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NATIONAL ACADEMY OF SCIENCES/NATIONAL RESEARCH COUNCIL
Commission on Geosciences, Environment, and Resources

BOARD ON EARTH SCIENCES AND RESOURCES
AND ITS ACTIVITIES

The Board on Earth Sciences and Resources coordinates the National Research Council's advice to the federal government on solid earth science issues. The board identifies opportunities for advancing basic research and understanding, reports on applications of earth sciences in such areas as disaster mitigation and resource utilization, and analyzes the scientific underpinnings and credibility of earth science information for resource, environmental, and other applications and policy decisions. The Board's actions address the overall health of the earth science disciplines (and the education of earth scientists) that are vital to the nation in maintaining and increasing its capability to make wise use of the earth and its resources.

As enunciated in the Board's 1993 report, *Solid-Earth Sciences and Society*, the challenge to the earth science community is to develop an integrated approach to the solid earth and its resources. Worldwide improved living standards and population increases combine to pose new problems extending from basic issues of the physics and chemistry of the earth to complex considerations of resources, environment, and land utilization. The Board needs the ability to keep the global issues in perspective while at the same time preserving the requirements for informed and specialized understanding in addressing individual issues.

The impact of the transition from a field that has traditionally focused on resource discovery, assessment, and extraction to a field increasingly dominated by environmental concerns is one that the Board is giving greater emphasis.

The activities of the Board are conducted through committees that the Board establishes to undertake studies on identified issues and topics developed by the Board. In order for the Board to develop such studies, the Board will, on occasion, form sub-units of itself to help develop specific activities in greater depth. Activities developed by these special sub-units will then be presented to the full Board for discussion and action.

The Board is establishing an agenda that addresses a wide variety of activities within the earth sciences and mineral/energy resource areas, both proactively (self-initiation) and reactively (responding to specific requests), including:

- *Accuracy, credibility, and management of earth science information*
Areas of concern include resource exploration, evaluation, and extraction; environmental protection; waste disposal (or isolation); land management; land use; and other applications. Management of the flow of data from primary collection to their eventual use in decision making is a continuing task for the Board and its committees.
- *Emerging frontiers of both the basic geosciences and their applications.*
Many of these frontiers are addressed in the *Solid-Earth Sciences and Society* report, which has acted as a starting point for the Board to provide additional leadership in the field.
- *Evaluation of hazards—their understanding, prediction, amelioration, and consequences.*

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The broad issue of hazards (earthquakes, volcanoes, landslides, tsunamis, etc.) remains an important consideration for the Board, and there is the need to integrate their scientific understanding with efforts of the Board on Natural Disasters.

• *Mineral and energy resources in the global economy and environment*

The Board is concerned with the implications of the domestic resource industry shifting to overseas production of oil, gas, and minerals. The concern is not only for the U.S. economy but also for the global environment; the Board has similar concerns about resources needed for rebuilding the physical infrastructure of the Nation and about the new technologies that could be developed to enhance recovery of petroleum and metals.

• *Earth science research in the environmental arena*

The Board's recent report on *Solid-Earth Sciences and Society* discusses research needed to better understand Earth processes (including earthquakes, volcanoes, landslides, and erosion) and to better protect the environment (including a call for interdisciplinary work on biogeochemistry and microbial methods for remediation). The study on Characterizing the Upper Part of the Earth's Crust and the pending study on Undergraduate Earth Science Education will address aspects of this issue.

• *Information for making wise decisions*

The Board's efforts in mapping science and in geophysical and environmental data are at the center of issues ranging from local planning to global change research. The Board's committees address government's role in developing the National Spatial Data Infrastructure, which will incorporate geographic information systems at various levels throughout society, and in managing and transmitting huge data sets.

• *The Board will be a focal point to encourage unified approaches from what has traditionally been a highly fragmented geoscience community.*

Common issues in such fields as education and training are emerging. In addition, the Board coordinates its activities with other units of the NRC (e.g., Ocean Studies Board, Board on Radioactive Waste Management, Water Science and Technology Board, Board on Natural Disasters, Board on Global Change, Board on Environmental Studies and Toxicology, Coordinating Council for Education) where there are degrees of mutual interest.

