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ABSTRACT

The American Geological Institute's Committee on Geoscience Information prepared this report as the terminal point to the first phase of its long-term goal, to develop a system for facilitating information transfer in the geosciences. The Concept report was presented by Dr. William Hambleton, chairman of the AGI Committee on Geoscience Information, at the Geological Society of America meeting in Milwaukee on November 11, 1970. On November 14th this report was submitted to the Institute's House of Society Representatives which unanimously adopted a resolution accepting and endorsing the principles and recommendations of the Concept. The Concept is a philosophical statement of the Committee's concern with information transfer in the geosciences; as such, it does not contain a discussion of specific operations or assignments of responsibility for implementation in any area. However, it should serve as a basis for more detailed planning and for development of a comprehensive geoscience information system. An appendix provides an overview of the history, activities, and future plans of the Institute's Committee on Geoscience Information. A brief description of the Geological Reference file (GEO.REF) system is also included. (Author/SG)

A CONCEPT OF AN INFORMATION SYSTEM FOR THE GEOSCIENCES

December, 1970

Department of Geoscience Information

AMERICAN GEOLOGICAL INSTITUTE

2201 M Street Northwest

Washington, D.C.

20037

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FOREWORD

The Concept of an Information System for the Geosciences was prepared by the American Geological Institute's Committee on Geoscience Information as the terminal point to the first phase of its long-term goal, to develop a system for facilitating information transfer in the geosciences. The Concept report was presented to the earth-science community by Dr. William Hambleton, chairman of the AGI Committee on Geoscience Information, at the Geological Society of America meeting in Milwaukee on November 11, 1970 (Geoscience Information Section). On November 14th this report was submitted to the Institute's House of Society Representatives, composed of the official delegates of its 17 member societies. The report was discussed by the House, which unanimously adopted a resolution accepting and endorsing the principles and recommendations of the Concept.

The Concept is a philosophical statement of the Committee's concern with information transfer in the geosciences; as such, it does not contain a discussion of specific operations or assignments of responsibility for implementation in any area. However, it should serve as a basis for more detailed planning and for development of a comprehensive geoscience information system.

An appendix has been added to the Concept paper to provide an overview of the history, activities, and future plans of the Institute's Committee on Geoscience Information. A brief description of the GEO·REF system has been included to round out the picture of AGI's information activities.

A Concept of an Information System for the Geosciences

by

the Committee on Geoscience Information

Definition

We define an "information system" as a functioning program for the efficient transfer of information, involving all conventional channels and services, updated to provide for the explosive growth of geoscience information during the past several decades, and employing new techniques introduced with the development of electronic data processing.

Such a system will be composed of units that may be cross-linked (such as primary and secondary publications), or disparate (such as publications and data collections), but all units will have a common concern for the dissemination of information and will employ, wherever possible, standard methods for intellectual and mechanical input in order to ensure mutual compatibility.

Need

Geologists, as other scientists, require the prompt and efficient exchange of scientific information.

The continued growth in the volume of geoscience information is beyond the scope of existing facilities and services. This situation encourages the creation of new services which do not always fill an essential need and frequently are not based on requirements of the user community.

The present unstructured pattern of services in the geosciences leads to the duplication of some information and the omission of other information.

The rising operational costs of all geoscience information services, largely borne by geoscientists themselves, can only be offset by greater cooperation and increased internal efficiency.

Scope

The system should encompass all types of geoscience information. It should be concerned with all of the following, and other areas of information transfer.

1. Formal meetings and symposia.

2. Primary journals and monographs.

3. Translations and review journals.

4. Bibliographies, abstract journals, and indexes.

5. Archival holdings of libraries.

6. Guidebooks and informal reports.

7. Theses and dissertations.

8. Data collections.

9. Glossaries and thesauruses.

10. Maps, charts and photographs.

11. Collections of interest to geoscientists (type specimens, cores, well logs, thin sections, mineral and fossil samples, etc.).

Characteristics

The system should be operated for geoscientists by geoscientists.

The system must not be static. It must be flexible enough to accept change when indicated, to admit new services that appear to be required, and to abandon services that are unused for whatever reasons.

System planning should be centralized for economy and efficiency. This task is a continuous effort, to be carried on by a committee of geoscientists representing existing major services and the user community. System operations should be decentralized in order to utilize the experience and capabilities of those organizations that are now engaged in the dissemination of geoscience information, or who may desire to become so engaged in the future.

The system should include the information services provided by all types of organizations within the geoscience community: societies, universities, state and federal agencies, industry, and commercial information companies, to the extent that these organizations accept the philosophy of the system as it works for the common good of the geoscience user community.

The system should operate economically. If deficit financing is required for the start of any facet of the system, a realistic time-table for achieving self-support must be established.

The system should be developed with cognizance of similar systems in other scientific disciplines, in order to promote efficiency and economy. It should overlap those systems to include the subject matter of other disciplines that may be of special interest to geoscientists. Wherever possible, it should interface with those systems in order to achieve better compatibility of systems operations.

The system should be user oriented.

Results

The information requirements of the geoscience community would be satisfied by members of the community who are aware of these needs and who work through existing organizations, rather than by government bodies or commercial concerns whose motivations might not be in the best interest of the geoscience community.

The whole body of geoscience information would become readily available to all members of the geoscience community.

The information requirements of government would be served by making geoscience information readily available to those agencies that need it.

