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KEEPING CURRENT WITH GEOSCIENCE INFORMATION

Edited By

Nancy Jones Pruett

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TABLE OF CONTENTS

APPENDIX A

APPENDIX B

PREFACE

The papers in these Proceedings were presented at the fifteenth meeting of the Geoscience Information Society held in Atlanta, November 16-20, 1980. The papers were presented in three technical sessions: the GIS Symposium entitled "Keeping Current with Geoscience Information", a Contributed Papers Session, and a Poster Session. The GeoRef Workshop is not represented directly by a paper in the Proceedings, but it capped off the technical sessions and contributed to the "Keeping Current" theme. The paper for the Poster Session appears at the end of Part II: Contributed Papers. Otherwise, all papers are arranged in the order they were presented at the meeting.

Among the different fields of the geological profession there is great variety in the way literature is used. Some geoscientists, like the paleontologists, need worldwide literature of any date, in any language, of any quality. Others, like the planetary geophysicists, use primarily new material in a few key journals. Others, like the consulting geologists, work in a number of fields and use literature to "get current" rather than to keep current. The idea for the GIS Symposium came from a discovery that what people in all these disciplines have in common is that they don't feel they are able to keep current. It is a rare person who will claim he does a good job at it; almost everyone would like to do it better.

For the Symposium, practicing geoscientists were invited to focus on how they attempt to keep current and information specialists were invited to describe tools, services or databases which could help geoscientists keep current. There are three papers by geoscientists covering the disciplines of minerals exploration, paleontology and engineering geology. And there are four papers from information specialists, updating our knowledge of USGS databases, BIOSIS, GeoRef and the technique of SDI.

The contributed papers and poster session paper provide a cross-section of the current activities in geoscience information. Nine papers cover aspects of the following areas of interest: uses of computers and of databases in the geosciences, collection analysis techniques, new publications, special geoscience collections and library instruction.

Nancy Jones Pruett
Program Chair, 1980

PART I

SYMPOSIUM:

KEEPING CURRENT
WITH
GEOSCIENCE INFORMATION

KEEPING INFORMED WITHIN THE MINERALS EXPLORATION COMMUNITY

Samuel B. Romberger

Department of Geology, Colorado School of Mines
Golden, Colorado 80401

Abstract: The importance of developing an efficient method of keeping up with the large volume of information being disseminated on various aspects of the minerals exploration industry has increased with increased interest in the minerals industry. Current knowledge is essential for those professionals actively searching for mineral resources, those interested in solving environmental problems, those involved with classroom updating and research, those actively consulting with the minerals industry, and those pursuing employment opportunities. The problems in keeping current include the large volume of literature appearing, the limited time available for reading, and the large amount of useful data classified by industry and government. The efficient individual adopts two or three journals which he feels maximizes the state of the art information, i.e., Economic Geology, Engineering and Mining Journal and A.I.M.E. Transactions. Economic Geology publishes titles of papers in other journals related to the mineral deposits field. Open file reports released by government agencies contain valuable up-to-date information, and frequent personal contact with colleagues within the professional community has no substitute. Future information retrieval systems most likely to be of service will be fast, efficient, and of widespread distribution and availability.

Introduction

In the past few years there has been a substantial increase in interest in the mineral industries from both the private and public sectors. In the United States this increase has been stimulated by shortages in certain commodities, economics, worldwide politics, environmental concerns and the removal of large segments of public lands from exploration and exploitation activities. In addition, mineral deposits are becoming harder to find, and the successful explorationist must be able to base his decisions on information from many different disciplines such as geophysics, geochemistry, ecology, economics, mineral processing, metallurgy and geology.

The problem of keeping current will be addressed first. Then the incentives to keep current in the academic environment will be considered, followed by the author's approach to the problem. Finally, a few recommendations for the future will be offered.

The Problem

The increase in interest in the minerals field has resulted in a significant growth in the volume of literature in this and allied fields. Exploration geologists must have access to literature in a wider variety of publications than in the past, and in more languages. For example, a recent leterature search on GeoRef for references on hydrothermal uranium deposits turned up 256 citations. Of these, 99 were in Russian, 16 in German, 9 in Spanish, 6 in French, 3 in Japanese, and 3 in Polish, accounting for more than half the entries. Also, a large volume of worthwhile information resides in the classified files of private corporations, presenting a problem for the geologist in a university environment.

The Incentives to Keeping Current

Activities which require and encourage the academic geologist to remain knowledgeable of the literature include: teaching; advising graduate students in their thesis research; conducting sponsored research; publishing papers; presenting and attending special short courses; leading and attending field trips; and participating in other professional activities such as consulting. Each one of these activities will be discussed in more detail below for the minerals field.

Teaching Graduate Courses in Mineral Deposits

Teaching advanced courses in mineral deposits requires awareness of the most recent information in the subject area. The area of mineral deposits is ever-changing. Ideas on the origin of mineral deposits are evolving constantly as more information about deposits and their relationship to regional tectonics becomes available. The current nature of the information presented is directly related to the value of an advanced course. And the advanced student is difficult to fool for very long.

Advising Graduate Students on Thesis Research

There should be a two-way exchange of information between student and advisor: the advisor supplies the guidance and the student collects information. No advisor can be an expert on all things, and he should learn as much or more from the student's research as the student does. In its final form the thesis should be a wealth of current information on a particular topic that the advisor has available for future reference. For example, in a recent paper published by the author, three theses completed within the last three years were cited. And in the development of a short course on the geology of gold and silver deposits, theses, both completed and nearly completed, were useful. Five published or nearly completed theses from the author's advisees contain a total of 316 cited references; of these 81 were separate references on gold deposits alone.

Sponsored Research

The initiation of a research proposal requires a complete and up-to-date review of the literature. This is necessary to ensure that the work has not already been done, and also to adequately demonstrate that the research is worthwhile. Often, the decision to fund a project is based on whether or not the proposer has done his homework.

Also, in order to be effective in the field of organized research, current knowledge of the research area is required. The interpretation of newly generated data is greatly facilitated by being familiar with what others are doing in the same field. Often current information may take years to appear in the literature.

Publishing Papers

The need for a comprehensive literature search when writing and publishing review articles should be obvious. The writer may take advantage of a continuously up-dated bibliography, or carry out a literature search at the time of writing.

Short Courses

The professional geologist may be involved with giving short courses on various aspects of mineral deposits. These courses will be concerned with a greater breadth of material than contained in a university course on a specific aspect of mineral deposits, and therefore require a greater range of current knowledge. Short courses are typically attended by professional geologists with significant experience from various exploration companies. These people are not willing to buy out-of-date information.

Attending short courses is equally valuable. Often they contain information not published in the literature. The notes supplied with many such courses are often the product of someone else's labors in the efforts to keep current. In addition, the professional contacts developed through both attending and offering short courses are invaluable.

Special Field Trips

Field trips are very helpful in obtaining current knowledge on mineral deposits. They represent first-hand experience with those deposits which we are attempting to understand and interpret. Often, the views of on-site geologists are different from those expressed by investigators in the literature because the latter may be biased towards a certain interpretation. The information obtained during a visit to an active mine is certainly more current than that obtained from the published literature. During the preparation for field trips, literature reviews may result in the development of ideas that can be tested on-site.

The Society of Economic Geologists regularly sponsors special field conferences which emphasize various aspects of mineral deposits. They are usually led by experts in the field. These field trips are extremely valuable in obtaining current knowledge. The conferences are attended by geologists from industry as well as the academic community. Much can be learned from these individuals about the current activities in minerals exploration.