In addition to the various activities and committees dealing with "domestic" issues, the Board also maintains international responsibilities through the U.S. National Committees for four unions in the International Council of Scientific Unions (ICSU): the International Union of Geological Sciences (IUGS), the International Union of Geodesy and Geophysics (IUGG), the International Geographical Union (IGU), and the International Union for Quaternary Research (INQUA). The U.S. Geodynamics Committee is the national committee for the International Lithosphere Program; the Committee on Geophysical and Environmental Data also serves as the U.S. Coordination Office for the World Data Centre System.

Recent Reports

The reports of the Board's committees give a clear idea of the strength and diversity of our activities. Each report has been transmitted to the supporting agencies; letters from senior officials of these and other agencies are supportive of the view that reports are perceived to be timely and effective. The reports are widely distributed to the sponsoring agencies in accordance with their requests and to those U.S. and foreign scientists that request specific reports (notices of availability are often listed in *Geotimes*, *EOS*, and other appropriate journals and newsletters).

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- *Research Programs of the U.S. Bureau of Mines: First Assessment 1994* (1994)

A presentation of the committee's assessment of the Bureau's research organization and the quality of its products, along with findings of the specific panels (Occupational Health Panel and the Panels on Facilities and Research) is contained in this report.

- *Mount Rainier: Active Cascade Volcano* (1994)

This report presents a science plan for the study of Mount Rainier as a Decade Volcano Demonstration Project and addresses the application of scientific results to the assessment of volcanic hazards and mitigation of risk. Although the science plan focuses primarily on research needed to understand the development and behavior of the volcano and to monitor potential hazards, it also addresses issues of communication and coordination among geoscientists, social scientists, planners, and responsible authorities, so that the results of this research can be used to support hazards reduction effort.

- *The National Geomagnetic Initiative* (December 1993)

In March 1992 the U.S. Geodynamics Committee convened the National Geomagnetic Initiative Workshop, which addressed scientific challenges in four principal areas: main field and core processes; electromagnetic induction in the solid Earth and oceans; lithospheric magnetic anomalies; and magnetospheric and ionospheric processes. The report is an assessment of the status of geomagnetic research and examines the benefits of coordinated activities, particularly between operational and research needs.

- *Letter Reports*

A letter report addressing the effectiveness of the *Reservoir Class Field Demonstration Program* was completed in February 1995 for the Office of Fossil Energy of the Department of Energy. In 1994 the Committee on Seismology also provided technical information to the U.S. Congress concerning academic seismological facilities for monitoring a comprehensive nuclear test ban treaty. Committees of the Board produced two brief, letter reports in December 1993. The Committee on Earth Resources responded to a request from the Department of Energy to provide comments on its *Accelerated Oil Program Plan (Reservoir Characterization and Production Area), a Report to Congress*. The Committee on Seismology commented to the Department of Defense on its plans for seismological research related to nuclear test ban treaties.

- *Solid-Earth Sciences and Society* (February 1993)

Breakthroughs in scientific understanding during the past quarter century as well as innovative technologies for gathering and organizing large amounts of information are expanding the frontiers of knowledge in the earth sciences at an accelerating pace. Basic research has increased our understanding of the origin and internal workings of our planet, of the processes that modify our landscape, and of the evolution of life during times of quite different global environments. A new approach to studying earth processes, in which the earth is viewed as an integrated, dynamic system rather than a collection of isolated components, has emerged.

The report explores these important new directions in earth sciences research and examines how they can enhance society's ability to make wise decisions on resource development, waste disposal, environmental protection, natural hazards reduction, and land use. The report, which reflects a long-term effort by a diverse expert committee, presents a vision of this rapidly changing field: its scope and goals, its emerging research issues, and its scientific contributions and applications.

We have reached a critical time in the solid-earth sciences. Many in the professional community are shifting their focus from exploring for and developing resources to addressing environmental and social problems on global as well as regional scales. Others are working to maintain the research base and acquire the new knowledge upon which the applications are built. The report recommends priorities for future research and discusses the scientific challenges facing our society.