The system would be able to profit from the experience of information systems developed for other disciplines.

Repetition of services could be avoided.

Duplication of research could be partially avoided by an information system that provided prompt and total information on any geoscience subject.

The privilege of advance information enjoyed by members of the "invisible colleges" could be extended to other members of the geoscience community.

A group of information experts would be available to help individuals and organizations solve special information problems.

New techniques for the dissemination of information would be presented to the service organizations for consideration and possible use.

A U.S. geoscience organization could be designated to receive and transmit communications with foreign geoscience information organizations.

A well planned and operated system would ensure maximum value for the information dollar to the geoscience community.

INTRODUCTION TO THE APPENDIX

The need for an improved system of information transfer in the geological sciences is as great as in other disciplines. The same phenomena have spawned the same problems -- an increase in geoscientists that has produced an expansion of research resulting in a proliferation of reporting. Table I presents the growth of 7 representative American geological societies during the decade and a half between 1950 and 1965.

	1950	1955	1960	1965
AAPG*	7,058	11,610	15,371	15,200
GS		375	1,943	2,111
GSA	1,965	3,948	5,156	6,913
NAGT	153	374	617	1,600
SEG	725	800	1,140	1,229
SEPM	798	1,188	1,631	2,201
SExG	2,566	4,370	5,756	6,024
TOTAL	13,265	22,625	31,614	35,278

Table I

Total society growth over this time span was greater than 160 percent. The United States Geological Survey reports that its production and distribution of geological quadrangle maps, during the same 15-year period, increased as follows: 1950 -- 1.5 million copies; 1955 -- 2.0 million copies; 1960 -- 4.25 million copies; 1965 -- 6.5 million copies.

The literature explosion has produced a spate of new scientific journals that are still unable to cope with the volume of scientific reports. Publication lag-times are as high as 2 years. The inability of the individual scientist to either afford more journals, or read the flood of print has created serious economic problems for the publishers. Increasing page charges are making inroads on research budgets and may threaten the publication of significant scientific results. Publishers, however, see page charges as the only alternative to pricing journals beyond the users' capacity to pay. The American scientist, who must be kept aware of work produced by his foreign counterparts, has yet another problem. The high cost of competent translations cannot be buried in a resilient research budget. The consequent price of translations journals puts them beyond the reach of all but the wealthiest libraries. It becomes obvious that the translation journal in its present form, without continued Government subsidy, cannot long exist.

* American Association of Petroleum Geologists, Geochemical Society, Geological Society of America, National Association of Geology Teachers, Society of Economic Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists.

The transfer problem is not restricted to the printed word. The size of today's scientific meeting, with thousands of attendees and hundreds of papers to be presented and discussed in a 3-day span, has resulted in a 3-ring circus effect that is at best frenetic, at worst chaotic. The leisurely presentations and discussions of the philosophical societies of a century ago will not return. Our present substitute demands reform.

New computer technologies offer the promise of solving many of our information problems. But unless they are approached with discretion and in a coördinated discipline-wide fashion, millions of dollars will be spent to produce a Babel of electronic voices. This applies to automated primary publication, bibliographies, and raw-data input.

The "Invisible College" has provided a forum for a select few ever since Robert Boyle invented the term back in the 17th century. But the privileged member who depends only on his inner-sanctum sources may be as deprived as the newly graduated PhD who has not yet earned admission. Today's scientist, dependant upon communication with his peers, must be provided with all of the world's information efficiently, effectively, and economically, or else he, his institution, and his science will be the losers.

This is a brief and incomplete sketch of the environment in which the geoscientist works. These were the compelling factors that led the American Geological Institute to recognition of the magnitude of the problem.

HISTORY OF THE PROJECT

The first substantive step toward a national geoscience information program was taken on February 23, 1967, when the National Science Foundation convened a meeting of geological scientists in Washington to consider the problems. The succeeding events are best presented in the following chronology.

4/9/67 -- Los Angeles: Dr. Burton W. Adkinson addressed a meeting of the AGI House of Society Representatives on "Information Problems in the Geosciences."

4/10/67 -- Los Angeles: The AGI Board of Directors approved the submittal of a proposal to NSF for the funding of liaison activities with the societies to consider information problems and approaches to solutions.

6/21/67 -- AGI received a Foundation grant of $44,400 to accomplish liaison and background investigations relating to the establishment of a national geoscience information program.

9/18/67 -- Denver: First liaison meeting convened by AGI with society representatives.

9/29/67 -- Wichita: Second liaison meeting convened by AGI with society representatives.

10/29/67 -- Oklahoma City: Results of liaison meetings presented to AGI Council of Society Presidents. Council unanimously passed a resolution requesting AGI to appoint an ad hoc committee, charged to develop a plan for a coordinated information system in the geological sciences.

11/19/67 -- New Orleans: AGI Board of Directors authorized the submittal of a proposal to NSF requesting 2-year funding for the planning of an information program.

1/19/68 -- The President of the Institute appointed 9 members to a Committee on Science Information.

4/1/68 -- Washington: First meeting of the Committee. Program priorities were considered.

6/3/68 -- AGI received a Foundation grant of $214,781 to support geoscience information planning for 2 years.

7/9/68 -- Washington: Second meeting of the Committee. Plans for background studies in special areas of program concern were developed.

11/1/68 -- Elkridge, Md.: Third meeting of the Committee. Nine primary areas of concern were defined and discussed.

