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DEVELOPING A COORDINATED INFORMATION PROGRAM FOR GEOLOGICAL SCIENTISTS IN THE UNITED STATES.

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DESCRIPTORS- *EARTH SCIENCE, *INFORMATION DISSEMINATION, *INFORMATION RETRIEVAL, *INFORMATION STORAGE, *INFORMATION SYSTEMS, INFORMATION SOURCES, PROGRAM DESCRIPTIONS, NATIONAL SCIENCE FOUNDATION, AMERICAN GEOLOGICAL INSTITUTE,

A PLAN FOR THE DEVELOPMENT OF A COORDINATED INFORMATION PROGRAM FOR GEOLOGICAL SCIENTISTS IN THE UNITED STATES IS DISCUSSED IN DETAIL IN THIS REPORT. THE AMERICAN GEOLOGICAL INSTITUTE APPOINTED A COMMITTEE ON SCIENCE INFORMATION TO DEVELOP A NEW NETWORK FOR COMMUNICATION. THE NEED AROSE FROM A REALIZATION OF SEVERAL DEFICIENCIES OF PRESENT METHODS--(1) GREATLY INCREASED VOLUME OF INFORMATION AND DATA, AND INCREASING TIME REQUIRED TO SEARCH AND REVIEW, (2) INCREASING NEED FOR INTERDISCIPLINARY INFORMATION, AND (3) DECREASING USEFULNESS OF TRADITIONAL METHODS OF INFORMATION EXCHANGE. THE COMMITTEE WAS TO (1) DEVELOP A CONCEPT FOR A NATIONAL INFORMATION SYSTEM IN THE GEOSCIENCES, INCLUDING GENERAL POLICY AND LONG RANGE GOALS, (2) FORMULATE A TENTATIVE 3-YEAR PLAN OF ACTION (1969-71), AND (3) SUPPORT AND COORDINATE ONGOING GEOSCIENCE INFORMATION PROJECTS AND PROPOSALS. THE RESPONSE TO THE COMMUNICATION PROBLEM IS FOCUSED ON (1) INFORMATION MANAGEMENT, (2) SYSTEMS ENGINEERING, (3) LARGE SYSTEMS MANAGEMENT, (4) NEW DISSEMINATION TECHNIQUES, (5) DATA PROCESSING, (6) MICROIMAGERY TECHNIQUES, AND (7) PHOTOCOMPOSITION. CHARACTERISTICS OF THE NEW SYSTEM WERE SEEN AS (1) EVOLUTIONARY, EXPANDING AS NEED ARISES, (2) EFFICIENT, AS GUIDED BY GENERAL AND SPECIFIC OPERATIONAL OBJECTIVES, (3) ALERT TO THE NEEDS OF INDIVIDUALS AND THE GEOSCIENCE COMMUNITY, AND (4) COMPATIBLE WITH OTHER INFORMATION SYSTEMS. A PROGRAM OF ANALYSIS WAS CONCERNED WITH (1) DEFINITION OF PURPOSE AND REQUIREMENTS, (2) DETERMINATION OF CURRENT STATUS, AND (3) IDENTIFICATION OF PROMISING AVENUES OF EFFORT. CURRENT COMMUNICATION ACTIVITIES WERE INVESTIGATED. AN OUTLINE OF THE STEPS INVOLVED IN THE FORMULATION OF A PROGRAM CONCLUDES THE REPORT. (DH)

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Developing a Coordinated Information Program for Geological Scientists in the United States

American Geological Institute

DEVELOPING A COORDINATED INFORMATION PROGRAM FOR GEOLOGICAL SCIENTISTS IN THE UNITED STATES

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I. INTRODUCTION

A. BACKGROUND

The American Geological Institute is a federation of sixteen national societies which represent more than 30,000 individual geological scientists. For over fifty years, these societies have filled an important role in science information exchange, although their formal cooperation in this field has been essentially limited to periodic joint meetings and to bilateral publication cooperation.

Examples of annual concurrent meetings are those of the AAPG and the SEPM, and those of GSA and its affiliated societies. Examples of cooperative publication efforts include: the Annotated Bibliography of Economic Geology (SEcG and GSA), the Journal of Paleontology (PS and SEPM), and the Bibliography and Index of Geology Exclusive of North America (GSA and AGI).

While justly proud of past accomplishments, it has become apparent to the officers of the AGI societies that a multilateral cooperative effort is necessary if the societies are to provide a more efficient and responsive science information service to their members.

On October 29, 1967, the Council of Society Presidents unanimously passed the following resolution:

> "That the President of American Geological Institute appoint a Committee on Science Information from a list of candidates nominated by the member societies and that this

committee, with the assistance of its working groups and AGI and society staff members, develop a plan for a coordinated information system in the geological sciences."

In the name of their respective societies, the presidents have advised the AGI President of their nominations to the committee, and he, acting with the advice of his Board of Directors, has selected the following nine man Committee on Science Information:

Chairman	Nominated by
William C. Krumbein Dept. of Geology Northwestern University Evanston, Illinois	Geological Society of America
Members	
Cornelius F. Burk, Jr. Geol. Survey of Canada 3303 33rd St. NW Calgary, Alberta, Canada	Geoscience Information Society
James M. Forgotson, Jr. Pan American Petr. Corp. Research Center P.O. Box 591 Tulsa, Oklahoma 74102	American Association of Petroleum Geologists
William W. Hambleton Kansas Geol. Survey University of Kansas Lawrence, Kansas	Geological Society of America
Clayton E. Ray Div. of Vertebrate Paleontology U.S. National Museum Washington, D.C. 20560	Society of Vertebrate Paleontology

Members	Nominated by
John S. Steinhart Carnegie Inst. of Washington 5241 Broad Branch Road Washington, D.C. 20015	American Geophysical Union
Robert Van Nostrand 1424 Kingston Avenue Alexandria, Va. 22302	Society of Exploration Geophysicists
Raymond E. Whitla c/o Geology Branch Eng. Div., CW Office Chief of Engineers Washington, D.C. 20315	Association of Engineering Geologists
Peter J. Wyllie University of Chicago Chicago, Illinois 60637	Mineralogical Society of America

In addition, the Office of Scientific and Technical Information of Great Britain has been invited to send an appropriately selected observer, since the British geological community is already actively cooperating with several of the AGI member societies.