Other Professional Activities

The value of a consultant is usually based on the premise that he has a little extra expertise that someone else does not have to help solve a problem. In order to maintain that expertise, it is necessary to remain current. In addition, contacts developed during consulting activities are very useful in finding out what is happening in the private sector. Often consulting experiences can be brought back to the classroom as well.

The Approach to Keeping Current

Some activities were outlined above which serve as incentives to keeping current in the area of minerals exploration. Keeping current has two purposes: 1) maintaining current knowledge (keeping up-to-date in your field) and 2) developing a literature base in a particular area which has recently become of interest. This author's methods for keeping current for these two purposes follows.

Maintaining Current Knowledge

The number of articles published each month in a large number of journals precludes a review of all journals by the typical minerals exploration geologist. The most efficient approach for one having a limited amount of time is to choose a few journals which come closest to containing a maximum amount of information in his area of interest. For the area of mineral deposits, the author considers two journals of primary importance: Economic Geology and Engineering and Mining Journal. In addition, A.I.M.E. Transactions is useful and may be preferred by some.

Economic Geology is published eight times a year by the Society of Economic Geologists. This journal is a primary source of information on mineral deposits research. It contains papers concerning current ideas on the origin of mineral deposits, and often devotes an entire issue to the review of a particular type of mineral deposit or geographic area. In addition, Economic Geology publishes titles of papers concerning mineral deposits appearing in other journals.

In the attempt to develop a literature base on gold deposits, a review of the five most recent volumes of Economic Geology resulted in 32 significant papers. The past 30 volumes yielded approximately 150 useful articles.

Engineering and Mining Journal is published each month by McGraw-Hill Publishing Company. Along with review articles concerned with various aspects of the mining industry, it contains short notes on current exploration activities and discoveries. This journal also contains information on the state of the minerals market as well as the status of legislation affecting the industry.

Government publications can be useful in keeping up-to-date on various aspects of mineral deposits. For geologists, publications released by the U.S. Geological Survey and the Department of Energy are most pertinent. Publications from the USGS usually require a significant length of time to appear in print. However, Open File Reports are timely and often can be obtained directly from their authors. Titles of all publications of the U.S. Geological Survey are released in the monthly New Publications of the Geological Survey. The Department of Energy also periodically releases open file reports which can be of value.

There are also current bibliographies which can be pertinent to the minerals explorationist. Minerals Exploration Alert (MEA) is a new biweekly publication available from the American Geological Institute which updates literature on various aspects of minerals exploration. This publication includes citations taken from over 3500 periodicals as well as books, theses, maps, patents, and other reports. The October 28, 1980 issue contained 110 titles on such topics as the geology, petrology and mineralogy of copper, gold, silver, tin, tungsten and uranium deposits as well as on various aspects of ore deposition.

Also, Selective Dissemination of Information (SDI), a monthly computer update of bibliographic information, is available from various computer-based vendors.

Developing a Literature Base

Often it is necessary to devleop a set of references on a new topic which has recently become of interest. There are two approaches that can be taken. One involves a personal search of library sources, the manual approach. The other involves the use of computer-based literature data. There are advantages and disadvantages to each approach. The disadvantage to the manual search is the time involved. The disadvantage to the computer search is that you do not always know what to expect in the printouts. Citations on file only go back a certain number of years. Often an article may be missed, if the key words do not appear in the title. For example, articles describing certain gold deposits often only have the name of the deposit in the title and not the word gold.

The manual search relies on the technique of multiplying references. That is, the most recent papers on the topic of interest are obtained, and the references in those papers are evaluated. The most useful references are subsequently obtained and citations evaluated. The result is an expanding list of references in the area of interest. This method also allows for a subjective evaluation of the usefulness of the articles, which may influence the direction one goes in discovering additional references.

The Future

Because of the exponential growth of the number of articles appearing in the literature, there may not be an alternative to computer-based data files. However, the identifiers used to call up citations need to be refined so the user can be more specific about what he receives. And the files must be expanded so that articles appearing in earlier years can also be found. Many old mining districts have not been considered in the literature in the past 50 to 75 years. Some of the more useful descriptions of these old mines were made when the district was producing, and these descriptions should be in the database.

Such monthly publications as Minerals Exploration Alert are useful, as is a periodic list of articles in specific fields, like that in each issue of Economic Geology. Perhaps more publishers might assume this time-saving practice.

KEEPING CURRENT IN AN INTERDISCIPLINARY FIELD: PALEONTOLOGY

R. K. Bambach
Department of Geological Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Abstract: Paleontology is interdisciplinary. Its data base and applications are geological but its subject matter is biological. Because paleontology is equally involved in several disciplines there is no single indexing source for the field. The computerized reference systems GEOREF and BIOSIS are both inadequate for research use by paleontologists. This is because of failure in keyword indexing, especially inadequate care and detail in taxonomic indexing, as well as capricious keyword listing of general topics. Keeping current in paleontology still requires look-for-yourself and word-of-mouth techniques. A four-fold system has proved useful. (1) Keeping in touch with colleagues active in research. The remark "so-and-so just discovered such-and-such" is as current as you can get. (2) Following the "mainstream" literature as it is published through weekly visits to the new geology journals section of the library and by personal journal subscriptions. (3) Reviewing of journals in general science, biology, zoology, ecology, oceanography, fisheries, general geology, sedimentology, stratigraphy, and marine geology at least once per year. (4) Using standard subject indexed bibliographic sources when checking for completeness on specific topics or for getting oriented to the older literature when starting research on a new topic.

Paleontology, An Interdisciplinary Field

Paleontology is necessarily associated with geology, usually considered as a physical science. The data base of paleontology, fossils, is obtained from the remains of ancient life found in sediments and sedimentary rocks. Supplementary information on environments and geographic conditions, needed for interpreting the conditions in which fossil organisms lived, comes from the study of rocks. The traditional applications of paleontology, such as the relative age dating of rocks and the interpretation of ancient environments, relate to the study of geologic history.

The subject matter of paleontology, however, is undeniably biological because fossils were once living organisms. Biological concepts such as evolution, ecology and taxonomy are the principal topics of paleontologic research. In fact, the only preserved evidence of the course of evolution is the fossil record.

Other distinctive features of paleontology are its immense scope and the rather small size of the profession. The field of paleontology covers the study of all kinds of life through all of time. In spite of this large conceptual framework paleontology is a small profession with only about 1700 members in the Paleontological Society and probably no more than 4000 paleontologists of all sorts active in the United States.

Because there are rather few paleontologists and because their interests are so diverse there are relatively few publication outlets devoted exclusively to paleontology. A large segment of the paleontologic literature is scattered through a variety of sources. In the last decade important articles on dinosaurs have appeared in "Evolution," on fossil clams in "Forma et Functio"; on depths of burrowing by fossil organisms in "Marine Geology", on fossil marine communities in "Journal of Sedimentary Petrology" and on feeding types in fossil marine communities in "American Association of Petroleum Geologists Bulletin". On top of this there are the articles on geologic and biologic topics that are relevant to paleontology that are the standard fare of the geologic and biologic literature. Keeping informed in paleontology requires the search of a widely scattered literature across several disciplines.

These conditions create difficulties for the scholar and the bibliographer. The small size of the profession means that groups of paleontologists are rarely employed in one institution. Most paleontologists are "lone wolves", or, if there are several in one location, they are usually specialists in widely divergent subdisciplines. It is normally impractical to set up a specialized reference service for the small paleontologic community at any one place. Most paleontologists are on their own in keeping up with developments in their field.