/14/69 -- Dallas: Fourth meeting of the Committee. Baseline studies were authorized. Developmental program plans were adopted. Program

priorities were established. AGI was requested to accept responsibility for the formation of a bibliographic reference center.

4/24/69 -- Washington: Representatives of the Foundation and the Institute reviewed progress of the planning program.

7/3/69 -- Washington: The AGI Board of Directors accepted the Committee's request to establish a bibliographic reference center for the geosciences (GEO-REF) and authorized a proposal to be submitted to NSF for its implementation.

9/15/69 -- Baseline study of geoscience library resources completed. Baseline study of conceptual alternatives to the scientific journal completed.

10/9/69 -- Baseline study of the feasibility of coöperative automated publishing in the geosciences completed.

10/14/69 -- Houston: Fifth meeting of the Committee. Working groups were established for the study of problems affecting primary publications and thesauri. Committee recommended that the AGI Board of Directors reconstitute the body as a permanent committee to be known as the Committee on Geoscience Information.

11/9/69 -- Atlantic City: Committee reported on its progress and activities to the AGI House of Society Representatives. The Board of Directors, with House approval, reconstituted the group as a permanent committee.

3/4/70 -- These reports were delivered to NSF: Conceptual Alternatives to the Scientific Journal, An lytical Study of Geoscience Library Resources and Services, Feasibility of Automating Production of Primary Journals in Geoscience.

3/15/70 -- Washington: Sixth meeting of the Committee.

5/6/70 -- Washington: Committee meeting on final Concept draft.

6/2/70 -- A proposal submitted to NSF for support of the Planning project through 1970.

8/12/70 -- A Foundation grant of $37,700 awarded to continue work to approximately December 31, 1970.

8/18/70 -- A draft proposal was submitted to the Foundation for the 2-year funding of a continuing program for the "Definition of a Comprehensive and Effective Disciplinewide Information Program."

11/11/70 -- The completed Concept was presented at the GSA meeting in Milwaukee.

11/14/70 -- House of Society Representatives, meeting in Milwaukee, unanimously passed a resolution accepting and endorsing the Committee's Concept as presented.

THE COMMITTEE ON GEOSCIENCE INFORMATION

Pursuant to the recommendation of the Council of Society Presidents and the resolution of the House of Society Representatives, Laurence L. Sloss, the President of the American Geological Institute solicited the names of candidates for the Committee on Geoscience Information from the member societies. From the ensuing list, Dr. Sloss appointed these geoscientists to serve on the Committee:

Dr. George Becraft	Director of Publications, USGS
Dr. Cornelius F. Burk, Jr.	National Coördinator, Secretariat for Geoscience Data, Geological Survey of Canada
Dr. James M. Forgotson, Jr.	Vice-President, Petroleum Information
Dr. John C. Griffiths	Professor, Pennsylvania State University
Dr. William W. Hambleton*	State Geologist, Kansas Geological Survey
Dr. William C. Krumbein**	Professor, Northwestern University
Dr. Clayton E. Ray***	Curator, United States National Museum
Dr. John S. Steinhart	Office of Science and Technology: (now Professor, University of Wisconsin)
Dr. Robert Van Nostrand	Manager, Teledyne Geotech Laboratories
Dr. Raymond Whitla***	Engineers Office, Department of the Army

* Chairman
** Past Chairman
*** Resigned

COMMITTEE ACTIVITIES

At the first and second Committee meetings, priorities were assigned to specific problems in information transfer based on their impact on geological communication, and on the Committee's ability to cope with them. The following progress can be reported on problem resolution within the time and funding limit imposed by the NSF grant of June 1968.

Primary Publications. Recognizing the gravity and the complexity of the problems facing the publishers, authors, and users of primary journals, the Committee established a working group to study and report on this facet of the information problem. Two consultant studies were authorized. The first, contracted to Westat Research, Inc., resulted in a state-of-the-art review entitled Conceptual Alternatives to the Scientific Journal. This 118-page report contained a summary and recommendations that were applicable to the special circumstances of geoscience publishing. The second, contracted to Publicate, Inc., was a study resulting in a report on The Feasibility of Automatic Production of Primary Journals in Geoscience. Both reports were widely circulated among geoscience publishers, and the second became the base document for a seminar held at the Association of Earth Science Editors conference in 1969.

Being aware of the Committee's work in this area, the editors of the Journal of Paleontology requested late in 1969, assistance in planning an alternative to the Journal's format and philosophy that might solve its economic and use problems. The information staff at the American Geological Institute worked with the editors to develop a concept tailored to the reading habits of the paleontological community. A newly inducted editorial staff decided for the time being not to adopt the concept, which would have been a revolutionary innovation in geoscience publishing. Nevertheless, note following excerpt from an editorial that appeared in the Journal of Sedimentary Petrology for June 1970.

> In assuming the Editorship, I also inherit a number of problems that plague all technical journals. Largest of these is the cost of publication. ... The search for alternative methods of publication is currently being explored by many societies. It is likely that all of us will see the result of these studies in the next 5 years. The Journal of Paleontology may follow a radically different path in the next year's volume. It is likely that in future years all geological journals may be combined after the fashion of the American Chemical Society publication.

