profit studyhouse that works almost exclusively for the Department of Defense, to provide us with information on which we can assess our need for minerals, materials. We have asked for research and development, in which we can develop appraisals for policy options.

Three, we have renewed and updated the charter and objectives of the Interagency Materials Availability Steering Committee which was established in 1974.

Four, we are assessing, with the assistance of the military departments, the impact of import dependency on specific weapon

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systems, subsystems, intermediate products, and structures.

Five, we have completed a proposed DOD-wide research and development plan for satisfying DOD critical and strategic materials requirements. This plan proposes a long-range Department of Defense-wide material substitute research and development program to assess our most critical needs. This plan is currently under review by the Joint Chiefs of Staff and will be reviewed by the Interagency Materials Availability Steering Committee.

Six, we conducted a DOD-wide metal matrix composites conference in May of this year and also conducted a Department of Defense-chaired OSTP committee on materials, rapid solidification technology working group conference in July. Both conferences addressed the potential of these material technologies for developing substitute materials.

Seven, in May of this year we conducted a 3-day industry conference workshop in conjunction with the American Defense Preparedness Association and secured industrial inputs to our overall materials situation assessment.

This completes the summary of the actions that we have taken, and I am pleased to say that we have noted in all cases, Mr. Chairman, great enthusiasm on the part of Government agencies and industry groups to attempt to help us resolve the problem of our materials shortages. We are also at this time identifying those sources of materials and processing sequences which need to be imported.

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Appendix J

U.S. GEOLOGICAL SURVEY INTERNATIONAL COOPERATIVE AGREEMENTS CURRENTLY IN FORCE

Country	Counterpart Agency	Program	Type of Agreement
Afghanistan	Kabul University, Seismological Center of the Faculty of Engineering	Cooperative Efforts in Seismology	Memorandum of Understanding
Bangladesh	Geological Survey of Bangladesh (GSB)	Accelerated Exploration for Mineral Resources & Modernization	Contract Agreement
Bolivia	Academia National de Ciencias de Bolivia - Observatorio San Calixto	Global Seismic Data Acquisition System	Memorandum of Understanding
Brazil	Ministry of Mines and Energy Department of the Interior	S&T Coop. in Geological Sciences and Earth Resources re: Mineral and Energy	Memorandum of Understanding
Canada	Geological Survey of Canada, Dept. of Energy, Mines and Resources	Scientific and Technical Cooperation in Geological Sciences	Memorandum of Understanding
Canada	Canadian Centre for Remote Sensing, Dept. of Energy, Mines and Resources	Scientific and Technical Cooperation in Remote Remote Sciences	Memorandum of Understanding
Chile	Services Nacional de Geologia y Mineria (SERNACLONIA)	Technical Cooperation in the Earth Sciences	Memorandum of Understanding
Circum-Pacific Rep.	Agency for International Development (AID)	Cooperative Earthquake & Tsunami Potential, Circum-Pacific Region Zones	Participating Agency Service Agreement
Columbia	Inst. Nacional de Investigiciones Geologico Mineras, Min. de Minas y Energia	Scientific and Technical Cooperation in the Earth Sciences	Memorandum of Understanding
Dominican Republic	Direccion General de Mineria e Higrocarburos	Cooperation in the Geological Sciences	Memorandum of Understanding
East Africa Region	Regional Remote Sensing Facility AID	Remote Sensing for Resource Assessment	Participating Agency Service