Problems With Comprehensive Indexing Services

Because paleontology is interdisciplinary there are no single reference, citation or abstracting services that actually cover all the areas of interest to paleontologists. Because of the scope of the subject, which includes so much supporting geologic and biologic information extending beyond publications on fossils alone, it would be difficult to create a comprehensive paleontologic literature indexing system. The small size of the profession also means that it is not practical to compile an adequate literature index specifically for paleontologists. It is not possible to justify the effort financially.

General computerized reference systems in geology and biology do exist and I have attempted to use GEOREF and BIOSIS, the two computer-based literature search services that relate directly to paleontology. I have requested references on subjects ranging from specific kinds of organisms to large theoretical concepts in an effort to test the utility of these systems for paleontological research. In no case have the results been fully satisfactory. Neither system is capable of producing a complete set of references on a topic from the literature included in the time span covered by the system. This is demonstrated by noting that each list of references from one system contains citations not duplicated by the other system. In numerous cases the keyword indexing omits crucial specialized keywords, synonym cross-references, or assignment to general conceptual terms so that significant citations present in the system are virtually unobtainable unless the searcher already knows about the reference in detail and is willing to play word games with the system, paying all the while, until the "jackpot" is hit. And even then you do not know if you have acquired all of the useful information that may be buried somewhere in that memory bank.

For example, references to specific groups should be the most accurately and completely recorded of any paleontologic subject matter because the biological classification scheme is the standard system for naming organisms on a worldwide basis. Scientific names for organisms could be as carefully treated as chemical compounds are in the chemical abstracting services. If they were, then at least one reliable date base would be available for use by paleontologists, as well as for biologists. Unfortunately scientific names are not consistently covered. In one case, an article using 73 scientific names at the subfamily level and above, has only 31 of them entered in the keyword listing for the article by GEOREF. The phylum (most inclusive), class, superorder and order names are all present but only two thirds (10 of 15) superfamily, less than half of the family (11 of 26), and none of the subfamily (0 of 20) names are indexed for this article.

I have looked into the date files of GEOREF and BIOSIS at the level of genus, the most important for doing detailed taxonomic research, family, the most useful general level of review, and class, a high level within which most people confine their specialized career work. The results have been disconcerting at each level.

I have asked for references to the trilobite genus Paratrinucleus but neither GEOREF or BIOSIS contains any citations even though the genus was described in the Philosophical Transactions of the Royal Society of London in 1975 (Hughes et al, 1975). Moving up to the family level, GEOREF does contain 11 references to the family Trinucleidae and BIOSIS has 4. When Trinuclei-(the truncated form of the name to catch such keywords as Trinucleiids) is used as the keyword GEOREF produces 21 citations and BIOSIS has 7. BIOSIS is available only for the 12 years from 1969 to the present whereas GEOREF covers the 20 years from 1961 to the present. Even when this is taken into account, BIOSIS has only 60% of the number of references contained in GEOREF. This conclusion is based on small numbers but the same proportions, or worse, are maintained in a larger test. GEOREF contains 1907 references to the class Trilobita. BIOSIS has but 104. If we assume a relatively constant rate of publication then 60% of the GEOREF citations were published during the 12 years also covered by BIOSIS. In this case BIOSIS contains only 9% of the references to the class Trilobita given by GEOREF. When BIOSIS is queried for the truncated form of the name Trilobit-(to catch such keywords as trilobite, trilobitoid, etc.) 702 citations are listed - but this is still proportionately only 60% of those in GEOREF for the same interval of time. If publication rates are increasing (as they are in many subjects) the coverage by BIOSIS would be even less complete. Trilobites are extinct and would be predominantly discussed in the paleontological literature. BIOSIS simply does not have adequate paleontologic coverage.

In another case, GEOREF contains no references to the bivalve mollusk genus name Byssonychia despite the existance of a whole paper on the group by Pojeta (1962). When the truncated name Ambonych- is used (to catch all varients on the family name that includes the genus Byssonychia) GEOREF contains six references, but Pojeta (1962) is still not listed, nor is Bretsky (1970) which also has descriptions of ambonychiids. In asking for the genus name Ambonychia, to which the species of Byssonychia were assigned by Pojeta in 1966, GEOREF lists one reference, but it is not Pojeta (1966).

Turning to a general question, information was sought on bivalve mollusks (clams) during the Paleozoic Era. In this case GEOREF contained 57 citations to Paleozoic Pelecypoda and 212 citations for Paleozoic Bivalvia. Only 15 of these are duplicated on both lists. 244 unduplicated references should appear on each list because Pelecypoda and Bivalvia are exact synonyms. Both are used as the class name for bivalve mollusks. Each time period (Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian and the two American subdivisions of the Carboniferous - Mississippian and Pennsylvanian) was also requested, for both Pelecypoda and Bivalvia. 349 more references to Pelecypoda and 376 more for Bivalvia appeared, with only 43 duplications on the two lists. 682 more references to bivalve mollusks are obtained when times within the Paleozoic are individually requested than when the all inclusive term Paleozoic is used. Again, the lists for Pelecypoda and Bivalvia are nearly mutually exclusive even though they should be identical. 18 separate requests must be made to get a full listing of citations of Paleozoic bivalve mollusks in GEOREF.

The BIOSIS search manual recommends the use of the Biosystematic Index when searching for taxonomic categories and concept codes for searching major concepts. I have tried these and found them even less complete than the keyword approach. There is no Biosystematic category entry for Trilobita in BIOSIS even though the Trilobita is a class of Arthopoda with every bit of the legal taxonomic status as the Insecta or Crustacea. When category codes are used, BIOSIS suggests that trilobites are included in the category code CC63552, Invertebrate Taxonomy, Arthropoda, General. There are 869 citations in BIOSIS category code CC63552. These are not all likely to be to trilobites but the number is far below 60% of GEOREF's 1907 references to trilobites anyway. When CC63552 is coupled to the truncated keyword Trilobit - in an effort to find the number of the trilobite references within the general concept code list, 468 citations are listed. This is 234 fewer than for the keyword Trilobit - alone.

BIOSIS also fails to follow general taxonomic practice, even at high levels. The Zoological Record has used the term Bivalvia as the class name for bivalved mollusks (clams and their relatives) since 1964. The biosystematic category for bivalved mollusks in BIOSIS is Pelecypoda (last used by Zoological Record in 1963). BC61500 (Pelecypoda) has 12015 total citations. The keyword Pelecypoda has only 317. There are 692 under the keyword Bivalvia. Are they included in BC61500 also? I don't know.

When the fossil record of the bivalve mollusks is considered, CC63000 (Paleozoology) combined with BC61500 (Pelecypoda), BIOSIS lists 2185 citations (about 1/6 the total Pelecypod entries). But there are also 164 citations for Bivalvia combined with Paleozoology. Since there are 578 references just to Paleozoic age Bivalvia in GEOREF it is again apparent that BIOSIS is very incomplete for paleontologic data.

When general concepts are investigated, idiosyncratic listings are produced. GEOREF has 215 references to "species diversity" covering the interval 1961 to 1980 whereas BIOSIS has 646 for just 1974 to 1980, proportionately 8 1/2 times as many references. BIOSIS has only 24 references to "marine benthic communities" whereas GEOREF has 83, a proportionately equal number. When references to species diversity in marine benthic communities were requested GEOREF had 4, BIOSIS none. The GEOREF list is simply capricious. It contains none of the papers from either the biological or geological literature that most workers think of when this subject is mentioned. When "species richness in the Phanerozoic" is requested the two principal recent references appear in both GEOREF and BIOSIS but none of the general set of papers that led to them are so indexed under either this subject or species diversity.