The Library Network. The Committee was aware that any consideration of the primary journals led irrevocably to the availability of those journals through the libraries serving the geoscience community. The Committee deemed that a study in this area was particularly suited to the special purposes of the Geoscience Information Society, whose membership includes almost all the geology librarians in this country. A contract was awarded to the GIS that resulted in a report entitled Analytical Study on Geoscience Library Resources and Services. This report,

with its pinpointing of the existing strengths and weaknesses of the existing network, will be the base for restructuring or reinforcing the libraries in order to provide for their maximum use in the most effective and economical manner.

Geoscience Serials. Concommitantly with a library study, the Committee realized the necessity of identifying the world's serial literature of geoscience. As a result of the explosive growth of research and reporting, geoscience journals -- sponsored by societies, universities, national academies, and commercial publishers -- are proliferating at an untoward rate. Many of these never survive the first or second issue, many are mergers of 2 or more established publications, and others are old wine with new labels. Their unprecedented proliferation has resulted in the outdating of earlier surveys, and even the librarians of the largest geological libraries were unable to approximate their number. The Committee faced the necessity of developing resources for the efficient transfer of geological information without knowing the extent or the address of a great part of that information.

In order to resolve this problem, the Committee contracted with the Science Library of the University of Kansas to identify the serial journals of the geosciences and to verify their listing. During the course of the work at Kansas, more than 12,000 serials were identified that were either entirely or partly concerned with the literature of geology. (The greatest earlier estimate was less than half that number.) The contract required that the investigators list not only the journal name, but also its publishers, address, language of publication, periodicity, language of included abstracts, and (for those serials only partially concerned with geoscience) the average number of papers in each volume year.

The unexpectedly high number made it impossible for the Library to complete the task with the time and money allotted. The list has not been completely verified, but the investigators are continuing the work in their spare time, and at an understandably slower pace.

Bibliographic Control. The next successive step in the process of primary information transfer is establishment of effective machinery for bibliographic control. The Committee, recognizing the authoritative position taken in this area by the American Geological Institute through its coöperative operation with the Geological Society of America to produce the Bibliography and Index of Geology, designated the Institute as the continuing center for this work. The development of AGI's bibliographic project is discussed in a following section.

Data Standardization. The Committee was aware that an area of information transfer (quite apart from the printed word, and one of vital concern to geoscientists) is the maximum efficient use of EDP equipment for the storage, classification or clustering, manipulation, and recall of raw data accumulated in the field or in the laboratory. Maximum efficiency requires the ability to combine storage files with files of similar data collected and stored by other research scientists working in centers widely separated, within this country or outside it. In order to achieve this efficiency, standardization is mandatory. Standardization, however, must proceed beyond the nomenclatural requirements that

have been long recognized but not always achieved. The standardization now required must also bear upon input procedures and software design.

On January 25, 1968, Dr. Alan B. Shaw, as president of the Paleontological Society, wrote in a letter addressed to the presidents of the Society of Economic Paleontologists and Mineralogists and the Society of Vertebrate Paleontology.

> This letter is an invitation to join me, as the Presidents of our three Societies, in a meeting to explore the ways and means of forming a joint committee on paleontologic information. The recent setting up by AGI of a Committee on Science Information implies that our three Societies will soon be asked to provide policy guidance in matters of paleontologic information exchange. I believe it would be unfortunate if the Societies were to make conflicting recommendations on some matter of policy simply because of crossed signals, and I fear this will happen unless we act to provide a single focus of information on data retrieval, computer use, and related communications activities for our Societies and their members.
>
> It is already apparent that many paleontologic data systems are being set up, catalogs are being automated, and retrieval mechanisms are being used in complete or partial isolation from one another. A joint committee would do a great service by simply bringing all of these uncoördinated efforts to public attention. Beyond this are the broad questions of compatibility of data systems, and the many types of data systems needed. The problem is already appallingly complex.

As a result of Dr. Shaw's letter, a Joint Committee on Paleontologic Information (JCPI) was established. JCPI sought, and received, the support and modest assistance of the Institute Committee. Since that time, JCPI has become the focal center for the standardization of paleontological data storage and has maintained its coöperative bond with the Committee.

The problem is not limited to paleontology. The hydrogeologists have issued a call for help to resolve similar conflicts. The International Union of Geological Sciences has named a commission on COGEODATA to consider the same area on an international scale. The Committee sees, as its role, the polarizing of national procedures in all of the subdisciplines of geoscience, and their extension abroad through COGEODATA.

Thesauri and Special Vocabularies. As both bibliographic control and raw-data input depend on a natural language set without any ambiguity, and as the international exchange of information must also be based on unit-meaning vocabularies, the Committee established a working group to consider this problem. The group collected and made a comparative study of the various thesauri that have been released for use by geoscientists. Areas of overlap were analyzed and semantic discrepancies were considered. This work was carried out with an awareness of

ongoing thesaurus-building projects under the auspices of the International Council of Scientific Unions/Abstracting Board, and of the theoretical work being done by UNESCO, as well as studies sponsored by the Polish Academy of Sciences. Meetings were held with EDP-based corporations with experience in the building of thesauri through automated methods. The working group has recommended to the full Committee that a pilot project be authorized, using a limited vocabulary from a subdiscipline of geoscience.