B. CHARGE TO THE COMMITTEE ON SCIENCE INFORMATION

"Science Information" is that recorded knowledge which comprises the critical intellectual resource of the general scientific community, excluding proprietary and confidential information. "Information exchange" denotes the present communication needs utilized by scientists: informal exchange meetings, report literature, formal publications, etc.; the present methods of making this information available: libraries, published and computer-based bibliographic tools, data banks, etc.; and innovations which bear on the effective handling and exchange of information.

The apparent effectiveness of this communication has been declining in recent years, due at least in part to:

1. The great increase of information and data, increasing the length of time required to search and review, and reducing the probability of finding the "best" answers.

2. The greatly increased need for interdisciplinary information, particularly with regard to new technology.

3. The apparently decreasing usefulness of some traditional means of exchanging information.

The present information communication network is large and complicated, but it is also effective to a very real degree. Any attempt to develop a new network without full regard for the present one might turn an existing state of complexity into one of chaos. Significant improvements are expected only from a program that is evolutionary in nature and that is designed to take advantage of existing channels and practices.

Therefore, we expect any information program in the earth sciences to start with a wide choice of alternate approaches. Careful evaluation is required in order to select combinations that will best fill the needs of the community which they are to serve.

With the foregoing in mind, the AGI Committee on Science Information has been given the following charge:

1. To develop a concept for a national information system in the geosciences, with the corresponding definition of general policy and long range goals.

   In essence, this implies the development of an AGI position that takes into account the viewpoints of its member societies, both with regard to their own operations and with regard to the activities of others in the field. The information system that exists in the geosciences today is an informal and relatively uncoordinated system which, in response to technological advances and other factors, is continually being modified and developed. The major charge to the Committee is to assist in guiding this development by the definition of recommended policy and goals.

   Target date (first draft): November 1968

2. To formulate a tentative plan for geoscience information activities during the three year period, 1969-1971.

   This plan will proceed from a baseline resumé of the present activities of the AGI societies. It will be developed principally as a coordinated forecast of the projected activities of the societies and, where feasible, of other organizations in the field. The Committee will identify those projects which it considers to be major steps toward the implementation of long range goals.

Target date: November 1968

3. To support and coordinate on-going geoscience information projects and proposals.

   The AGI Director of Science Information will keep the Committee members informed of all pertinent projects and proposals that come to his attention. Committee opinion will be solicited. Action will be required of the Committee only in exceptional cases.

4. To recommend modifications of the charge to the Committee (Items 1-3) and recommend modifications in operating procedure if either appears to be desirable.

C. GENERAL PLAN OF ACTION

The AGI Committee on Science Information reports to the President of the Institute. Its main concern is with general policy and long range goals. It will be assisted by working groups, which will submit recommendations for review and synthesis.

Approximately eight working groups are envisaged in the fields of bibliographic services and publications, translations, vocabulary and terminology, meetings and personal communications, library sources and services, special information and data services, primary publications, and information on current research. The Chairman, with the advice of the AGI Executive Director, will designate group leaders, who will select the members of their working groups.

The Committee Chairman may alter the number of working groups at his discretion. However, the initial planning is for 8 three-man groups. It is anticipated that some members of society committees on publications or related fields will become members of the working groups.

The AGI Director of Science Information and staff will be responsible for the development and formalization of detailed operational planning consistent with the objectives defined by the working groups and the Committee. This work will include the formalization of specifications, scheduling and budgeting, and, on occasion, technical assistance in the acquisition of required resources, including the selection and coordination of subcontracting. He and his staff will be responsible for the preparation of position papers for the Committee and working groups, for the selection and transmittal to them of the most pertinent information originating in other organizations, and for a report on science information activities to be published regularly in Geotimes. As requested by the group leaders and the Committee Chairman, support will be provided in arranging meetings, obtaining consultant services, preparing agenda and reports. An AGI staff member will also be available to attend important working group and Committee meetings.

D. PURPOSE OF THIS REPORT

This report is intended as a working document to provide a base from which the Committee can formulate a program that will fit the requirements of the geoscience community. It is not intended to impose any restrictions on how the Committee goes about performing its assigned functions or to act as a substitute for the Committee's judgement concerning the needs and viewpoints of the societies it is representing. Rather, it is designed to provide a background context that may help clarify judgements concerning organization, methodology, analysis, and areas of emphasis.

II. THE SCIENCE INFORMATION PROBLEM

A. NATURE OF THE PROBLEM

The problem of how to improve upon the existing communications channels is both complex and subtle. More effective information storage and retrieval systems and more effective dissemination of information are, in themselves, not the complete answer. Information communication is an integral part of the scientific and technical processes, and significant improvements involve changes in the basic methodology for managing and conducting these processes.

Communications channels already do exist, and, despite the fact that the network they form is both huge and complex, it also is effective to a degree that cannot be discounted. The existing network does communicate material among the individuals who are a part of it. Moreover, it does evolve. Scientific journals come and go, and new channels and modes of communication develop in response to new needs.

Furthermore, the network is one in which the individual scientist feels comfortable. He has learned how to compensate for functional shortcomings and does a credible job of acquiring the needed information.

Improving the communication of scientific information is not a single monolithic problem to which there is a single solution. Because there are so many different aspects to scientific communication, each with its own unique characteristics, there are a number of productive ways to approach the problem.