Computerized reference systems may be of use in calling attention to references not immediately at hand or in supplying some references to help a researcher start into an unfamiliar field. The major problems then become defining the material desired. If the subject is too large the volume of extaneous material, as well as the cost, is excessive. Biosystematic code 61500 (Pelecypoda) in BIOSIS has 12015 citations, concept code CC63000 (Paleozoology) has 20602 citations. GEOREF contains 10144 citations to the Triassic time period and 3430 to reefs. If a specific subject is requested then the problem of inadequate keyword entries or incomplete indexing remain. GEROEF has 7 citations to Triassic coral reefs, but only 3 look as if they will be very informative. BIOSIS has only one, but it is different than any of the seven in GEOREF. As already noted, no references or inadequate lists appear when topics such as *Paratrinucleus* or Mississippian vertebrate tracks or *Ambonychia* are sought.

When publication lists by authors are requested it becomes apparent that the computer-based systems do contain citations to most of the recently published literature. Author listings tend to give complete listings. The reason that subject requests result in incomplete or inadequate sets of citations is because of incomplete, inconsistent and idiosyncratic use of keywords. The keyword indexing is the Achilles heel of existing computer-based reference systems.

Because expected references do not turn up, even when keywords in the title are used, because the cross referencing of synonymous terms is not extensively practiced, because consistent indexing to some standard level of detail is not reliably performed, and because the same request in different systems regularly produces different listings of references it is apparent that existing computer-based reference systems are seriously deficient for use in paleontology.

Both GEOREF and BIOSIS seem to be inadequate as methods for literature search to keep one informed about recent developments in paleontology. Neither system extends for enough back in time to be useful for historical documentation. BIOSIS is available only back through 1969, GEOREF back through 1961. In the future these services may be extended back in time but if the indexing of key-word assignments is not revised for the existing files, and made more adequate for them as well as future entries, these computer-based systems will not become useful.

Methods That Work

I have found that a four-fold program of information gathering is useful for keeping up with developments in paleontology. In decreasing order of utility for staying abreast of current activity in the field the four approaches are (1) keeping up with colleagues, (2) reading the "mainstream" literature as it appears, (3) reviewing a broad spectrum of journals on a periodic basis, and (4) checking standard bibliographic sources for specific topics.

Keeping up with colleagues

C. P. Snow's concept of "the invisible university" is a meaningful one. There is a network of people that are active in forefront research in almost every field. They seem to keep in touch with each other by correspondence, phone and personal visits. These people are doing much of the ground-breaking in their disciplines and, because of their need for information that is not yet common published knowledge, they seek and supply knowledge within their active research cadre.

I try to keep in touch with the active scholars in my fields of interest. In our exchanges I "pick" their brains and I trust they "pick" mine. People in other environments than your own do different things and pay attention to different things than you do at home. Every campus or laboratory visit, speaking engagement, hosting of a visting scholar, or scientific meeting produces new ideas and new directions to search. The remark "did you know so-and-so just discovered such-and-such" is about as current as you can get unless you do it yourself.

The "mainstream" literature

There is a core of journal and book literature that a well-informed scholar in any field simply must read as it becomes available. In paleontology there are four primarily English language periodicals that should be seen by all invertebrate paleontologists: "Paleobiology", "The Journal of Paleontology", "Paleontology", and "Lethaia". Besides these it behooves anyone interested in the sciences to follow the "newsier" general magazines such as "Science", "Nature", "American Scientist" and "Scientific American", as well as a selection of the broadly based journals in their own general field. This can be done either through private subscriptions or through faithful visits to the library. I suspect most professionals make a compromise on these. In my own case I subscribe to 12 journals (3 general, 2 paleontological, 3 geological, and 4 biological). This is painfully expensive but I do not miss anything in a fair distribution of disciplines. I also try hard to make at least weekly visits to the new journals section of the library. This works well for the geology and paleontology materials I seek because the geology library at my institution is only 16 steps from my office. The biological materials are less regularly scanned because they are three blocks away in the main library!

Reviewing a broad spectrum of literature

Everyone seems to casually check through the new periodicals on most visits to the library but I wonder how many people have a systematic search procedure to help direct them to a balanced review of the literature? Keeping informed not only means seeing useful material but also keeping track of it so that you can recover it. It also means knowing what you have and have not seen so that you can systematically expand your knowledge rather than going back to already noted material or inadvertantly skipping material. This means a person must not only develop a system but they must practice following it.

In my own system, I keep a notebook with separate sheets for each of 122 journals available in my university's libraries that contain material, at least occasionally, that is relevant to the areas of paleontology that interest me. This includes 6 in general science, 31 in general and regional geology, 3 in geophysics and tectonics, 6 in stratigraphy, 6 in sedimentation and geochemistry, 9 in marine geology and oceanography, 20 in paleontology, 4 on mollusks (the taxonomic group of most interest to me), 13 in marine biology, 8 in ecology, 7 in zoology and 9 in general biology, including evolution. This material is scattered across Library of Congress call letters GC, Q, QC, QH, QL, SH and TN.

Each sheet contains columns for each issue of the journal for a year and years are noted in the cross lines. I check off the issues of each journal I have reviewed and note page numbers of articles I wish to read or copy. When I have done so I circle the page number entry. If an article is of particular use I note its subject in a separate column. This way I can tell, at a glance, which issues of any one of my target journals I have seen, whether it contains material of interest and whether I have read or acquired the material of interest. I not only keep track of what I see that is new - and remind myself of what I need to look for - but I use the system to work backwards into older years. One sheet can accommodate a record of thirty years of perusal of a monthly journal. The system of annotation permits me to keep track of where I am in my study of each journal - and even if I fall behind it doesn't break the continuity of the system. I can catch up at any time. I try to make the time to do a reasonably thorough library review two or three times a year and succeed once or twice a year. I am particularly enthusiastic about search systems of this sort because of their regular utility. Almost every time I am working through a search visit to the library I discover several references on topics that students or I have just begun to investigate in sources that we otherwise might easily overlook.

<u>Checking standard bibliographic sources</u>

Despite my pessimusm about the utility of computer based reference systems as a method for keeping up with developments in paleontology it is obvious that there are several invaluable uses for these and other standard bibliographic sources. They are particularly useful (1) for establishing a base of reference when starting work in an unfamiliar field, (2) searching out older references for historical documentation in a field and (3) as a check to insure that the standard items on a topic have been noted, especially those that may be in sources not readily available.

At the time a new project is being started and the literature on that topic is not yet familiar it is nice to get any information that will open the door on the subject. The first source I turn to when beginning to look into a new field is the "Bibliography and Index of Geology". Because of its generally thorough coverage of geologic material it is reliable. It is also available free in the library and can be searched for the most likely keyword quickly. Scanning the reference lists allows one to pick the most likely citations and they can be immediately checked in the library stacks. For most items this will start a person into recent papers from which further references can be gleaned in bibliographies. It is usually faster, as reliable (since the data base is the same) and much less expensive than using GEOREF. On top of that, keyword search is more flexible with the printed publication.

Tracking down older works that are considered the sources for widely held concepts and checking for widely cited references not already encountered are two other significant uses of the standard bibliographic tools. Whereas these activities are not "keeping informed" in the sense of keeping up-to-date they are major aspects of good, thorough scholarship. Major bibliographic compilations of any age retain their value. I still use Bassler's "Bibliographic Index of American Ordovician and Silurian Fossils" even though it was published 65 years ago.