Resource Inventory. It has long been known that many specialized collections of geoscience material existed in this country, held by private institututions, universities, and individuals, that were not generally available but could be used for serious research purposes. The collections vary widely in their content and form. They included bore-hole cuttings and cores; geophysical and lithologic well logs; type specimens of paleofauna and paleoflora; micromount and macro mineral specimens; hand samples and thin sections of rocks; gravity, magnetic, and seismic data; and special map and report collections of almost every possible description. They exist as tape-stored data collections, as classified displays, and as jumbles contained in cigar boxes. Representing the basic material of completed research projects, their sum value based on intrinsic worth and acquisition costs probably exceeds many million dollars. Although their existence was known, their whereabouts were not. Taking cognizance of this circumstance, and realizing the value of this material to geoscientists, the Committee requested the American Geological Institute to acquire information pertaining to these collections. A questionnaire was designed to provide essential information (description of the collection, location, name of curator, conditions of availability, etc.) and was widely circularized. Announcements of the AGI quest were published in Geotimes, and in the GSA Geologist and other newsletters. The response was gratifying. Over 500 resource collections have been identified. The information has been classified, indexed, and filed. The Committee intends to continue until satisfied that all the resources have been found and then to publish the results in an indexed listing.

Translations. The Committee has been concerned with the dissemination of the foreign geoscience literature in English translation. An AGI Translations Committee exists and controls the material that is processed for publication in the AGI translations journals. The Committee's interest is not to overlap or duplicate that control, but with other factors affecting the journals. Considering the economic problems facing the translations journals, and recognizing their importance to American scientists, the Committee is seeking methods to insure their uninterrupted publication. They have recommended that primary publication alternates, developed in another area of the Committee interest, be applied to the translation journals. Moreover, they see the translation journals as a pilot vehicle for testing alternate publishing methods.

FUTURE PLANS

During the next phase of its activities, the Committee on Geoscience Information will continue to develop plans for a comprehensive system based on the principles expressed in its Concept report. Ongoing projects will continue with studies in greater detail where they are indicated; geoscience organizations will be sought to implement the results of these studies with pilot projects if they are necessary, with the assistance of the Committee and whatever facilities are at its disposal. Work will be started in new problem areas that have been identified, and innovative approaches to information transfer will be tested.

Liaison will be established with the directors of information programs in the other natural and social sciences in order to share knowledge and experience for the benefit of all disciplines. Above all, the Committee will remain sensitive and alert to the wishes of the geoscience community, and to the complex problems of information exchange, in order to serve their growing requirements.

Primary Publications. It is frequently stated that "Primary journals are published for the benefit of authors." Although the authors' interests are undeniably important, the readers' requirements and desires are paramount. The Committee plans to survey journal readers in an effort to learn how much of any journal is read, scanned, or set aside; how much is clipped and filed, and how the abstracts are used. What are the strengths and weaknesses of the publications they receive? What would they like to have that they are not now receiving -- review articles, short notes, discussions? How would they respond to format changes such as microforms, or long summaries with full-text backup? The survey will be based on questionnaires sent to users in each of the subdisciplines. It is believed that the use patterns will vary between fields of interest. Until the results are received, classified and analyzed to establish user profiles, it would be foolhardy to recommend changes for any specific journal. (The reading habits of paleontologists were a prime consideration in planning the change for the Journal of Paleontology.)

Authors' requirements must also be considered. The vexing problems of publication lag-time and page charges must be re-examined. Professor J. M. Ziman of Bristol University recently wrote that as a consequence of extending the page-charge system, control of content will be taken away from the editors and fall into the hands of research-institution administrators (Nature, August 10, 1970). His arguments are logical enough to warrant attention. Long lag-times may be the result of economic factors or of the review and editorial process. In the first case the total situation must be remedied; in the second a simple solution may be available.

A common complaint among all scientists is the inadequacy or absence of "review" journals. This is particularly true in the geosciences. The Committee will study ways and means to fill this gap, and seek a society or institution to sponsor a publication.

The Library Network. The Committee hopes to obtain the necessary funds to complete the work that has been done in compiling a complete list of geoscience serials. That, however, is only the first stage of the task. The list must then be complemented by adding the names of libraries holding the serials. The finished guide will be published and distributed. Certain printed ephemera of the geosciences must also be brought under control. Contract reports and guidebooks are inadequately publicized and stored. An inventory is required and the location of material must be made known to the community. It may become evident that closer coöperation is required among the geological libraries of the country. In order to minimize acquisition costs and improve the dissemination of published information, archival centers may have to be designated. All the studies, surveys, and recommended implementation in this area will be performed in close coöperation with the Geoscience Information Society, whose role in the library community is preëminent.

Bibliographic Control. The Committee, having designated the American Geological Institute as the principal operator of a geoscience bibliographic reference service (GEO·REF), will continue to serve as an advisory body for the bibliographic activities being carried out by AGI. It will provide studies to guide the selective storage of the vast back log that has never been recorded in a secondary publication. It will initiate meetings between GEO·REF and the publishers of the primary journals that may -- let's hope -- lead to standardizations and printing processes that ensure rapid citation of the primary information while reducing the operating cost of GEO·REF. Profile studies are planned of worldwide bibliographic services (including those of other science disciplines that share overlapping areas with the geosciences) to establish existing coverage and to explore methods of eliminating the repetition of intellectual processing preliminary to tape storage. An area of Committee interest is the statistical research capability of the GEO·REF programs. A statistical study of worldwide publishing patterns will be an aid to the budget-conscious librarian and to the author seeking the most effective publication for his research results. Frequent reference is made to the "core journals" in science. The term is generally applied to the small nucleus of serials that provide the greatest percentage of published papers in the discipline. There has always existed a small doubt that these may not include the most significant contributions, or that an important paper may appear in a non-core publication. A study of the references cited by authors may be illuminating.