- The Mapping Science Committee's most recent report *A Data Foundation for the National Spatial Data Infrastructure* [1995] examines the fundamental data that needs to underlay all spatial information

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if this information is to be integrated and shared with data produced by others. *Promoting the National Spatial Data Infrastructure Through Partnerships* (December 1994) examines partnerships between the federal government and state and local governments. Several key elements that should be common to future partnerships were identified. *Toward a Coordinated Spatial Data Infrastructure for the Nation*, a 1993 report of the committee, addresses the accessibility, communication, and use of spatially referenced data to support a wide variety of decisions at all levels of society. By creating an effective, efficient, and widely accessible "information highway"—the backbone of a robust National Spatial Data Infrastructure (NSDI)—data could be readily transported and easily integrated both horizontally (e.g., across environmental, economic, and institutional data bases) and vertically (e.g., from local to national and eventually to global levels).

The committee, in cooperation with the NRC Marine Board, issued the report *Charting a Course into the Digital Era: Guidance for NOAA's Nautical Charting Mission*, which assessed the information content, the user needs, and the revision cycle of the nautical chart series and the transition from paper map to digital data bases.

- The Committee on Geophysical and Environmental Data, which has played a national role for over 20 years, is currently completing several of its occasional requested reviews (involving site visitation) of elements of World Data Center-A that are housed in federal data centers. The review of the WDC-A for Meteorology/National Climatic Data Center was published in August 1994; it makes recommendations for improving data center operations in an era in which new meteorological observing systems are delivering orders of magnitude more data than past systems. Another report, published in 1993, is the *1992 Review of the World Data Center-A for Rockets and Satellites and the National Space Science Data Center*. The Committee also completed a report, *A U.S. Strategy for Global Change Data and Information Management* (1992), at the request of the federal Committees on Earth and Environmental Sciences. The Committee on Geophysical and Environmental Data convened a forum to comment on the federal plan for global change data management; the results of the forum are reported in *1992 Data Forum: A Review of a Federal Plan for Managing Global Change Data and Information*. A similar forum to review the plans for federal implementation of this plan was held in 1993 and a report was published in July 1994.
- The Board, in a cooperative activity with the Ocean Studies Board, completed *A Review of the Long-Range Plan of the Ocean Drilling Program* (1992).
- The Committee on Seismology issued a report, *Real-Time Earthquake Monitoring* (1991), which assessed the feasibility of an earthquake early warning system and the use of such a system in post-disaster relief efforts. The Committee also issued a report on *Probabilistic Seismic Hazard Analysis* (1988), which evaluated the methodologies of quantitative seismic hazard estimation; and *Assessing the Nation's Earthquakes: The Health and Future of Regional Seismographic Networks* (1990).
- *Forum on NOAA's National Spatial Reference System* (August 1994) is a report resulting from the forum held to evaluate the strategic plan in the context of the national need for a coordinated spatial data system by the diverse community of geodetic and spatial data users. The Committee on Geodesy documents in its 1990 report, *Geodesy in the Year 2000*, a fundamental shift now occurring in the geodetic sciences—capabilities of the new space geodetic technology are producing profound changes in the way geodetic observations are carried out and in the kinds of scientific questions which may be answered. The Committee completed a report on *International Global Network of Fiducial Stations: Scientific and Implementation Issues* (December 1991) that evaluated the scientific impact of a global network of fiducial sites, strategies for implementing and operating such a network in light of anticipated scientific return using existing capabilities where possible, and whether such a network would provide a suitable global infrastructure for geodetic and other geophysical systems of the next century.

The series "Studies in Geophysics" (Geophysics Study Committee) have served as background documentation for developing research initiatives. Over 20 reports have been published over the

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past decade; the o most recent being *Material Fluxes on the Surface of the Earth* (1994) and *Effects of Past Global Change on Life* (March 1995). The Committee is now disbanded.

- The Committee on Advanced Drilling Technologies (a joint effort of the Board on Earth Sciences and Resources and the former Geotechnical Board) issued its report, *Drilling and Excavation Technologies for the Future* in 1994.
- Committee to Review Alaskan Outer Continental Shelf Environmental Information (a joint effort of the Board on Earth Sciences and Resources and the Board on Environmental Studies and Toxicology) issued its report, *Environmental Information for Outer Continental Shelf Oil and Gas Decisions* in 1994.