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Country	Counterpart Agency	Program	Type of Agreement
El Salvador	Centro de Investigaciones Geotechnicas, Ministerio de Opras Publicas	Cooperative Investigations in Earthquake Research	Memorandum of Understanding
El Salvador	Center for Geotechnical Investigations (CIG) - AID	Coop.Invests. with CIG in EQ Reduction & Engineering Geology	Participating Agency Service Agreement
France	Service Geologique National, Bureau de Recherches Geologiques et Minieres	Cooperation in the Field of Geological Sciences	Memorandum of Understanding
France	Ecole Nationale Superieure des Mines de Paris	Cooperation in the Geological Sciences	Memorandum of Understanding
Germany/ Fed.Rep.of	Bundesanstalt für Geowissenschaften und Rohstofte	Cooperation in the Geological Sciences	Memorandum of Understanding
Guatemala	Central Am. Inst. for Industrial Tech. & Research (CAIITR)/AID	Workshop, Development of Minerals, Energy, Water Resources & Misc. of Geologic Hazards	Participating Agency Service Agreement
Guatemala	Natl. Inst. of Seismology, Vulcanology, Meteorology, and Hydrology (INSIVUMEH)-AID	Zonification and Seismic Risk in Guatemala	Participating Agency Service Agreement
Hungary	Central Office of Geology	Scientific and Technical Cooperation in the Earth Sciences	Memorandum of Understanding
Iceland	National Research Council, Ministry of Education	Science and Technology in Earth Sciences	Memorandum of Understanding
Indonesia, Rep. of	AID - Volcanological Survey of Indonesia	Volcano Monitoring and Research in Indonesia	Participating Agency Service Agreement
Israel, State of	Earth Science Research Administration of Israel (ESRA)	Establish Station as Part of Global Seismograph Network	Memorandum of Understanding
Italian Republic	Consiglio Nazionale Delle Ricerche (CNR)	Cooperation in Earth Sciences	Memorandum of Understanding
Italian Republic	Istituto Nazionale di Geofisica (ING)	Regional Digital Seismic Studies	Memorandum of Understanding
Japan	The Geological Survey of Japan	Cooperation in the field of Geological Sciences	Memorandum of Understanding
Jordan	Natural Resources Authority of Jordan - AID	Systematic Assessment of Ground Water Resources of Northern Jordan	Participating Agency Service Agreement
Jordan	Natural Resources Authority Jordan - AID	Establishment of a Jordanian Seismic System	Participating Agency Service Agreement
Jordan	Natural Resources Authority of Jordan	Scientific Cooperation in the Earth Sciences	Memorandum of Understanding
Kuwait	Kuwait Institute for Scientific Research	Cooperation in the Earth Sciences	Memorandum of Understanding

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Country	Counterpart Agency	Program	Type of Agreement
Latin America	Centro Regional de Sismologia para America del Sur (CERESIS) AID/OFDA	Earthquake Disaster Mitigation in the Andean Region	Participating Agency Service Agreement
Mexico	Instituto de Investigaciones Electricas	Cooperation in Geothermal and Related Volcanic Investigations	Memorandum of Understanding
Morocco, Kingdom of	Bureau of Geology, Ministry of Energy and Mines	Technical Cooperation in the Earth Sciences	Memorandum of Understanding
Peoples Rep. of China	State Seismological Bureau of PRC and (US) National Science Foundation	Scientific and Technical Cooperation in Earthquake Studies - II	Protocol
Peoples Rep. of China	Chinese Academy of Geological Sciences, Ministry of Geology and Mineral Resources	Scientific and Technical Cooperation in the Earth Sciences	Protocol
Peoples Rep. of China	Ministry of Water Conservancy	Scientific and Technical Cooperation in Surface Water Hydrology	Protocol
Peoples Rep. of China	The National Bureau of Surveying and Mapping the PRC	Scientific and Technical Cooperation in Surveying and Mapping Studies	Protocol
Peru	Empresa Minera del Centro del Peru (CENTROMIN)	Scientific Cooperation in the Earth Sciences	Memorandum of Understanding
Portugal	Regional Government of the Azores - AID	Azores Geothermal Project	Participating Agency Service Agreement
Saudia Arabia	Ministry of Finance and National Economy	Technical Assistance in Hydrology	Memorandum of Understanding
Senegal, Republic of	Agency for International Development (AID)	Groundwater Monitoring	Participating Agency Service
South Korea	Korea Institute of Energy and Resources (KIER)	Technical Cooperation in Earth Sciences	Memorandum of Understanding
Southeast Asia	Regional Governments in South-East Asia - AID	Earthquake Hazard Mitigation Program in Southeast Asia	Participating Agency Service Agreement
Southeast Asia	Regional Governments in South-East Asia - AID	Upgrade of Seismic Network in Southeast Asia	Participating Agency Service Agreement
Turkey	Ministry of Public Works and Resettlement - Middle East Technical University	Global Accelerograph Program	Memorandum of Understanding
United Kingdom	Natural Environment Research Council	Earth Resources and Environmental Studies	Memorandum of Understanding
Venezuela	Ministry of Energy and Mines (DGSMG)	Science and Technology in Earth Sciences	Memorandum Understanding