Conclusions

Subjects of interest to paleontology stretch across a spectrum of disciplines from geophysics to evolution. Paleontology is both a part of the geological sciences and, as paleobiology, a part of the biological sciences. "Deep Sea Research" (GCI), "Science" (OI), "The Journal of Geology" (QEI) "Marine Geology" (QE39), "Sedimentary Geology" (QE581), "Paleobiology" (QE701) "American Naturalist" (QH1), "Systematic Zoology" (QH83), "Marine Biology" (QH91), "Quarterly Review of Biology" (QH301), "Ecology" (QH540), "Journal of Zoology" (QL1), "The Veliger" (QL401), "Fisbery Bulletin (SH11), and "American Society of Petroleum Geologists Bulletin" (TN860) are all useful journals to an invertebrate paleontologist interested in marine fossils. You can't just look at one shelf in the library and be informed.

This is the main message I wish to bring to the library professional. The help you can give paleontologists is really much more broadly based than you might think. You need to know your collection and point out new acquisitions of paleontologic materials. But beyond that, and maybe even more importantly, you can help the research professional seek sources of information outside the obvious. I wonder what areas I neglect that I should examine. If you know the scope of interests of your library users you might help steer them toward useful periferal areas. When the researcher turns to bibliographic aids you should know how to use them and give pointers. I would have drowned in confusion and gone deep into real financial debt in struggling with GEOREF and BIOSIS without the cooperation, help and good ideas of the gology librarian at Virginia Tech. I would have been a long time thinking of compiling the composite reference lists to Paleozoic bivalve mollusks which was an immediate idea of his. If you have faculty colleagues who wonder how to go about coping with the flood of new literature or the diversity of information they would like to cover, help them organize a simple check system such as the one I described earlier. Better that people keep a record for themselves then keep marking up journals with little cryptic dots and checks - which they promptly forget about since the notations are on the journals and not in their offices.

Keeping informed means different things depending on the source for the information. The researcher in the laboratory is the most up-to-date. The researcher knows first, as discoveries made. Doing research means you know now. When you get information from colleagues who are active in research you get the information before it is presented publicly but after the researcher found out. Getting informed by knowing people means you probably know within six months or so of when it was discovered. By attending meetings and public presentations a person can keep ahead of the printed literature and feel quite up-to-date, but people present information at meetings that they have been developing for a year or more, usually. The meeting attender is then about a year behind the researcher. Most journal articles are in review and in the press for a year, the writing takes several months, and the writing is usually not started for months or even years after the basic shape of the conclusions became known during research. The journal reader is, therefore, two to three years, on average, behind the researcher in knowing about new developments. Searching for information in the literature implies looking for material that is already available and has been available long enough to have been indexed in a bibliographic source, or at least catalogued, bound and shelved in the library. We think of things published in the past three to five years as recent - yet when the lag time in publication is added it seems that the literature searcher is being informed about things the researcher knew five or more years ago. Keeping informed is an active, personal activity of individuals. Doing scholarship and insuring thorough evaluation of research in light of the range of ideas people have had on the subject through time is an interactive function of bibliographic services, resource staff, and academic scholars.

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RESEARCH AND THE CONSULTING ENGINEERING GEOLOGIST

E.D. Michael

Consulting Engineering Geologist
6225 Bonsall Drive
Malibu, California 90265

Abstract: The work of the consulting engineering geologist is somewhat different from that of the engineering geologist working for a large organization. In California, he practices primarily in the field of site development and less commonly in environmental and forensic geology. Important research aspects are the limited time available, the necessity for thoroughness, the topical and cumulative nature of some data, the scope of the work, and the necessity for rapid retrieval. Most engineering geologists attempt to keep aware of sources and get current as the need arises. Three common problems are the inadequacy of key word indexing, dispersed sources of information, and difficulties in obtaining data from public agencies.

Research materials most useful to the engineering geologist include periodic or recurring data and pictorial materials. Analytical and certain miscellaneous references more or less unique to the practice of engineering geology also are valuable.

A collection of photo indexes would permit rapid determination of coverage and quality. A more complete collection of current-review documents, a comprehensive publication of book reviews, better use of industrial publications and an efficient inter-library loan service also would be helpful. An engineering geology archives might best meet the engineering geologist's research problems. Finally, it is worthwhile to consider supplementing word indexing by instituting a system analogous to Shephard's citations used in the legal profession.

INTRODUCTION

Engineering geology is the application of the principles of geology to civil works. This application of scientific principles to the art of engineering, particularly in the context of legal obligations, and professional responsibilities relating to the public health, safety and welfare, results in unique problems of research for the consulting engineering geologist. The field of engineering geology is expanding, and there is an increasing need for institutions to adopt an engineering geology curriculum.

The Consulting Engineering Geologist

"Civil works" refers primarily to large public construction projects such as dams, bridges, highways and the like. To a great extent, the engineering geologist working on such projects does so as a member of an organization, either a public agency or a corporation, with a large staff. The consultant is essentially an independent expert in one or more specialized fields, while the organization geologist is essentially a team member with certain special skills. Their research requirements, although similar, are not the same. This paper is concerned with the consultant's research problems.

Fields of Specialization

The activities of consulting engineering geologists in southern California are numerous and varied, and resulting research problems probably are typical of the profession. Much of the work involves site development, i.e., studies of slope stability and suitability for grading. Also important are the specialties of hydrogeology and seismic safety.

Each of these specialities has significant legal aspects. Site development commonly involves municipal codes with which recommendations must be consistent. Hydrogeologic studies are almost invariably related to the vast body of California water law. Studies of seismicity are required by various public agencies because of the Alquist-Priolo Act, a state statute specifying the need for such work in areas considered to be seismically active.

Some engineering geologists consult in the closely allied fields of environmental geology and what might be called, for want of a better term, forensic geology. As with site development, environmental geology has a close relationship to law, since developers are required to comply with two important California statutes, the California Environmental Quality Act and the California Coastal Act.

Forensic geology may be defined as the application of geologic principles to law. Its scope is somewhat broader than the normal activities of the expert witness, and it is of primary use in the field of civil rather than criminal law in contrast to most other forensic sciences. In cases of civil liability arising from geologic conditions, certain relevant facts and geologic processes are not obvious to laymen. The forensic geologist is most helpful to the attorney when he is able not only to explain physical conditions but, being conversant in the law, can also recognize circumstances where various legal theories are applicable and actually make suggestions in framing causes of action or defenses.

SPECIAL RESEARCH CHARACTERISTICS

The nature of the data normally required in research related to engineering geology, and the restrictions imposed by the fact that the work is almost always undertaken in a contractual context, gives the research work of the consultant certain special characteristics. These include a limited budget for research, the necessity for reasonable thoroughness, the significance of topical and cumulative data, a relatively broad scope, and the need for rapid retrieval.

Limited Research Budget

Most smaller projects will not support an exhaustive research effort because of the cost. Commonly, the work is done on the basis of "immediately available" data. Only the largest projects produce funds sufficient to permit personal contacts with unpublished authorities, detailed examination of the various colleges and universities for graduate theses, or examination of records at out-of-town agencies. Fortunately, most smaller projects do not require such efforts.

Reasonable Thoroughness

A reasonable degree of thoroughness is, nevertheless, necessary not only because of the nature of the problem, but also to guard against legal liability. Lawsuits brought against geologists commonly are for professional malpractice, a species of the tort of negligence. The consulting geologist is not necessarily negligent if he makes an error in judgment, but only if, in doing so, he failed to pursue his activities in a reasonable manner consistent with procedures common to other consulting geologists of the professional community.