Consequently, each information program starts with a wide choice of alternative approaches for bringing about improvements, and careful evaluation must be made of the alternate combination that will best fill the information needs of the scientific community which the program is to serve. The questions that must be answered are "how?" and "by whom?".

B. RESPONSE TO THE PROBLEM

The need for improving the information patterns of the scientific community has not gone unnoticed. Congressional committees, corporations, technical societies, and many government agencies including the National Science Foundation have recognized the growing problems and are earnestly attempting their amelioration.

These efforts are producing significant advances which, when properly integrated and applied, can bring about major improvements in communication effectiveness.

New concepts are providing ways of managing information more effectively. The information user and his information acquisition and use habits have been studied rigorously in recent years, and the relationship between information and the job function is becoming more clearly understood. The practices of systems engineering, the ability to examine effectively a large number of related functions as an integrated whole, are being successfully applied in the solution of many information system problems. The concept of switching, both at the theoretical and application levels, is creating a major revolution in all types of communications. Furthermore, we know much more about organizing, manipulating, and searching large files.

With the new concepts, improved methods and procedures of handling large systems information are being established. Better indexing techniques are being developed, and specific application criteria are being defined. Dissemination practices are also being improved with new forms of announcement journals, microfiche packages, and selective dissemination programs.

Probably the most important single hardware advance has been the evolution of the computer and its application to large scale information systems. In addition, there have been other highly significant developments. New techniques and forms of microimagery have greatly simplified the materials handling problem involved in distributing information. Photocomposition has expedited the production and reduced the cost of printed material.

III. ROUTE TO SOLUTIONS

A. TYPE OF SOLUTION NEEDED

Information systems should perform two basic functions: first, to preserve, enhance, and provide access to the scientific record; and, second, to supply the right information to the right man at the right time, preferably at his work station, without forcing significant changes in work habits. These two objectives are relatively simple to state, but exceedingly difficult to achieve. The publishing and library facilities of the country do a reasonably good job of preserving the scientific record. However, there has been considerably less success in delivering the right information to the right man at the right time, particularly while meeting the requirements of noninterference with his work habits. This objective is perhaps the crux of the information problem.

To be most useful, an information system should provide material to the individual scientist that is reasonably complete, current, pertinent, and accurate, on both a routine and special request basis. The system must be so effective that the individual will elect to use the formal service systems rather than to rely on his own limited collection or that of his colleagues.

Possibly the greatest problem that faces the individual scientist in utilizing existing information resources is that too much material is available from too many sources. This complicates the task of finding what he needs and makes it more difficult for him to tell whether his search has been reasonably complete.

Therefore, the second characteristic of an effective solution is that it should gather pertinent material from as many sources as possible and make it available in a manner useful to the individual scientist.

It is clear that any practical solution must start with today's conditions, systems, resources, scientists, and existing work habits, and make gradual use of the new equipment, concepts, and methods of systems engineering and the information technologies.

B. ROLE OF THE SCIENTIFIC SOCIETIES

Rapid progress toward an effective solution requires strong leadership, effective coordination, and careful planning. Of the many groups actively engaged in developing solutions, the scientific societies seem to be among the best qualified to take a leadership position. They have long concerned themselves with communication problems among their members and between their members and others. Most society functions are strongly information oriented. Therefore, it is logical to believe that they can do an effective job of evaluating, planning, and implementing programs to improve information communication.

Not only do individual societies have a long and impressive record of innovation in the information field, but they have a recognized responsibility to help facilitate the professional growth of their members by providing the communication channels necessary to this growth. Moreover, coordinated society programs do not curtail the information activities of the participating societies. Rather, as the coordinated systems develop, so does the need for the individual services of the societies.

C. OBJECTIVES

Implementation of a successful, innovating information program for the geosciences community will require the cooperation of the individual societies. The projected program provides for coordination through the Committee on Science Information, which will formulate recommended general policy and establish guidelines and operational objectives.

Working groups composed of representatives of the societies and other organizations will investigate specific aspects of science information communication and use, and will recommend plans and policies to the Committee. This approach is designed to provide the geoscience community with a realistic program that will be:

1. Evolutionary in nature, commencing with current environmental conditions.

2. Characterized by accepted general and specific operational objectives.

3. Cognizant of the needs of the individuals and of the organizations comprising the geoscience community.

4. Compatible with other information patterns with which it will interface.

Any large scale systems endeavor should formulate a set of program objectives. These working guidelines will increase the degree of certainty that each evolutionary step serves the overall program in a specific manner, and that each component of the overall system interacts effectively with all other components. The following series of operational objectives may prove to be useful as a "starting base."

1. Overall Program Objectives - - in order that the work of the committee structure will proceed in an orderly and effective manner, toward implementing specific goals. Through the Committee structure the AGI societies will provide coordinated leadership and direction to the entire program. Each society will be given the opportunity to participate in program planning, to become aware of available resources, knowledgeable in the application of "state-of-the-art" information processing, and may contribute to the acceptance and implementation of the program in the geosciences community. The program objectives to which early efforts should be directed are, in fact, the charge of the Committee on Science Information.

2. System Performance Objectives - - in order that the overall utility of the proposed, improved system can be judged in information-use terms throughout formulation, design and implementation stages. The first major charge to the Committee is the development of a concept for a national information system in the geosciences, and the definition of long range goals. To insure that the concept devised will actually improve the information communication patterns of the geosciences community,

the program must be examined in terms of how well it will meet such objectives as:

a. Providing for better use of existing knowhow and faster application of new knowledge.

b. Improving the communication between geosciences and other disciplines.