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Country	Counterpart Agency	Program	Type of Agreement
Worldwide	Regional Governments - AID	Technical Support in Conventional Energy Resources Identification	Resources Support Services Agreement
Worldwide	U.S. Department of State	Regional Resource Officer (RRO) Program	Memorandum of Understanding

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Appendix K

COOPERATIVE SCIENCE WITH HUNGARY

United States Department of the Interior
Geological Survey
Reston, VA 22092

In Reply Refer To:
Mail Stop 915

May 3, 1985

MEMORANDUM

To: The record

From: Paul Teleki

Subject: Cooperative science with Hungary

Detached as possible, I need to make a few points concerning the 5-year old USGS-Central Office of Geology of Hungary program.

1. In the 10 years that I have been with the Survey, it is the only cooperative science program that returned to us as much as we gave. Lately the benefits have shifted even more toward the Survey as specific field experiments the Survey could not afford were being set up.
2. It is a program that interested the World Bank enough to approve USGS consultancy in petroleum exploration in Hungary, not an easy decision with private consultants milling around by the 100's. But consultancy won't replace cooperative science.
3. It is one of a very small number of programs where the State Department and the U.S. Ambassador recognized that the Survey contributed substantially toward U.S. foreign policy objectives.
4. The annual out-of-pocket cost ($25-30K) is a piddling sum compared to the benefits received, and that this amount is equivalent to the purchase price of 2 NBI's surprises even me.

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5. The monetary benefits:

   a. Five dedicated boreholes drilled to 1000-1500 m depth with oriented samples taken for magnetostratigraphic determinations, if done by the USGS: $10M (estimated).
   b. Computer software in graphics and in electromagnetics, if developed by the GS: $500K (estimated).
   c. Vertical seismic profiling field experiments and data, if done by the USGS: $750K (est.).
   d. Borehole data (cores, samples, logs) for sedimentological and facies analysis, if drilled and logged by the GS: $800K (est.).
   e. Data made available for control and development of interpretation techniques in electrical geophysical methods, if developed by the GS: at least $1M.
   f. Receipt of 800 km of high quality CDP land seismic-reflection profiles, a $2M acquisition cost in the U.S.

6. The scientific benefits:

   a. Continental magnetostratigraphic data to update the polarity time scale known from marine DSDP and continental shelf sediments, data, and to develop a global magnetic reversal scale.
   b. Ability to test time-domain EM and IP systems and models for ore exploration, and a series of "firsts" in establishing the theoretical basis and demonstrating application to bauxite deposits, karst and water-bearing sediments.
   c. Seismic reflection profiles and borehole data provided to understand a unique (young, pull-apart), geological basin, one of the few in the world where seismic stratigraphic studies can reveal, in great detail, the mechanics of extensional faulting, map a complete progression of basin infilling, and understand petroleum reservoir properties in lacustrine continental settings. This can only help as an analog for U.S. basin studies.
   d. Oil samples from several wells analyzed jointly provided some of the first clues to migration and maturation of petroleum in a young basin with high geothermal gradients.
   e. An opportunity to study heavy mineral suites not existing in the U.S.
   f. Whereas the GS scientists have been working on vertical seismic profiling for about 10 years and extended the theory for it, and published extensively on this topic (a book by Balch and Lee), the only non-proprietary data available to test the VSP theory further was afforded to them by field experiments set up in Hungary. In addition, the GS never had any success with explosives as