Data Standardization. The Committee plans to survey data-inputting centers in the United States that are concerned with the storage of geoscience information. Such a survey may reveal a duplication of identical effort unknown to research investigators. Where non-identical data is being collected and stored within a particular area of specialization, efforts will be made to standardize intellectual and automatic procedures. Meetings between the involved scientists and computer consultants will be encouraged and assisted if possible. The results will be publicized on a national and international level.

Thesauri and Special Vocabularies. The Committee will seek the funding required to construct a pilot thesaurus with EDP methods using a subdiscipline or

special area with a relatively limited vocabulary. The result will be distributed for evaluation and may lead to a single thesaurus for the geosciences to replace the many, and contradictory ones, that have been published in the past.

Resource Inventory. The Committee plans to continue the inventory of geoscience material until it is satisfied that all of the collections in the United States have been identified, indexed, and classified. The information then will be published and offered to the community. Before publication, however, the information will be made available upon request to geoscientists who may direct letter or telephone inquiries to the American Geological Institute. Upon completion of the American collections, a similar effort will be directed toward the material stored outside of the United States that is available for use and study by American scientists.

Translations. Working coöperatively with the AGI Translation Committee, the Committee will undertake a survey of user needs in the foreign literature. Whereas the major stress has been on Russian literature, it is possible that translations of publications in other languages are required. When use-patterns are determined it will be possible to design alternative publishing methods to satisfy the community's requirements.

Meetings. The Committee is concerned with the direction being followed in the structuring of major scientific meetings. The continued growth of sessions and papers, pacing the literature explosion, is reducing the impact and the importance of the formal meeting. The Committee plans to undertake, or to authorize, an analytical survey of meetings scheduled for the coming year. This will be followed by discussions with representatives of the sponsoring societies. New techniques in personal communication will be evaluated for their application to the meetings of the geoscience societies. A report of the findings, with recommendations for better structuring -- if they emerge -- will be submitted to the sponsors of geoscience meetings.

Research in Progress. A putative truism is that every subject specialist knows what every other specialist in his subject field is working on. But is he aware of the research in progress of every doctoral candidate -- or of the young geoscientist who has yet to publish his first significant paper? The Committee believes it probable that he does not. It also believes that a source of information on research in progress might prevent unnecessary repetition (and priority disputes), or it might serve the geoscience investigator through comparison of methods and preliminary results.

The Science Information Exchange (S.I.E.) maintains a computerized file of all research projects in progress at federal institutions. It has attempted to extend its data base to include privately funded or executed research, but its success in this area has been questioned. The Committee believes that this area of pre-publication information exchange should be examined and strengthened. It proposes to study the S.I.E. data base and check it against known ongoing research. It will decide, on the basis of its findings, to encourage a broader use of the S.I.E. facilities or to develop a research-in-progress information base for the exclusive use of geoscientists.

User Education. There is reason to believe that neither undergraduate nor graduate students are being sufficiently grounded in the techniques and facilities of information exchange. On the other hand, it appears that many professional geoscientists, particularly those engaged by industry, have only a vague idea of the new and growing opportunities afforded by EDP methods applied to the storage and exchange of data and information. The Committee proposes, therefore, to support a program of user education that will be directed to on-campus groups and through the professional societies. It hopes to enlist the services of the National Association of Geology Teachers (NAGT), together with consultants from the computer industry, to assist in curricula design.

Reporting. The Committee on Geoscience Information will continue -- and intensify its program of reporting. The geoscience community will be advised of the Committee's progress and results through papers presented at national and local meetings, and through articles and news items in Geotimes or in a Committee newsletter. The societies will receive reports and frequent communications from the Committee, and will in turn be sought out for advice and cooperation.

The Committee is grateful for the unqualified endorsement that its Concept received from the societies in the resolution of the November 1970 Meeting of the House of Society Representatives. Its major purpose is to serve geoscience, and that can only be done with the support and assistance of geoscientists.

THE GEO·REF SYSTEM

The Committee has designated the American Geological Institute as the center for bibliographic control of the geoscience literature in recognition of the Institute's 11 years of experience in this area. The Institute's Geoscience Abstracts was first published in 1959. Early in 1966, the Institute and the Geological Society of America concluded an agreement for a joint project to convert the Bibliography and Index of Geology Exclusive of North America from an annual volume to an expanded, automated monthly publication. The Institute was to be responsible for acquisition, abstracting, and indexing the literature, and the production of the volumes, while the Society would continue its role as publisher and provide for promotion and distribution. The National Science Foundation provided deficit support for this cooperative project.

In 1967, Geoscience Abstracts was suspended and replaced by the new monthly Bibliography, which grew from the 6,000 citations of the 1966 annual edition to almost double that number. By 1969, the Bibliography had been expanded to almost 28,000 citations. In the same year, following a decision of the GSA Council, abstracts were replaced by brief annotations and the name was changed to the Bibliography and Index of Geology, extending its scope to world coverage.

Following the Committee's designation, the Institute developed plans for extension of the Bibliography's magnetic tape file to provide further services to the geoscience community. Thus, at the beginning of 1970, the Geological Reference file (GEO·REF) came into being and although the photocomposed pages of the GSA Bibliography continues to be its most important output many other products have been developed.