Ongoing Board Studies

Mapping Science Committee

- The principal activity for 1995 will be a study of the future evolution of the National Spatial Data Infrastructure.
- A follow up study on nautical charting production options is planned, as a joint effort with the NRC Marine Board.

U.S. Geodynamics Committee

- A recently initiated study, *The Geodynamics of Sedimentary Basins*, will assess opportunities for multidisciplinary research on the origin and evolution of sedimentary basins by scientists in academia, industry, and government.
- The committee is cosponsoring a special session on *Tectonics and Climate* at the spring meeting of the American Geophysical Union.
- At the request of NASA, the committee is evaluating the potential application of satellite-derived data of the secular gravity field to a variety of geodynamics, natural hazards, and global change problems.

Committee on Geodesy

- *Airborne Geophysics*. The study will assess the enhanced capabilities of geophysical and photogrammetric measurements from aircraft having precise locational control using GPS. A workshop was held in July 1993, and a report is in press.
- The Committee will also examine such issues as declassification of geophysical and geodetic data, selective availability and antispoofing in GPS, applications of modern geodetic techniques to the solution of geologic problems, and satellite geopotential missions.
- The committee is considering initiating studies on deformation in geothermal fields; satellite gravity (with the U.S. Geodynamics Committee); meteorological applications of GPA; and, very long baseline interferometry (VLBI).

Committee on Seismology

- *Probabilistic Seismic Hazard Evaluation*. The study, which was requested by the Nuclear Regulatory Commission, is evaluating the methodology proposed for reconciling the results of two earlier studies of probabilistic seismic hazards at nuclear power plants.
- The committee sponsored a workshop on *High-Performance Computing in Seismology* in October 1994; a report that highlights opportunities and challenges for advanced computing in seismology is currently in preparation.
- *Coordinating the Needs of Comprehensive Test Ban Monitoring with Other Seismology Research*. A panel under the aegis of the Committee on Seismology will look at the efforts to coordinate the needs of the Comprehensive Test Ban Monitoring System with other seismological research; in particular three issues will be looked at—data characteristics, data access, and research feedback.
- A study is being considered that addresses the state of knowledge in earthquake monitoring and prediction for the National Earthquake Hazards Reduction Program (NEHRP).

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Committee on Geophysical and Environmental Data

- A report on site visits to 4 NASA Distributed Active Archive Centers as possible sites for new elements of the World Data Center-A system.
- Review of the National Oceanographic Data Center is also nearing completion.

Committee on Earth Resources

- The Committee has identified four priority issues for possible studies and reports: (1) *Implications of a Shifting Domestic Resource Industry* (2) *Resources for the Infrastructure of America*, (3) *The Need for Greater Public Appreciation and Understanding of the Importance of Mineral Resources* and (4) *The Impact of Technology on Mineral Wealth*. A fifth topic under discussion, *Prevention and Remediation of Surface and Ground Water Contamination by Wastes from Hard Rock Mining, Milling, and Smelting*, would be studied jointly with the Water Science and Technology Board.
- Responding to a request from the Department of Energy, the committee has established a panel to review the DOE's Reservoir Field Class Demonstration Program

Committee on Research Programs of the U.S. Bureau of Mines

The Research Directorate of the U.S. Department of Interior, Bureau of Mines has requested that the National Research Council establish a committee to assess the Bureau's research programs. The committee produces an annual report detailing its activities and recommendations covering the preceding federal fiscal year. The overall objective of the effort is to provide advice that will help to continuously improve the quality of research programs of the Bureau of Mines.

Committee on Rediscovering Geography: New Relevance for the New Century

A committee of distinguished scholars is undertaking a comprehensive assessment of the discipline of geography in the United States, the first such assessment in almost 30 years. This report will highlight opportunities and challenges for the discipline in light of emerging societal expectations in the areas of research, education, and policymaking. The committee's report will be completed in 1995.

Characterizing the Upper Part of the Earth's Crust

A multidisciplinary committee of scientists and engineers is assessing current capabilities for noninvasive characterization of the shallow (< 1 km depth) crust for scientific, engineering, and environmental applications. The objective of this assessment is to identify gaps in current capabilities and to recommend R&D to fill those gaps.