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a seismic (sound) source, which the Hungarians solved.

g. A place where an integrated basin analysis could be carried out on account of a very high data density - nothing in the U.S. compares to this density in any basin.

h. A willingness of Hungarian earth science institutes to run field programs with their staff and equipment) specification or input by Survey scientists (EM, IP, VSP, seismic reflection and refraction profiles, drilling and coring).

i. Where coal classification and quality studies, intercomparing U.S. and European classification schemes, can be compared and contrasted, replacing earlier studies with Poland.

i. Where theoretical geophysics is on a world class level, and has supplemented practical problems in mineral resources the GS had to solve domestically and on a reimbursable basis (Saudi Arabia).

k. Technical achievements of each side complement one another and generate high benefits for both.

Granted, money is in short supply. But the problems with the Hungarian co-op are symptomatic of deeper, more fundamental problems the USGS has with international activities. Whatever the raison d'etre, a vacuum is being left behind by the Survey in all parts of the world, that is quickly filled by the French, Canadians, Germans, Norwegians, British, Japanese, Soviets, and others. We are gradually working ourselves into a state of isolation. This will play into the hands of those governments who are encouraged by other powers to minimize foreign scientific visitors snooping around (paraphrasing Linn Hoover). But more importantly, we cannot keep a leading edge (if still any) in science and technology if we only talk to ourselves.

I don't see how we can walk away from an integrated basin analysis program carefully structured over the years with the storehouse data raw samples and depositories backing it up, that we couldn't afford to collect in 10 or 20 years.

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Appendix L

PARTICIPATING AGENCY SERVICE AGREEMENT (PASA)
BETWEEN THE AGENCY FOR INTERNATIONAL DEVELOPMENT
AND
U.S. DEPARTMENT OF INTERIOR, U.S. GEOLOGICAL SURVEY

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1. Initial Starting Date (Mo., Day, Yr.) o/a 3/1/83	**PASA** PARTICIPATING AGENCY SERVICE AGREEMENT BETWEEN THE AGENCY FOR INTERNATIONAL DEVELOPMENT AND U.S. DEPARTMENT OF INTERIOR U.S. GEOLOGICAL SURVEY	☐ PASA ORIGINAL ☒ PASA AMENDMENT 1
2. Projected Completion Date (Mo., Day, Yr.) o/a 12/31/84		7. PASA Number BOF-0000-P-IC-3064-01
3. Category ☒ TDY ☐ ASSIGNED		8. Country/AID/W Office WORLDWIDE/OFDA
4. Duration of Funding ☒ CURRENT YEAR ☒ FORWARD FUNDING	5. Project Number and Title Geologic and Hydrologic Hazards Training Program	9. Type ☒ GRANT ☐ LOAN ☐ COUNTRY FINANCED; 10. Year FY 1984

11. FUNDING

A. CITATIONS	(1) Appropriation Number 72- 11X1035	(2) Allotment Number JFDX-84-10700-HG45		(3) PIO/T/Obligation Number 0743039
B. FOR PARTICIPATING AGENCY	(1) Initial or Current $ 157,600	(2) Change (+ or –) $ 363,750		(3) New Total $521,350
C. RETAINED FOR AID DIRECT DISBURSEMENT	(1) Initial or Current $ -0-	(2) Change (+ or –) $ 84,551		(3) New Total $ 84,551
D. TOTAL AMOUNT OBLIGATED (Blocks B + C)	(1) Initial or Current $ 157,600	(2) Change (+ or –) $ 448,301		(3) New Total $605,901
E. PRINCIPAL COST COMPONENTS OF (Block B)	(1) Salaries, Differential and Benefits $ 20,389	(2) Transportation including Per Diem $165,400	(3) Miscellaneous $74,037	(4) Overhead $103,224

12. Statement of Purpose

I. **Summary**

The purpose of this PASA Amendment between the U.S. Geological Survey (USGS) and A.I.D. is to conduct a geologic and hydrologic hazards training program and to provide OFDA assistance in developing hazard abatement expertise worldwide to save lives and reduce economic losses in countries where geologic and hydrologic hazards are prevalent. This amendment funds services through December 31, 1984. All other terms and conditions of the agreement, not specifically changed by this document, remain as previously negotiated.