Reasonable thoroughness in research is some evidence that the geologist has performed adequately in this regard. Conversely, lack of thoroughness, when coupled with the other elements of negligence may be a basis for assigning liability.

Topical and Cumulative Data

A third special characteristic of research in engineering geology is the highly topical and cumulative nature of some of the data. Much information, particularly observations of physical phenomena, is reported periodically and frequently for certain localities. This presents a problem for the geologist in "keeping current."

Scope

The scope of the consultant's work is a fourth special characteristic of his research effort. Recent interest in conservation and increased recognition that civil engineering has severe limitations in certain respects has resulted in an ever-widening field in which the engineering geologist is called upon for advice. Advances in technology also have the effect of broadening the scope of the consultant's research. Innovations in automatic field-data retrieval methods, progress in the design of exploration equipment and new scientific techniques such as carbon-14 and amino-acid dating are examples.

Another aspect of the scope of the consultant's research effort is the fact that some undertake projects geographically widespread. It is not uncommon for a consultant based in southern California, for example, to work in much of the southwestern United States during the course of a year.

Rapid Retrieval

Finally, rapid retrieval is very important. Contractual demands and a limited budget require that the necessary data be obtained almost immediately. This problem is somewhat ameliorated by the fact that the actual cost of the material generally is not a limiting factor in research efforts. The cost of the consultant's time is far greater than that of most research materials. Any reduction of research time, generally charged in the range of $40 to $60 per hour, easily compensates for the cost of most research materials, whether it be for the publications themselves or copies, and commonly, whether there is a direct or only a peripheral connection to the project.

TYPES AND SOURCES OF RESEARCH MATERIALS

The types of research materials available and their sources in southern California are quite diverse and certainly unique to that area. However, their description may be found useful for other parts of the country.

Periodic or Recurring Data

Periodic or recurring data include rainfall depths and intensities, stream flows, seismic events, ground-water levels, tide levels and similar information. These are produced almost entirely by government agencies. Agencies performing this function in California include city and county engineering facilities, state agencies, particularly the Department of Water Resources and the Division of Mines and Geology, and the U.S. Geological Survey. In addition, there are many types of quasi-governmental entities such as county flood control districts, that maintain records. There is a growing effort to store these data for automatic retrieval.

Pictorial Materials

Foremost among pictorial materials utilized by the consultant are geologic maps, particularly regional maps, that indicate the general geologic characteristics of a project site and related references. The Geologic Atlas of California published by the Division of Mines and Geology, which includes 27 1:250,000 sheets, is an excellent example of this type of material. More detailed geologic maps also are of great value, of course. The main sources are public agencies and college libraries.

Topographic maps are very important. The 1:24,000, 7.5-minute U.S. Geological Survey quadrangles are quite helpful, but most engineering geology problems require maps of larger scale. Most commonly used are 20- to 200-scale maps; and if they are not available they have to be produced. Fortunately, due to interest in property development, some areas in southern California have been topographically mapped by various municipal agencies. Funds expended for these materials have been justified many times over in terms of their research value.

Aerial photographs are a third type of pictorial data of great importance. These are used primarily for geologic mapping and to compare terrain changes. Both governmental agencies and private firms have collections of such photographs, particularly of the stereo-pair variety, and most are for sale. However, it is fairly common for the consulting engineering geologist to contract for aerial photographs if they are not available, because like other research materials, the capital investment represented by the project and the usefulness of the photographs easily justifies the cost.

Political boundary maps are a fourth type of useful pictorial material. These include tax assessor's maps, city or county street and house numbering maps, and related materials that are invariably a part of municipal business. Maps produced by such agencies as the National Forest Service or the Bureau of Land Management can also be of use.

Analytical Publications

Analytical publications, which make up the bulk of a geology library collection, are required by the engineering geologist who, like others, occasionally needs review and additional education. They include descriptive studies, theoretical studies, studies of applied theory, and various types of reviews; in other words, the information generally contained in texts, journals, and certain publications of research-oriented government agencies. Of special value to the consultant are reviews of the literature, both those relating to fundamental advances in the science as is commonly presented in texts as well as the more current reviews such as annual reviews, reports of symposia, state-of-the-art studies, summaries of research in progress, and field guides. Book reviews are especially helpful.

Industrial Publications

Certain industrial publications have considerable value, and the fact that they are a form of advertisement is irrelevant. Generally, professionals easily distinguish puffery from useful information. Well known industrial publications such as those of the Portland Cement Association, the newsletters of the Edward E. Johnson, Inc., a water well screen manufacturing firm, and certain handbooks are quite reliable and widely utilized by consultants.

Catalogs are useful as references both with regard to costs and technological advances. Data commonly sought by the engineering geologist are those relating to the rental or purchase of equipment used in field exploration and field and laboratory equipment for water quality or mineralogical analysis. Also of considerable value are catalogs and handbooks on pumps, water level and flow measurement equipment, and automatic recording devices.

Engineering Publications

The engineering geologist depends to a considerable extent upon certain publications that commonly are found only in engineering libraries. The most useful information is that relating to soils engineering, water supply, and coastal engineering. Of particular value are the journals of the American Society of Civil Engineers and the American Water Works Association, and research materials generated by the U.S. Army Corps of Engineers.

Legal References

There are three types of legal references of considerable value to the engineering geologist. One is the various municipal codes relating to the local permit process for construction. These include planning and building codes, and the regulations relating to the construction of waste-water disposal facilities, commonly contained in either a health code or a plumbing code.

The second type are the state statues relating to the profession of engineering geology. These are contained in the various state codes such as the business and professions code, and those statutes that come within the general purview of resources and conservation.

A third type of legal reference includes analyses of bodies of law relating to geology. A good example is that published by the State of California in cooperation with the United States Department of Agriculture entitled, "The California Law of Water Rights," by Wells A. Hutchins, and a similar volume entitled, "Water Rights Laws in the Nineteen Western States, Volume I," by Hutchins completed posthumously by Harold H. Ellis and J. Peter Debraal. Another example is that published by the Continuing Education of the Bar in California relating to landslide risk and liability.

SPECIAL PROBLEMS IN THE RESEARCH PROCESS

It may come as no surprise that consulting engineering geologists generally do not "keep current" in the accepted sense. Rather, they keep aware and get current, i.e., they attempt to keep aware of the availability of research materials through a more or less systematic process of inquiry, and when the need arises in the form of a particular project, they get current by collecting whatever data are available. To keep aware, periodicals such as "Geotimes," "California Geology," the AGU "Transactions," and the GSA's "Geology," are very useful.

Geology, engineering, research and law libraries such as those of the University of California, Los Angeles, satisfy to a considerable extent the research requirements of the consulting engineering geologist. However, there are three especially important problems the engineering geologist encounters in research of which the geoscience information specialist should be aware.

Inadequacy of Word Indexing

Possibly because of the broad scope of his work, and no doubt due in part to the burgeoning nature of geologic science, the engineering geologist is finding the standard reference technique of word indexing by subject, name, or place, inadequate. Computerized word index systems are of some value, since they fail to find references more quickly than one fails to find them on one's own.

The problem occurs primarily where the subject matter does not closely correspond to a reference title. An example I encountered recently involved documenting whether or not vibrations caused by heavy truck traffic could cause resonance to the extent that a landslide could develop. Somewhere, this problem may have been addressed; but to learn of it will involve reviewing many titles containing such key words as "vibration," "resonance," etc., and then obtaining for reading likely ones, a very tedious process.