3. Systems Characterization Objectives - - in order that the utility of design of the system can be evaluated at each program step. To accomplish such systems performance objectives as have been set forth above, information systems must, as a minimum:

a. Become a part of the actual everyday work of the geoscientist - - a realistic component of his information-communication work pattern.

b. Acquire, from both within and without the geosciences community, the data and information required for the effective and efficient conduct of research, application and management in the community.

c. Retrieve pertinent information irrespective of the viewpoints and terminology used in originating and storing it.

d. Correlate information as may be required, so that material supplied to the user will have sufficient detail to give him confidence in its accuracy, timeliness and comprehensiveness.

e. Contain a maximum amount of valuable information and a minimal amount of information that is of low or questionable value.

f. Provide access to expert human assistance, i.e., a route to who knows what.

g. Keep stored information up-to-date and accurate so as to operate as a timely part of the day-to-day activity of the geosciences community.

h. Minimize paper flow in meeting the needs of users by reducing to data formats as much information as possible.

i. Deliver the right information, in the desired format, at the right time, to the man at his work station and in a manner that will minimize queueing and material handling problems.

j. Enhance the preservation and use of the scientific record.

It will be a major function of the Committee to establish, reevaluate, and refine objectives during program formulation stages.

D. FACTORS FOR SUCCESS

An objective of any information program is to bring about improved application of existing knowhow and past experience. Consequently, it is reasonable to examine the diverse experience of other groups that have developed large scale information problems and implemented programs for improving information communication.

The following factors appear pertinent:

1. Program Coordination

Each successful program should be coordinated and controlled so that program objectives are achieved with minimal expenditure of time and money. A useful approach to coordination among working groups has been to designate a full-time secretariat that serves as a program planning and control function for the Committee, and all advisory and working groups. Thus, a common communication bridge is created among the various groups involved through a central office maintaining agendas and schedules, providing documentation of the entire program and channeling requisite information for decision to the various groups; in essence, tying together all the procedural and routine communication aspects of the entire operation. This is the major task of the AGI staff, working under its Director of Science Information.

2. Wide Society Participation

A prime objective of any improvement to the information communication pattern should be in terms of better information services for individual members of the community. In order that both individual and organization information needs and related socio-political requirements are fully understood and considered in the planning operation, full participation by all societies of the community is most desirable. Each society's needs and requirements must be understood.

3. Establishment of Specific Plan

The improved use of information appears to require highly specific plans for system development and implementation. Limited success is to be expected if plans are set forth in an abstract manner, if they lack comprehension of basic problems to be solved, or fail to provide a clear planning base from which individual groups can contribute. Any successful information program for the geosciences community will require formulation and wide acceptance of detailed, specific plans.

4. Realistic Goals

Goals established should be realistic in terms of resources available; such as, the time and effort society members can devote to planning and guidance, skilled personnel and funds that can be made available, and the information and library resources of the community.

5. Utilitarian Objectives

The more successful information ventures will clearly serve the real needs of the science community involved. Clear-cut, broadly-accepted objectives should characterize such endeavors from the time of conceptual development to full operational status. A realistic understanding of the information needs of the geoscience community is a requisite to developing utilitarian objectives that will be most useful to the society, understandable by the individual members of the community and worthy of attention of the industrial complex within that community. Recognition must be taken of the human climate within which both the present and proposed information network will function. Full cognizance must be taken of current conditions to assure that present acceptable service functions are not downgraded as a result of alteration.

6. Use of Systems and Information Technology

The function under consideration is information systems formulation. Just as any problem solution requires the proper application of technology, so information systems formulation requires an understanding and application of systems engineering and information skills. The assistance of skilled systems engineers and information technologists will be required.

E. ANALYSIS REQUIREMENTS

The Committee must continuously make certain that it is operating within the framework of current environmental factors, - - working to ends most useful to the geoscience community, always evaluating the application of proven, yet forward looking practices, and applying them in the most promising avenues for success. It should request that the AGI attempt to provide it with the preliminary analysis and information gathering required for its work, where necessary engaging such advisory groups or contractors as may be needed.

The program of analysis and investigation is concerned with three principal areas: 1) definition of purpose and requirements, 2) determination of current status, and 3) identification of promising avenues of effort.

1. Definition of Purpose and Needs

Statements of purpose are required in order that all sub-groups may work toward common goals. Care is needed to make sure that objectives are understood at the operational levels. Individual, industrial, educational and other information and data requirements within the geoscience community should be determined as clearly as possible and used as guide posts in formulation of plans and programs.

2. Determination of Current Status

The current status of information services within the geological sciences community and how it reacts with information patterns in other communities, commercial publishers, and the Federal Government must be defined. If possible, some set of measurements, however subjective, should be evolved to determine how well the information needs of the geological sciences are being served compared to how well they could be served.

3. Identification of Promising Avenues of Effort

The Committee should determine which sequence of steps would result in maximum improvement of geoscience information communication. Efforts could then be concentrated on devising programs for the most promising areas in order that best use would be made of available resources. A program of cooperation with other technical societies engaged in improving science communication patterns should be considered so that maximum use of knowhow is achieved and effective interaction with other scientific communities is developed.

IV. AREAS OF INVESTIGATION

A. <u>INTRODUCTION</u>

In order to define constructive and realistic plans for a geoscience information program, the major formal science information functions and existing activities within these functions may first be examined.

At the present time, such activities are carried out by a wide variety of organizations, each acting independently or with a limited viewpoint concerning the community they serve and acting independently of other science information organizations performing similar or related functions.

The concept of a coordinated and comprehensive program gives rise to a need for definition of basic terms; for example:

- What subjects or disciplines are covered by the geosciences?

- What are the major formalized means of documenting and disseminating scientific information in these disciplines?

- What organizations are currently performing science information functions in the geosciences?

- What are the basic patterns for providing information service in the geosciences and what are the major interrelationships among participating organizations?

In addition to definitions, the formulation of other basic guidelines appears to be necessary:

- The roles and responsibilities of various organizations for performing science information activities in the geosciences.