During 1970 the GEO·REF bibliographic base was augmented by approximately 40,000 entries (of which 30,000 are contained in the Bibliography and Index of Geology), and 50,000 are expected for the 1971 input. Successive incremental increases during succeeding years are planned to achieve total bibliographic coverage of the world's current literature. Moreover, in consideration of the geoscientists' dependence upon the back literature and the long half-life value of published contributions, a plan is in preparation to recapture on tape the significant literature of geology as far as the middle of the 19th century. If funding is obtained, almost half a million older citations will be stored before the end of 1972.

A recent GEO·REF study of the references cited to current papers published in six geoscience journals reveals the interesting figures of this table:

	A	B	C	D	E	F
Total Citations	1,141	2,960	3,203	1,667	1,571	1,179
Older than 5 years	77%	76%	70%	85%	68%	77%
Older than 10 years	61%	55%	44%	57%	36%	55%
Older than 25 years	31%	33%	16%	32%	12%	32%
Older than 50 years	12%	16%	6%	16%	3%	15%
Oldest	1838	1758	1719	1821	1801	1771
Median	1953	1960	1961	1956	1962	1958

Table II

A -- USGS Professional Paper 580, Mineral Resources of the Appalachian Region, 1968

B -- Journal of Paleontology, Volume 43, 1969

C -- American Association of Petroleum Geologists, Bulletin, Vol. 53, 1969

D -- Paleontologicheskiy Zhurnal, Akademiya Nauk SSSR, 1967-68

E -- Moskovskoye Obshchestvo Ispytateley Prirody, Byulleten, Otdel Geologicheskiy, 1969

F -- Neues Jahrbuch für Geologie und Paläontologie, 1969

The magnetic tape base of GEO'REF contains approximately 100,000 bibliographic citations, stored for bibliographic use since 1967, each of which is "flagged" in the 14 following "fields":

1. A unique identifying number
2. Full title in original, or transliterated language
3. Title, if foreign, in English translation
4. Senior author
5. Junior authors (limited to ten)
6. American National Standards Institute (ANSI) abbreviated journal title
7. Volume and Issue numbers, pages, content description (maps, illustrations, abstracts, etc.)
8. Year of issue
9. Abstracts or annotations
10. All subject index terms
11. UDC number
12. Language of paper
13. Serial, Monograph, or Conference Report
14. Subdiscipline classification number

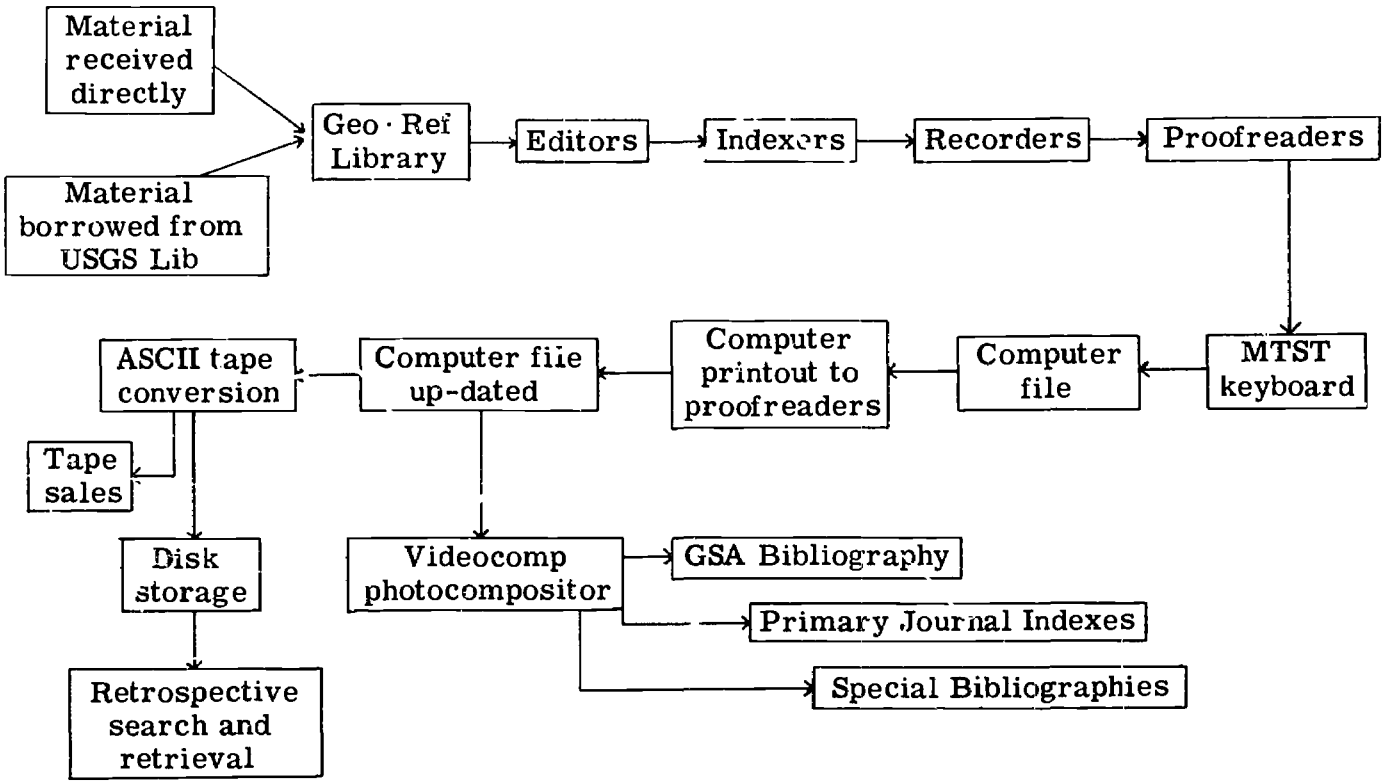
The fielding permits a manipulation, independent of the search modulus, to permute the elements for a printed display, and to produce or suppress any subset of the total fields. It also permits rapid retrieval of statistical information; e.g., the number of papers published by any given journal in any of the subdisciplinary categories in a given year; the number of topically selected papers published in any particular language over a stated period of time; the number of any foreign-language papers that contained a second- (or third-) language abstract. If desired, the papers identified in the statistical count could be automatically selected for printing.