Source Dispersal

Another problem is that of source dispersal. No geoscience information service can possibly supply all the references the consulting engineering geologist may require, although in a metropolitan area such as Los Angeles, adequate sources exist within a radius of about 50 miles. Systems of interlibrary loans exist, but generally they are not well developed and take too much time.

The Public Agency Jungle

A third problem facing the engineering geologist is that of making his way through the jungle of public agencies. There are extremely valuable reference sources within the various public agencies, but their usefulness is limited by the fact that the available data and the processes of retrieval are virtually unknown to the uninitiated.

To use California as an example, certain agencies such as the Department of Water Resources and the divisions of Mines and Geology and Oil and Gas have as one of their main functions the distribution of technical information, and these are well known to consultants. With a little experience, one learns that much information is available from agencies such as the Division of Highways, flood control districts, and soil conservation districts. Less well known are sources such as the State Water Rights Board, the Department of Navigation and Ocean Development, county improvement districts and water resources districts. Perhaps most obscure of all are the various offices within a single municipal entity, where even the employees commonly are unaware, outside their own offices, of data available from departments of surveying, zoning, building and safety, engineering, roads, health, and the like.

A similar hierarchy exists in the federal complex starting with the U.S. Geological Survey, clearly the best single source of geoscience data by any measure. The U.S. Army Corps of Engineers, NOAA's National Ocean Survey and National Climatic Center and Interior's Bureau of Mines also are valuable. Less well known are publications by such agencies as Interior's Bureau of Reclamation, the Department of Agriculture and those spasmodically produced by a continuously stirred melange of national resources and research boards, commissions, committees, councils and study groups.

Government research installations such as the Jet Propulsion Laboratory and private firms such as the Rand Corporation form a third group of agencies of a public or quasi-public nature that may be a source of useful geoscience data. However, there seems to be no ready means of access to their publications.

SUGGESTED IMPROVEMENTS

There is a number of improvements that would assist the engineering geologist in his research. They would be of considerable benefit to other specialists as well.

Photo Index Collection

Photo indexes for flights of stereo-pair coverage are valuable references. These include either schematic drawings keyed to some grid system such as township and range lines or a single montage photograph, commonly about two feet square, of the actual photographs. The latter is preferable, since it gives some idea of the quality of the prints as well as the coverage.

Generally, photo indexes can be obtained only at the few widely dispersed offices from which the photographs are available. A geology library that includes maps in its collection can certainly obtain and store photo indexes for much if not all of the state in which the library is located and probably for other areas as well.

More Complete Collection of Current-review Documents

Current-review documents, as previously mentioned, include those analytical materials which by their nature are intended to bring segments of the professional community up to date. Reports of symposia, state-of-the-art studies, summaries of research in progress and field guides are typical of these references. Most are produced in very limited editions, and that probably is the reason they sometimes are not included in library collections. This is unfortunate, since in them are found valuable data and provocative ideas which, for one reason or another, never attain a more formal level of publication.

It should be the business of librarians to keep aware of the more local events that commonly give rise to current-review documents. And those in charge of such events should make available to the libraries the documents generated.

Comprehensive Book Review Publication

The large and growing number of texts produced annually underscores the need for an efficient means of review. Aside from examination of the volume itself, the independent book review is the only efficient means of evaluation. However, book reviews are widely dispersed in various publications. A single publication that periodically reviews geoscience books would be very helpful. Good reviews now go unread simply because of the time necessary to obtain the various publications in which they appear.

Efficient Inter-library Loan Service

A fairly efficient system is available in some libraries in southern California to determine locations of particular publications. It utilizes micro-fische transparencies and a special viewer with which it is relatively easy to locate one or more sources. Nevertheless, the problem of obtaining the publication remains.

Inter-library loan systems, where they exist, seem to operate excessively slowly. It is not uncommon to take a week or more to have a publication sent from one library to another less than 30 miles away. The problem lies in delivery, since a telephone call from the requesting library and retrieval at the sending library should not take more than a few minutes.

There are bonded services that for a fee will pick up and deliver such articles as books within a matter of a few hours or a day at the most. The only thing that seems to be needed is efficiency in implementing such a system. As in the case of other research material costs, the consulting engineering geologist can easily justify a fee to cover the costs of delivery and special service required.

Research for Peripheral Data

There is a significant need for research to identify sources of data from within industry, the legal profession, and the public and quasi-public agency complex. The engineering geologist could especially benefit from research that would establish a basis for "cross-fertilization" between engineering and geology. Ultimately, an engineering geology archives would best meet this problem.

Most consultants have a working knowledge of these types of materials, and they have developed their own reference collections and techniques for acquisition. But this takes years. A compilation and synthesis of these materials would be of great value to younger members of the profession.

"Shepardizing"

A solution to the problem geologists experience in using the key-word research technique may lie in initiating a system similar to that which has been used for many years by the legal profession. In legal research, it is important to know the manner in which a court decision has been utilized in subsequent decisions. This otherwise formidable research task is simplified by listing for each reported case, all subsequent references to it by use of a simple code. A Shepard citator provides, for each reported case code designation, a list of similar designations which shows, for that case, subsequently published opinions referring to it. In addition, a series of script marks indicates in general terms the use that the referencing opinion makes of the particular case in question. This system could easily be applied to the more important geology publications.

A publication provides basically two kinds of data. First, the work itself, and second, the bibilography. It brings the researcher up to the date of the publication of the article and hence is retroactive. If the article could be "shepardized," a list of references that have referred to it since its publication also would be available. The shepardizing technique is thus prospective in nature. The Science Citation Index provides a certain degree of prospectiveness. However, its use is limited in that it is not cumulative, it is not limited to geoscience, and it provides no means to evaluate the referencing article.

It is the prospective character of the shepardizing technique that gives it so much value. This is especially so since certain publications are far more valuable than others and give rise to whole new lines of research. A single key article can provide an invaluable vehicle to take the researcher forward from the time of its publication with a major savings in effort.

INFORMATION AND DATA SERVICES OF THE U.S. GEOLOGICAL SURVEY'S NATIONAL MAPPING DIVISION

Gary W. North

U.S. Geological Survey
341 National Center
Reston, Virginia 22092

ABSTRACT: In November 1979 the Department of the Interior approved the U.S. Geological Survey's request to combine its Topographic Division, Publications Division, and Geography Program into a new National Mapping Division. As part of that reorganization an Office of Information and Data Services has been established. This office has the responsibility for the National Cartographic Information Center, and the Survey's Public Inquiries Offices. Two new branches were established for publications liaison and review and for product distribution policy. This paper discusses the programs and services and includes information about the Map and Chart Information System (MCIS), the Aerial Photography Summary Record System (APSRS), the Geographic Names Information System (GNIS), the Geographic Information, Research and Analysis System (GIRAS), and the Open-File Services Section (OFSS). To insure that the customer's needs are met, new programs for marketing, packaging, advertising, and distributing earth-science products are being tried.

Efforts are also underway to open a series of State-level points of contact and to establish continuing ties with various earth-science professional societies and associations.

INTRODUCTION

On November 30, 1979, the Department of the Interior approved a Geological Survey reorganization plan to merge its Topographic and Publications Divisions along with its Geography Program into a National Mapping Division.