- Basic deficiencies in existing information activities in the geosciences.

- Promising avenues of remedy or improvement of science information activities.

- Identification of areas for emphasis or priority consideration.

Conducting the type of baseline analysis or foundation study outlined above is a large but essential task in the development of a sound science information program of the scope and magnitude of the one contemplated for the geosciences. However, the effort can be reduced to more manageable proportions by subdividing the entire program area along the major functional lines of formal science information activities. Based upon a preliminary analysis of science information activities in the geosciences, it may be well to formulate basic analytical studies for eight functional areas, such as:

- Bibliographic Publications and Services

- Translation Publications and Services

- Vocabularies, Definitions, and Nomenclature

- Meetings, Symposia and Personal Information Exchange
- Library Sources and Services
- Specialized Information and Data Services
- Primary and Informal Publications
- Services Providing Information on Current R & D

Such studies could be synthesized into a coherent whole to provide the following information:

- A complete and up-to-date profile of the major information and activities in the geosciences and the relationships among them and with other activities that interface with the geosciences.
- Recommendations setting forth immediate policy, and procedural actions that, in themselves, would improve science information activities in the geosciences.
- Identification of data that must be collected and studies that must be conducted as necessary precursors to the further development of meaningful program plans.

A brief profile of the subject areas suggested above and remarks concerning some of the major topics to be considered are presented in the following paragraphs.

B. BIBLIOGRAPHIC SERVICES AND PUBLICATIONS

Bibliographic services and publications provide comprehensive announcements and descriptions of the scientific literature. Often referred to as secondary services, these activities include indexing publications, citation and abstract journals, review publications and bibliographies. The majcrity of the scientific indexing and abstracting in the United States is produced by scientific societies.

In the geosciences, there are several major abstracting services; the Russian Referativnyi Zhurnal, the French Bulletin Signalétique and the Bibliographie des Services de la Terre, and the American Bibliography of North American Geology and Bibliography and Index of Geology Exclusive of North America. The Referativnyi Zhurnal and the Bibliographie des Services de la Terre each cover approximately 35,000 items in the earth sciences literature per year.

Together, the two U.S. publications now cover a total of approximately 20,000 items per year. In the general field of geoscience, there are approximately twenty-five serials that produce nearly 100,000 abstracts or literature citations per year. Among the AGI and its member societies, a total of six abstracting services publish approximately 18,000 abstracts and citations per year.

There are approximately 1,400 state-of-the-art review type publications per year in the earth sciences.

In order to assess current bibliographic services in the geosciences and devise plans for improving them, a number of fundamental topics must be examined, including the following:

- What information is needed in order to evaluate current bibliographic services publications and to provide a basis for the development of plans for improving these services in the geosciences? What planning data are readily available? What planning data are not readily available and how might they be best obtained?

- What is the basic role or function of bibliographic services in the geosciences and how well are current activities satisfying this role?

- Do new concepts or alternative approaches offer promise for improving bibliographic services in the geosciences?

- How can recent developments in the field of information and data processing technology be applied to bibliographic services in the geosciences to improve their effectiveness or their efficiency?

- In what areas can the development and wide spread adoption of standards serve to improve bibliographic services and publications? Would standards be beneficial in bibliographic style and format? In subject classification and indexing vocabulary? In physical format? In techniques for indexing and abstracting? In procedures and formats for computer processing?

- How might cooperative efforts serve to benefit all concerned in providing bibliographic services in the geosciences? How can exchange of abstracts be optimized? Can feasible techniques be developed for sharing the original primary literature among interested abstracting services? Can the coverage of the primary literature be arranged among interested abstracting and indexing services to minimize unnecessary duplication of effort?

C. TRANSLATION PUBLICATIONS AND SERVICES

A variety of approaches are employed to convert foreign language science information into English for use by U.S. scientists. In some cases, foreign language journals are translated from cover-to-cover on a regular basis. In other cases, only selected articles or publications are translated and republished in English. In other cases, translation is not accomplished at all until requested by a prospective scientific user of the information. The publication of an English abstract may stimulate demand for the translation of a foreign language article.

During the past decade, cover-to-cover translation of significant foreign language journals, especially Soviet journals, has been employed as a means of making important scientific information available to U.S. scientists. The support of cover-to-cover translation programs has been a major area of government subsidy for science information programs during this period. At the present time, approximately 20 Russian environmental science journals are translated cover-to-cover.

In the geosciences, approximately 73% of the literature is non-English, and therefore difficult or impossible for many U.S. scientists to use without translation. Approximately 30% of the geoscience literature is in Russian, and 22% is in either French or German. The above percentages do not reflect the publication in the Oriental languages, much of which is unavailable even in its original form, and measures of its quality or value are not clear.

In the overall assessment of translation requirements in the geosciences, the following topics should be considered:

- What basic data are required in order to define geoscience translation requirements and to evaluate the adequacy of present services and activities? What portion of the required data is presently available? What data required for program evaluation and planning are not readily available and how can they be obtained?

- How can translation requirements of U.S. geoscientists best be met? What types and quantities of translation service are required and how are these likely to change within the foreseeable future?

- What are the practical alternatives to cover-to-cover translation? How can more emphasis be placed upon selective and demand translation? To what extent can indexing and abstracting services be employed to announce and identify significant foreign language literature?

- Where should the emphasis be placed in the investment of translation funds? What foreign nations are doing the most significant work in the geosciences? What foreign languages are most unknown to U.S. geoscientists?

- How can foreign language training be employed to reduce the translation requirements of U.S. scientists?

- Can cooperation with the foreign countries or foreign institutions be employed to expedite and facilitate identification of significant information currently being published?

- Do centralized translation facilities offer practical means for satisfying translation requirements?