13. GOVERNING PROVISIONS: Pursuant to the General Agreement dated February 5, 1967 between AID and the Department of Interior, the Agency named above agrees to provide the services outlined in Block 12 amplified as needed by Appendix A, unless otherwise authorized by AID, all services shall be of U.S. origin. Any appendices attached hereto are considered part of this PASA.

14. Signatures

NAME Peter F. Bermel	NAME Ellen R. Wills
TITLE/OFFICE Assistant Director for Programs	Acting TITLE/OFFICE CHIEF, INTERNAT'L & INTERAGENCY BRANCH CONTRACT MANAGEMENT AID
DATE June 6, 1984	DATE May 29, 1984

15. Appendices

☒ APPENDIX A - SCOPE OF WORK
☒ APPENDIX B - BUDGET PLAN
☒ APPENDIX C - USE OF AID PERSONNEL/FACILITIES
☒ APPENDIX D - SUBCONTRACTING
☒ OTHER/REFERENCE Appendix E - Billing
Appendix F - HAC for Participant Training

16. Negotiating Officers

AID: CM/SOD/IIA – John H. Duncan

AGENCY: DOI/USGS: Lee Benton

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APPENDIX B SCOPE OF WORK PAGE 1 OF 2	BETWEEN THE AGENCY FOR INTERNATIONAL DEVELOPMENT AND U. S. Department of Interior U. S. Geological Survey	PASA NO. 01 BOF-0000-P-IC-3064- FISCAL YEAR 1984

II. Scope of Work

1. Conduct a series of instructional seminars and workshops (including field trips) over a five-week period (March 5-30, 1984) at the U.S. Geological Survey Federal Training Center in Denver, Colorado on the subjects of geological and hydrological hazards for not less than 30 foreign participants from earthquake and/or flood disaster-prone developing countries.

2. Select and invite seminar participants as identified by USAIDs, OFDA and U.S.G.S. technical team visits to host countries. Review all appropriate applications and arrange all travel and per diem for trainees.

3. Select and invite distinguished foreign guest lecturers from each of three regions previously visited by the U.S.G.S. teams.

4. Finalize agenda for seminar/workshop program and coordinate preparation of final instructional materials and arrangements for lecture exercises, slides and reprint/publications distribution.

5. Coordinate and implement foreign and domestic travel logistics and per diem distribution for all lecturers consultants, and participants.

6. Develop a post-disaster response to plan to assist counterpart experts in host countries to determine the nature of disaster events and probability of further activity. Provide guidelines for in-country use in protecting life and property against disasters caused by floods, earthquakes, landslides, volcanoes etc.

7. Assist host countries in collecting the technical information needed to develop comprehensive disaster preparedness programs and assist in post-disaster scientific response activities.

8. Publish training program presentations, instructional materials content, technical results and other substantive materials in a final volume (i.e. U.S.G.S. Professional Paper) for worldwide public dissemination.

III. Background

"Proposal A" (attached) included by reference in this amendment.

IV. Reports

1. Quarterly Progress reports are required (six copies).

2. Final Report (see No. 8 above) is required in (draft) four months following completion of the training program. Final U.S.G.S. (and A.I.D. approved) Professional Paper to be published before completion of the project.

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APPENDIX B SCOPE OF WORK PAGE 2 OF 2	RTICIPATING AGENCY SERVICE AG EMENT BETWEEN THE GENCY FOR INTERNATIONAL DEVE PMENT AND U. S. Department of Interior U. S. Geological Survey	ORIGINAL / AMEND. NO. PASA NO. BOF-0000-P-IC-3064 FISCAL YEAR 1984

V. Relationships

A. The U.S Geological Survey will conduct the activity using U.S.G.S. personnel, and university specialists as appropriate. AID/OFDA will coordinate with the USGS in conducting the program in cooperation with the LDCs and USAIDs.