Other Board Activities

The meetings of the Board and its committees and their resultant reports are the most visible forms of accomplishing their goals. Important to the activities, particularly at the various meetings, is the maintenance of a dialogue among the scientific community and the federal agencies on a variety of issues. Through such dialogue, the Board and its committees have developed a number of programs or activities within the past three years. Notable among these are the following:

- The Board has sponsored three recent summit meetings of presidents and executive directors of earth science societies. The meeting in 1991 focused on education and helped lead to the formation of the Coalition for Earth Science Education, which provides a forum for coordination of educational programs and activities. The meeting in November 1993 focused on government affairs and congressional science fellow programs in the earth sciences. Following the 1993 meeting, Dr. Richard S. Fiske of the Smithsonian Institution presented the Dallas Peck Lecture, in honor of Dr. Peck's distinguished career with the USGS. In 1994 the theme of the forum was *Education and Employment Trends for Earth Scientists* and was followed by the first NRC *Distinguished Lecture in Geoscience Policy*.

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- The U.S. National Committee for the International Union of Geodesy and Geophysics (IUGG) organized the U.S. invitation for the IUGG to hold its 1995 Congress in Boulder, Colorado. This invitation was accepted at the 1991 IUGG Congress in Vienna, Austria; the Committee will be assisting the planning and coordination for the 1995 IUGG Congress.

PROPOSED PLAN OF ACTION

During the time frame covered by this proposal, the Board will continue to address the following objectives: (1) to set forth the current and prospective contributions that the earth sciences can make to issues concerning energy, nonrenewable resources, and the environment; (2) to provide government officials with technological and scientific evaluations that can help serve as a basis for decision making in matters involving earth science research and knowledge, both in policies and programs; and (3) to provide to the scientific community a basis for judgments with respect to the development of the earth sciences in the broad sense and with respect to the relative importance of the developments within the various disciplines.

Possible New Activities

The Board on Earth Sciences and Resources expects to consider several topics that could be initiated as separately funded studies in the coming year. Some are mentioned in the section *Ongoing Board Activities*. Additional possible topics are:

Undergraduate Earth Science Education

The Board is concerned with the currency and adequacy of undergraduate earth science curricula, given needs for environmental protection and restoration and volatility in employment in the resource industries. A proposed study will coordinate with ongoing programs in the earth science community and with other NRC activities in education, which address such important issues as teaching methods in science and diversity in the professions.

Rock System Science

The Board will be evaluating the concept of rock system science as a new approach to understanding earth processes. Plate tectonics, which revolutionized thought about whole-earth processes, set the stage for much geologic research in the last generation. The focus has been largely on global issues and problems. Numerous current problems, such as cleanup of polluted industrial sites and discovery of deeply buried energy and mineral resources, require thorough understanding of processes operating on much finer scales.

Summit Meeting of Presidents and Executive Directors of Earth Science Societies

At the November 1994 forum, which was attended by approximately 30 geoscience organizations, a consensus was reached that society leaders should meet periodically to discuss issues of common interest. Pending development of an adequate agenda, another forum likely will be held within a year.

Aggregate Resources in the United States

The Committee on Earth Resources is developing a study on the availability of aggregate resources in the United States. The study would delve into the conflicts that arise concerning crushed stone and sand and gravel quarries in and near metropolitan areas.

Geological Input into Global Change

The Board and its committees will be discussing aspects of how the solid-earth sciences can contribute more to policy making regarding global change. Specific interests have been expressed by the U.S. National Committee for the International Union of Quaternary Research

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and by the U.S. Geodynamics Committee, which has been discussing linkages between tectonics and climate.

Prevention and Remediation of Surface and Ground Water Contamination by Wastes from Hard Rock Mining, Milling, and Smelting

The Board intends to pursue a study on the effects of hard rock mining and related metal processing on surface and ground waters. This activity will be conducted jointly with the Water Science and Technology Board.

Requests by federal agencies for the Board to undertake studies and other activities

The Board will continue to be enthusiastically responsive to federal agency requests for studies on specific issues.

Membership of the Board on Earth Sciences and Resources

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