D. VOCABULARIES, DEFINITIONS, AND NOMENCLATURE

Virtually every activity involving the organization, retrieval, and dissemination of scientific information requires vocabulary tools to define the terminology that will be used, how that terminology will be used, meanings and their relationships to other terms. This is true for library classification, indexing and abstracting, and information retrieval, as well as for primary publications and data collection. As the subject areas covered by any science information system expands, and as more cooperation or interrelated processing is attempted, the need for complete, consistent, and effective vocabulary tools increases sharply.

In the geological sciences, there are a number of conventional dictionaries and glossaries of geological and related terms, and various library classification schemes treat the geosciences extensively. Various thesauri and authority lists are designed for subject indexing and retrieval (such as the DDC Thesaurus). However, no single universally acceptable vocabulary tool exists in the geosciences within which and upon which all bibliographic indexing and classification could be based.

In examining the needs for vocabulary tools in the geosciences and in defining plans for developing them, the following should be considered:

- What are the various requirements for vocabulary tools in the processing and disseminating of geoscience information?

- What vocabulary tools currently exist in the geosciences, what are they used for and how adaptable are they to the needs of the entire geoscience community?

- What type of vocabulary tools are needed in the geosciences? What would they be used for? Who would use them?

- How can the necessary types of vocabulary tools be developed? Who will develop them? Who will support their development? How will they be maintained once they are developed?

- What are the areas of vocabulary overlap with other scientific disciplines? How can these areas of overlap be best treated for maximum compatibility and minimal duplication?

- What scope of disciplines and activities should be covered by the terminology of the geosciences?

- Should standards be developed for term definition, for indexing techniques, and for the development of vocabulary tools?

E. MEETINGS, SYMPOSIA, AND PERSONAL INFORMATION EXCHANGE

Within science, a variety of formal methods are employed to stimulate and facilitate the direct oral exchange of information among scientists. These activities include regular scientific meetings, special symposia conferences, and colloquia; as well as the formulation of special working and interests groups.

The organization and sponsorship of various types of meetings and symposia has always been a major function of the scientific societies. Within recent years, other organizations, particularly government agencies, have also become more active in the organization and sponsorship of scientific meetings.

Within the geosciences, meetings and other forms of personal information exchange are extremely important, and AGI societies sponsor annual meetings as well as other forms of scientific convocation. Examination of the calendar of scientific meetings published in Geotimes indicates that there are probably well over 100 major U.S. conferences and meetings each year in the geosciences.

In order to evaluate the current effectiveness of scientific meetings in the geosciences and to define plans for improving this area of activities, the following could be considered:

- What is the proper role of scientific meetings and conferences in the dissemination of scientific information and how effectively is this role being fulfilled in the geosciences?

- What new insights are available concerning scientific meetings and their functions? Who has conducted investigations of scientific meetings such as those of the American Psychological Association, and to what extent are these findings applicable to the geosciences?

- What information is needed about scientific meetings' activities in the geosciences and how can this information be obtained?

- Who attends meetings and for what purpose?

- How can meetings and conferences be improved with respect to their effectiveness in disseminating scientific information?

- How efficient are scientific meetings as a means of disseminating scientific information from a standpoint of the cost involved versus benefits received? How can the organization and attendance at meetings be made more efficient? Can geographic location of meetings be improved to minimize travel costs? Can program planning among various organizations be coordinated to reduce program overlap and duplication? Can scheduling of meetings be coordinated to reduce conflicts?

- How can the documentation of scientific information presented at meetings be improved? How can preprints be most effectively employed? How can the publication of proceedings be improved?

F. LIBRARY SOURCES AND SERVICES

The major responsibility for collecting, maintaining, and providing access to the literature of science resides in libraries. The more important of these libraries are the special academic and government libraries.

Frequently, important library resources are not narrowly specialized with respect to subject fields but tend to cover a broad area of subject matter or disciplines, perhaps with emphasis on special collections or fields of concentration. It is difficult to identify special library resources as a part of the information system or network within a given discipline or subject field. Nevertheless, these libraries are the main sources of available scientific documentation and must be considered an integral part of the coordinated geoscience program.

Within the geosciences, over 100 U.S. libraries indicate special collections or subject concentration in the earth sciences. The U.S. Geological Survey Library holds over 400,000 bound volumes and currently accessions more than 1,000 periodicals.

Among the matters to be considered in the assessment of library resources in the geosciences are the following:

- What data and information are required in order to evaluate current library resources and services in the geosciences? Of the data required, what are readily available? What data and information required for library evaluation are not readily available and how can they be obtained?

- How adequate are geoscience library resources in the United States? Are libraries collecting all or most of the significant literature? Are there significant gaps in the patterns of library collection in the United States? To what extent can available library holdings be considered as a part of the national resources with regard to their availability?

- How adequate are present library services for the needs of U.S. geological scientists? Do all geological scientists have access to library service? What types of library services are needed that are not currently being provided? Are the speed and quality of service provided by libraries responsive to the needs?

- What new library concepts and techniques offer promises for the geological sciences? Can selective dissemination techniques be practically applied? Does computer technology and reproduction technology offer applicable possibilities?

- Can standardization of library operations such as cataloguing, machine processing, and serials control improve the efficiency of library operation?

- Can the establishment of policies concerning such matters as document lending and reproduction improve the utility of libraries to the geoscience user?

- Should cooperative efforts be instituted to develop union lists and other guides to available library resources? Can better cooperation and communication among libraries lead to the more effective acquisitioning of significant geoscience documentation and the concommitant reduction of unnecessary duplication?

- How can geoscientists and students be better prepared to utilize available library resources and services? To what extent is formalized education or training required in this area? Are orientation or retraining programs necessary precursors to the improved use of library resources by contemporary geoscientists?