B. Cooperating Country Liaison Official

The U.S.G.S will coordinate in-country with counterpart governmental agencies and institutions and all logistical arrangements involved in the training course.

C. AID Liaison Officials

Paul F. Krumpe
Program Officer, AID/OFDA, Rm. 1262A, N.S.
Washington, D.C. 20523

VI. Logistics

USGS will make all international and domestic travel arrangements, including purchase of tickets, obtaining passports or visas as required, and make all transportation arrangements for domestic rental cars for official travel as required.

VII. Special requirements:

No international travel originating in the U.S. should be undertaken without prior approval of AID/OFDA/W and or CM/SOD/IIA.

Subcontracting authority is granted to USGS under its own contracting authority, and in accordance with A.I.D. Handbook 12, pages 1-21 and 1-21a, not to exceed $55,000 as stipulated in the attached budget.

All training under this agreement shall be provided in accordance with A.I.D. Handbook 10.

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Appendix M

FOURTH INTERNATIONAL SYMPOSIUM ON MINERAL RESOURCES OF THE FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES

GEO-RESOURCES AND ENVIRONMENT
Examples from the Applied Geosciences

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**Viertes Internationales Rohstoff-Symposium
der Bundesanstalt für Geowissenschaften und Rohstoffe**

**ROHSTOFFE UND UMWELT
Beispiele aus den angewandten Geowissenschaften**

***Fourth International Symposium on Mineral Resources
of the
Federal Institute for Geosciences and Natural Resources***

***GEO-RESOURCES AND ENVIRONMENT
Examples from the Applied Geosciences***

Das vierte Internationale Rohstoff-Symposium wird sich mit der immer schwieriger werdenden Problematik der Nutzungsansprüche an die Erde, dem Erhalt und dem Schutz der Umwelt befassen.

The Fourth International Symposium on Mineral Resources will deal with the problems resulting from differing demands on the earth's resources and with the problems of environmental conservation and protection.

Vorläufiges Programm — *Preliminary Program*

Mittwoch, 16. 10. 1985 ***Wednesday*** **14.30 Uhr/*hrs***	Begrüßung *Welcoming address* Eröffnungsvortrag *Opening address* Plenarvortrag „Geowissenschaftliche Erkenntnisse zur politischen Entscheidungsfindung" *Plenary Paper "Geoscience Information and Public Policy"*
anschließend ***followed by***	Empfang in der BGR *Reception*
Donnerstag, 17. 10. 1985 ***Thursday*** **8.30 Uhr/*hrs***	Themenkreis: Boden und Wasser *Topic: Soil and Water* „Vorsorge beim Bodenschutz" *"Precautionary Measures for Soil Protection"* „Verhalten von Schwermetallen in Boden" *"Behavior of Heavy Metals in Soils"* „Wasser – ein Rohstoff in Gefahr" *"Water: A Natural Resource in Danger"* „Grundwassernutzung und -schutz" *"Groundwater Development and -Protection"* Themenkreis: Lagerung toxischer Abfälle *Topic: Disposal of hazardous wastes* „Abfall – eine Herausforderung für die Industriegesellschaft" *"Waste: A Challenge for Industrial Societies"* „Der Umgang mit radioaktiven Abfällen – ein Modellfall für die Abfallwirtschaft?" *"The Handling of Radioactive Wastes: A Model for the Waste Disposal Industry?"*
Freitag, 18. 10. 1985 ***Friday*** **9.00 Uhr/*hrs***	Themenkreis: Raumordnung und Regionalplanung *Topic: Regional Policy and Planning* „Regionale Planung und Raumordnung bei der Förderung mineralischer Rohstoffe in Norwegen" *"Mineral Resources Production: Regional Policy and Planning in Norway"* „Umweltgeologie von Großbritannien" *"Environmental Geology in Great Britain"* „Rohstoffsicherung in der Bundesrepublik Deutschland unter besonderer Berücksichtigung Niedersachsens" *"The Protection of Raw Materials Deposits in the Federal Republic of Germany, especially Lower Saxony"*