GEO•REF has stored the citation references to all master's and doctoral theses in the geosciences produced at United States and Canadian universities since 1965. These theses often remain unpublished but are held in the archives of the degree-granting institution. As such, they will not appear in the printed bibliographies of the formal literature although they may contain data and results of significance to other research projects. In recognition of their value, they have been added to the file where they are either available through publication in bibliography of theses or through retrospective search and recall.

Similarly, GEO•REF has started to store the geoscience literature of contract reports, Clearinghouse reports, guidebooks, maps, and the significant portion of information that is referred to as "informal publication" and thus outside the purlieu of conventional bibliographies.

The flow chart on the next page is a graphic presentation of the internal operation of the GEO•REF system leading to the variety of services that automation makes possible.

The GEO·REF Operation



The GEO·REF system includes the capability of providing the service strongly recommended by the SATCOM committee to science information specialists -- the repackaging of information for small groups of specialized users. The system's computer base, programmed to identify any subset of the total file, can produce it through the photocompositor with the speed and ease of a total tape printout. Special bibliographies can be automatically formatted from the tapes. Topical or geographic listings can be produced or any combination of subject-selected listings. Thus a special Bibliography of Coal Deposits in Kentucky was prepared in 1970, but a bibliography of all coal literature, or of all the geological references to Kentucky could as easily have been withdrawn. The strength of the system has been recognized by State geological surveys who in the past have had experience with the costly and time-consuming effort of compiling and indexing the references to the geology of their states. Requests have been received for this service from 8 surveys and many more have sought information.

The possibilities are not limited to State bibliographies. The GSA is considering the publication of a Bibliography of Global Tectonics, and the economic geologists have been long interested in the feasibility of generating a special bibliography for them. The limiting restraint on GEO·REF's immediate acceptance of these contracts is the present "youth" of the computer-stored file. Almost all require references to information published before 1966, the first year systematically collected for storage. Many will need citations to the literature of the early 20th century and the latter half of the 19th century. This requirement is part of the special problem that involves the backlog.

The provision of primary-journal indexes is a natural product of an automated bibliographic system. In 1970, GEO·REF obtained the necessary software to select the index terms for any journal from its file and to reformat them to meet the requirements of the publishers. Volume-year indexes were prepared and supplied to the Geological Society of America Bulletin, the American Mineralogist, the Canadian Journal of Earth Sciences, and to all 3 sections of the Journal of Geophysical Research. To these the Journal of Sedimentary Petrology will be added in 1971 and possibly the American Journal of Science and the American Geophysical Union's translation journals. In addition to the annual indexes, GEO·REF has compiled and composed a 10-year cumulative of the GSA Bulletin covering the period 1960-1969. This is being published by the Society.

Many advantages, beyond the obvious saving of time and money for the publishers, are inherent to GEO·REF indexing of the primary journals. A standardization of key words used in indexing becomes a reality, rather than the subject of meetings and conferences. The subject indexes of the geoscience literature share a common format to be used by the primary publications as well as the USGS and GSA bibliographies. Users will be provided with in-depth indexes rather than having to depend on the superficialities of KWIC systems. Indexes will be presented in a high-quality graphic form rather than in reduced computer printouts that are often barely readable.

The GEO·REF retrospective search-and-retrieval system was demonstrated at 5 major scientific meetings in 1970, using a remote terminal that is coupled by

telephone with a computer in the Washington area. The search system has full Boolean capabilities, which permit its use for research queries as well as bibliographic listings. During 1970 the system was used by geologists at universities, in mining and oil companies, and in government agencies. The economic operation of the system puts its use easily within the price range of graduate students.

GEO•REF tapes have been converted to ASCII format (American Standard Code for Information Interchange) giving them a universal application with any hardware configuration. They have been tested by an industrial user and a major science library and are now being offered on a leasing agreement to institutions with a computer facility. Conversations are under way with "data centers" throughout the country that may lead to the establishment of local bases for retrospective searching of the tapes.

New services and new uses for the GEO•REF system are projected for the near future. A Selective Dissemination of Information (SDI) service may be offered in the coming year. A quick-alerting service of new titles is a real possibility. The total system of automation may be used in the production of established bibliographies in special fields. Meetings have been held with the American Water Resources Association, the publishers of Hydata, and with the editors of the Bibliography of Fossil Vertebrates, that may lead to the automation of those publications and the inclusion of their content in the GEO•REF data base.

The pricing of all GEO•REF services has been designed to make them economically attractive to individual and society users, and to make the system self-supporting within the next decade.