G. SPECIALIZED INFORMATION AND DATA SERVICES

In addition to actual libraries, a large and increasing number of other organizations are engaged in the collection, storage, dissemination (and in some cases synthesis) of specialized forms of scientific information, data, and artifacts. In some cases, these organizations are identified as data centers, specimen collections, information centers, documentation centers, and archives. In other cases, these organizations have no special name or identification for their specialized information activities and are not identified as a separate entity.

In an effort to identify and develop an awareness of this elusive but important body of scientific information activities, the National Science Foundation and the Library of Congress established the National Referral Center in 1962. The mission of the National Referral Center is to identify specialized information and data centers in the United States, and to disseminate information about their activities and resources to prospective scientific users. NRC carries out its functions by providing information in response to specific requests as well as by publishing specialized directories such as the one recently published on specialized information and data centers related to the field of water resources.

In the geosciences, there is a large number of specialized information and data centers such as the IGY World Data Centers for geomagnetism and glaciology, and the National Museum's specimen collection.

In addition to the centers dealing with specific subject matter pertinent to the geosciences, there are also information and data centers that specialize in special types or forms of scientific documentation encompassing the geosciences, such as the Defense Documentation Center and the Federal Clearinghouse for Scientific and Technical Information.

The assessment of specialized information and data activities in the geosciences should include the following:

- What specialized information and data activities currently exist which are pertinent to the geosciences?

- Are there any areas in the geosciences where specialized information or data services are required for the collection, preservation, or dissemination of specialized scientific information or data?

- How can the availability, the services, and the resources of the specialized information and data services be best brought to the cognizance of prospective users in the geosciences? Should a catalogue of available sources and services be prepared and maintained?

- Is a special depository or central clearinghouse required for general control over unpublished information and data in the geosciences? Is a central clearinghouse in the geosciences needed to assist scientists in the location of specialized information and data? Should the plan recently adopted by the Canadian geological community be considered for the United States?

H. PRIMARY AND INFORMAL PUBLICATIONS

1) Primary Publications

Primary publications provide the traditional and formalized means of documenting new and significant scientific information. They include scientific journals, other forms of serial literature, monographs, scientific bulletins, and proceedings. The principal avenue for publishing new scientific information in the geosciences is through the scientific journals.

According to relatively current estimates, there are between 35,000 and 50,000 scientific serials currently published throughout the world. This includes all fields of science and all forms of serials, periodic and non-periodic. A very rough estimate indicates that the large bulk of the scientific papers in the geosciences come from approximately 4,000 of these scientific serials. Estimates of the number of formal scientific papers, or individual units of new scientific information, in the geosciences range variously from 35,000 to 100,000 units per year, with 7,000 to 10,000 of these papers representing North American publications.

The AGI member societies alone publish approximately twenty scientific journals in the geosciences which yield approximately 1,000 scientific papers per year.

Perhaps one of the areas of fundamental importance to the AGI societies is an analysis of primary publications in the geosciences. For example:

- What information is needed concerning primary publications to evaluate current activities? Which data are readily available and how may they be obtained? What data which are needed are not readily available and how can they be obtained or their need avoided?

- What are the fundamental purposes and functions of the scientific journal and other forms of primary publications? How well are current practices of primary publications satisfying or fulfilling these primary functions?

- Do alternatives to traditional forms of primary publication or new concepts of primary publications offer attractive prospects? Do concepts such as micropublications, the precis journal, and the publication of separate papers in lieu of scientific journals offer potentially attractive approaches?

- How can new techniques and equipment improve the efficiency of scientific publication? How and to what extent can such developments as photocomposition, micro-documentation, and computer processing be applied to primary publications in the geosciences?

- In what areas can the formulation and wide adoption of operational standards improve scientific publications in the geosciences? What standards are needed for physical format of journals, bibliographic and editorial style, author preparation of manuscripts, and for measuring journal production activities and costs?

- What are the major publication policy considerations concerning geoscience journals? How should the practice of page charges be applied? How should prior publication in the report literature effect the eligibility of an article for publication in a scientific journal?

In what areas would cooperative efforts among scientific publishers in the geosciences lead to mutual benefits and improvements? What are the prospects and potentials for a central editorial operation for cooperating earth science journals? How feasible is collective bargaining by groups of journals as a means of obtaining more favorable prices and services from printers and distributors?

2) Informal Publications

An increasing amount of new scientific information is being documented and disseminated through channels other than the traditional primary publications. Informal documentation activities usually take the form of research reports, theses, memoranda, occasional papers, laboratory bulletins, and field reports. Reports of research supported by federal and state government agencies is one of the large sources of informal documentation in the geosciences.

Since informal documentation activities are characteristically diffuse and unconventional, they are not readily identifiable. Some of the larger and more obvious sources of informal documentation can be readily identified. The Defense Documentation Center currently collects approximately 53,000 R & D reports per year from government contractors, of which approximately 1,500 relate directly to the earth sciences. However, the overall picture of how much scientific information of what type is being documented and added to the scientific record through these relatively obscure, uncontrolled channels is unknown.

Among the topics to be examined concerning informal documentation in the geosciences are:

- What information and data are needed concerning informal documentation in order to evaluate current information service activities in the geosciences and to formulate programs for improving these services? What information necessary for program evaluation and planning is currently available? What information and data necessary for program planning and evaluation is not readily available and how can it be obtained?

- What is the proper role for informal documentation in the geosciences? How can the use of informal methods of scientific documentation be controlled? What should be the proper relationship between informal scientific documentation and formal primary publication?

- What types of services are needed to handle informal scientific documentation? How can informal documentation be collected? Archived? Announced? Retrieved? Disseminated?

- How can the body of informal documentation best be controlled in the geosciences? Is a central depository needed? A clearinghouse? A central bibliography?