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Appendix N

INTERNATIONAL CENTRE FOR TRAINING AND GEOLOGICAL EXCHANGES (ICTGE)

Centre International
Pour la Formation et les Echanges Geologiques
103 Rue de Lile, 75007 PARIS, France

At the closing of the 26th International Geological Congress held in Paris in July 1980, an idea was launched for the creation of a permanent center which, working together with the international organizations, would encourage and facilitate exchanges between institutions of all nationalities specializing in the Earth Sciences, and would provide assistance, in particular, for scientists and technicians with advanced training and study opportunities.

The Earth Sciences contribute to the economic and social development of a nation via the exploitation and development of its mining resources. They also have a number of other important spheres of influence, in particular in the energy sector and that of territorial development. Geological studies are fundamental to the search for and the management of water resources. They are necessary for large-scale civil engineering projects and for environmental and impact studies, problems connected with urban expansion, etc.

International cooperation implies that those countries that have an established tradition in the technologies corresponding to these activities have a duty to assist less industrialized nations, sharing with them the benefit of their experience.

In order to do this, it is first necessary to find out the actual requirements of such countries, to study with them the consequences on a national or regional scale of new technological input, so that, in response to requests, efficient assistance may be provided for their development.

Contacts established with the representative authorities responsible for international cooperation projects in the field of the Earth Sciences, have confirmed the concern of many countries--in particular those with developing industrialization--concerning scientific information, training opportunities and higher education for their executive staff.

For practical considerations, the ICTGE--an internationally oriented organization under French jurisdiction--was created in August 1981 by the transformation of an already existing foundation.

Administrative control of the Centre is assured by a Board of Directors of 24 members from various nations and belonging to a variety of organizations (including UNESCO).

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An Upper Scientific and Technical Council, again of international composition, will be created to assist the Board of Directors. This body will propose the general principles to govern the orientation of the Centre and give advice on the ICTGE work program. Its members will be drawn from representatives of the international organizations and from persons with experience of international cooperation in the Earth Sciences.

The objectives of the ICTGE as regards the Earth Sciences have been outlined as follows:

• to promote the exchange of information between countries;

• to encourage all initiatives for scientific and technical training within the countries concerned, or outside them where no suitable facilities are locally available;

• to gather the requirements in geological information as expressed by these countries and to find with them the way of meeting these needs;

• to involve all types of organizations and associations concerned by the Earth Sciences in this work. The new Centre is not to form a substitute for the organizations already participating in international cooperation of this sort, but to facilitate their contacts and make the best possible use of their initiatives.

TRAINING

The ICTGE must first make an accurate survey of the requirements in cooperation-training as expressed by the various countries and in particular by the developing countries. This will be balanced by a survey of all the opportunities offered for higher education and specialized training in the industrialized countries.

The training to be undertaken will be of two main types:

• group training programs inside the developing countries, usually intended for technicians, the coaching being provided by foreign teachers and engineers;

• research work or specialized studies by engineers and scientists carried out in the countries possessing the corresponding technology.

MEETING PLACE AND COMMUNICATION CENTER

The Centre will serve as a focal point for meetings and communication between engineers and scientists from throughout the world. This part of its functions will present a threefold complementary aspect, in close association with its role as a documentation center (see below):

• welcome and information (scientific, technical and practical) at the head office;

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- response to scientific and technical requests from various countries, often by channeling these requests towards the most suitable organizations;
- publication of an information and liaison bulletin.

DOCUMENTATION CENTER

In this role the ICTGE will provide geological and mining information, together with macroeconomic data, particularly concerned with the developing countries of the world. For these purposes, the Centre will possess a library containing synthesis studies, monographs (thematic or regional), and the programs for bilateral and multilateral cooperation. It will be equipped with all the documentary and data processing means allowing it access to the international data banks. It will therefore be able to establish an information network with all the main documentary centers.

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