I. SERVICES PROVIDING INFORMATION ON CURRENT RESEARCH AND DEVELOPMENT

Most formalized science information activities deal with the results of completed research and development activities. However, with the increasing amount of research and development activity and with effort directed toward the improvement of science communication, the development of formalized means of disseminating information about current R & D is receiving increasing attention. If available, information concerning R & D in progress can provide valuable inputs to related research efforts and stimulate direct exchange among scientists with similar interests, as well as help research planners avoid the unnecessary duplication of ongoing research.

In its simplest form, a current R & D system might consist of nothing more than a list of individual investigators with their names and addresses and a brief profile of their research interests and activities. A more advanced system would probably contain a more detailed description of the current R & D projects of each scientist along with the appropriate indexing terms to permit retrieval of the information by subject as well as by institution, etc.

The most notable example of an advanced current R & D information system is the Science Information Exchange operated by the Smithsonian Institution in Washington, D.C. The sole mission of the SIE is to collect brief profiles of current research and development activities and to provide this information to other legitimate investigators upon request. Within certain government agencies, the inclusion of current research and development project descriptions in the SIE file is an automatic procedure. For all others, submission of information is purely voluntary.

Within the earth sciences, SIE currently has approximately 3,000 to 4,000 descriptions of current research and development projects on file. The SIE is capable of and willing to expand its activities substantially in order to cover the geosciences. However, the SIE will require considerable assistance from the geoscience community to stimulate the submission of more project descriptions for inclusion in their files, as well as to make prospective users in the geosciences aware of the SIE and its services.

In defining plans for disseminating information on current R & D in the geosciences, the following topics should be considered:

- What is the SIE currently doing in the geosciences? Is the SIE capable of providing the amount and the type of service required in the geosciences for disseminating current R & D information? How can the geoscience community assist the SIE in the effective collection and dissemination of current R & D information?

- In addition to the SIE, do other approaches for the dissemination and exchange of current R & D information appear attractive?

- To what extent can effective arrangements be made with other nations or foreign organizations to facilitate the exchange of current R & D information?

- How can the exchange of current R & D information be accomplished while providing protection of proprietary information and preventing the abusive or unauthorized use of the information?

V. METHODOLOGY OF PROGRAM FORMULATION

A. INTRODUCTION

Developing and implementing a program for the long-range, evolutionary improvement of the information communication pattern of geosciences will require a step-by-step systems oriented program. The general steps for such a solution may be:

1. Establishment of Purpose: soliciting and obtaining the consensus of the scientific community involved; organization of a nucleus around which an improvement program can be formulated; establishment of definitive objectives; concerted agreement by the societies to spearhead the improvement program.

2. Determination of Current Environment: determination of the requirements and needs of the members of the scientific community involved; documentation of existing services; development of an operational structure through which desired improvements can be obtained.

3. Staff Development: obtaining a capable staff for the coordination and detailed development of the systems improvement program, and placing it in a responsible position.

4. <u>Long Range Program Formulation</u>: analysis and investigation of current environment; appointment of representative committees involved to ensure full recognition of society requirements; determination of the position and needs of major industries most directly related to that scientific discipline; actual formulation and acceptance of detailed long range programs.

5. <u>System Analysis and Synthesis</u>: establishment of system design data base; analysis of current environmental and technological tools for improving and synthesizing the relationship into a system concept; determination of resources required to implement system development of step-by-step program.

6. <u>System Development and Design</u>: detailed system design; formulation of hardware requirements; detailing of information processing steps; performance of research where required.

7. <u>Test and Implementation</u>: full scale field testing of components as required; step-wise implementation of improvement program in current environment.

8. <u>Operation and Evolution</u>: actual operation of program directed toward evolutionary, full scale improvement for the science community involved.

B. FUNCTIONAL ACTIVITY OF THE COMMITTEE ON SCIENCE INFORMATION

The Committee will provide coordinated leadership for the program, directing the working groups and bringing the effort to a successful and timely conclusion. It will:

1. Establish operational objectives.

2. Provide guidelines for the working groups.

3. Make its needs known to the AGI staff so that overall program documentation, schedules, detailed planning, business relations with contractors and consultants, and related functions will be conducted effectively.

C. MODE OF OPERATION

The Committee will be undertaking a major task in the formulation of a long-range information program. It must effectively coordinate the objectives and programs of several working groups, be responsive to the entire geosciences community, draw on the best of large scale information systems technology and be cognizant of the information experience, requirements and services of other scientific societies. Further, it will be faced with problems of assuring that full cognizance has been taken of the interests, plans and programs of others. Problems of interaction with other information resources and systems must also be resolved in the planning operation.

To produce an evolutionary, pragmatic program when confronted with such a multiplicity of uncoordinated factors, the Committee will require a well-thought-out mode of operation embracing specific plans and programs, controls, coordination and reporting functions.

1. Plans and Program

The Committee may wish to formulate an overall plan and schedule for achieving its program objectives. This may require:

a. Establishment of program objectives at the several operational levels required: for the overall program, for each subgroup, for system design and for performance determination.

b. Development of an overall master schedule for meetings, reporting, program review, and final report.

c. Establishment of clear communication channels among all subgroups so that maximum use will be made of available skills and background and duplication of effort will be minimized.

2. Coordination and Reporting

There will be a need for the orderly documentation of information gathered and generated during the program as well as a need for frequent and effective written reports to the program planning office and to the Committee.

Careful documentation of the studies, findings, and recommendations will be necessary not only as effective working tools among the various parties but also to provide a complete record of the data and information that forms the basis of analysis, evaluation, conclusion, and final decisions. Special care may be needed to maintain close communication among the working groups, especially in formulation of policy that may have significant socio-political implications in the geoscience community.

The AGI staff will assist the Committee throughout the planning of the final report. The various working groups will submit to the Committee the reports of their findings and recommendations. The Committee, with AGI staff and working group assistance, will synthesize the several working group reports into a single body of recommendations and plans.

Interim and final Committee reports will be submitted to the AGI Board of Directors.