As the Nation's primary civilian mapping organization, the National Mapping Division conducts a nationwide program to provide the public with geographic and cartographic information, maps, technical assistance, and related earth-science data and research results. The Division collects, compiles, and analyzes information about natural and manmade features on the Earth's surface and documents changes as appropriate through the production and maintenance of accurate general-purpose base maps and thematic products such as land use/land cover maps. In addition, it develops and maintains a digital geographic/cartographic data base for multipurpose needs and assists other Federal and State agencies in developing and applying spatial data; conducts geographic, cartographic, and map reproduction research; provides thematic mapping support to other Federal agencies; prints topographic, geologic, hydrologic, land use, and other thematic maps; and operates an information and technical assistance service which gathers, indexes, analyzes, and catalogs geographic and cartographic information. The Division coordinates Federal mapping activities and provides leadership in the development and advancement of geographic information systems, cartographic and geographic classification systems, and surveying and mapping technology. The product and information services are needed to support programs and activities of dozens of Federal agencies and hundreds of State, local, and metropolitan governments, universities, research institutions, and the general public.

The U.S. Geological Survey is the only Federal agency concerned entirely with large-scale national topographic mapping with directed authority to coordinate Federal mapping and Federal mapping priorities. This leadership role enables the National Mapping Division to concentrate on completion of national map coverage, maintenance of that map coverage, and research and development to advance mapping techniques, and to provide cartographic and geographic information to the many agencies who have similar interests, responsibilities, and requirements.

INFORMATION AND DATA SERVICES

The Information and Data Services (IDS) Office of the National Mapping Division is responsible for planning and developing policies and procedures for: (1) managing the information and distribution activities of the Division, the National Cartographic Information Center, and the Public Inquiry Offices; (2) developing and conducting cartographic and geographic information assistance programs; (3) coordinating telecommunications support; (4) designing and programming computer software for cartographic and geographic information and distribution systems; (5) providing assistance for contracting activities related to printing technical standards, leaflets, speeches, and manuscripts produced by various components of the Division; and (6) coordinating marketing, packaging, advertising, and dealer/distributor programs.

National Cartographic Information Center

The National Cartographic Information Center (NCIC) was established in 1974 to act as a clearinghouse for the Nation's cartographic information. "Cartographic data" is defined as maps and charts, aerial and space imagery, geodetic data, and map data in digital form. Geographic data and information have been added to the scope of this IDS component and includes land use/land cover data and geographic names information.

The NCIC operates seven major information systems that contain data from Federal, State, local government and private sector organizations. Unique among other Federal agency programs, NCIC, for example, has over 70 private companies submitting data for entry into one of the systems. The major systems are:

o Cartographic Catalog

The Cartographic Catalog describes maps and charts, aerial photographs and images, geodetic control data, map data in digital form, and cartographically related books, studies, indexes, and reports. Because entries are brief, the Catalog is used primarily to direct researchers to other NCIC data bases for more detailed information.

The Catalog is an automated encyclopedia of cartographic information and contains over 40,000 records from the Library of Congress. Information in the Catalog is output in two forms: Standard microfiche and custom listings. The custom listings are processed either online using interactive terminals in the USGS teleprocessing network, or by the USGS computer facility at the National Center.

The outputs from the Cartographic Catalog contain all item descriptions contained in the data base for each entry. The outputs are divided into two sets, each containing the same information but in different sequence. Set 1 is grouped by State, and sequenced by type of product within a geographic area. For example, similar products related to Imperial Valley, California, are grouped together and listed alphabetically. Set 2 is also grouped by State, but is sequenced by the geographic area the product type covers. A comparison of the two sets follows:

Sequence of Set 1	Sequence of Set 2
California	California
Imperial Valley	Recreational Facilities
Drainage and Sewerage	Barstow
Roads and Streets	Contra Costs County
Transit	Death Valley
Water Supply	Half Moon Bay
Flood Control/Hydraulics	Imperial Valley
Recreational Facilities	Monterey
Public Safety Systems	Palo Alto
etc.	etc.

- Aerial Photography Summary Record System (APSRS)

APSRS is a computerized system for gathering and distributing information about aerial photographs. This system can identify and describe over 12,000,000 photos that have been collected by various agencies and companies. Catalogs are produced for the public and special computer searches and graphic plots are used to help locate particular data. Catalogs are available for each State. Lists of photographs are available on microfiche.

The building block of APSRS is the summary record. These records are prepared by each contributor to describe blocks of aerial photographs held by their organizations. To be included in one summary record the photographs must: (1) Be held by the same contributor; (2) have been taken at approximately the same time; (3) be the same scale; (4) be on the same type film; and (5) cover an area which approximates the 7.5-minute topographic quadrangle map.

- Map and Chart Information Systems (MCIS)

MCIS is a system for organizing information about domestic maps and charts. This system currently holds and outputs information on over 200,000 of the Nation's maps and charts.

The MCIS file comprises records containing the name, scale, publisher, publication, revision, and survey dates, content, and the geographic bounds of each map or chart entered. Data may also be entered describing insets, irregular boundaries, historical information, map editions, and other significant features. Where possible, these computer descriptions are supplemented by 35-mm roll film copies of the map.

Information in the MCIS file can be retrieved by any map descriptor as well as by area of coverage. Periodically, the entire content of the file is reproduced on microfiche in sequence by type of product, latitude/longitude, or State/county. The MCIS also contains a graphic display program which plots the location of the different types of maps and charts and numerically indexes them to a descriptive report. Inquiries can be made to meet specific customer requests.

o Geographic Names Information System (GNIS)

GNIS is a computerized file of all the significant place and feature names from the Nation's topographic maps. The system is developed and operated under the auspices of the Board on Geographic Names and data are made available on request to the public. Approximately 1,300,000 records are handled by the system. A series of State gazetteers is currently being produced based on the names in this system.

o Geodetic Information System

NCIC cooperates with the National Oceanic and Atmospheric Administration's (NOAA) National Geodetic Information Service (NGIS) to provide them with information on the Geological Survey's horizontal and vertical measurements of geodetic control points in the United States. NCIC also maintains a file of Geological Survey geodetic data to service the public when required.

o Geographic Information Research and Analysis System (GIRAS)

GIRAS holds the digital land use/land cover data for the United States. Technical assistance programs are also conducted in conjunction with the use of this data to assist State and local users.

The land use and land cover maps are compiled on planimetric base maps prepared by the Geological Survey at scales of 1:250,000 or 1:100,000. As more 1:100,000-scale planimetric base maps become available, more map sets will be prepared at that scale. Most of the maps will be published at a scale of 1:250,000. Updating of land use and land cover maps will be at a scale 1:100,000 for areas where such a scale should be used to properly represent complex land use and land cover patterns.

The land use and land cover and associated maps currently available are shown in the "Index to Land Use and Land Cover and Associated Maps" published by the U.S. Geological Survey.

Sets of four associated maps are prepared at the same scale as the land use/land cover maps in order to relate those maps to other data. For example, land use data can be combined with the socioeconomic data compiled by the Bureau of Census by census county subdivisions or census tracts or can be compared to hydrologic data compiled for hydrologic units. These associated maps are: (1) Political Units, which depict county and State boundaries as shown on U.S. Geological Survey maps; (2) Hydrologic Units, which delineate hydrologic units as established by the Water Resources Council and published by the Survey's Water Resources Division on 1:500,000-scale State maps; (3) Census County Subdivisions, which show minor civil divisions or equivalent areas. Census tracts also are shown within Standard Metropolitan Statistical Areas (SMSA); and (4) Federal Land Ownership, which delineates surface ownership in a minimum mapping unit size of 40 acres (16 hectares) for lands owned and administered by Federal agencies. Subsurface ownership rights are not shown.

- o Digital cartographic data files

Various cartographic data in digital form are now handled by NCIC. For example, approximately 1,000 digital terrain tapes from the Defense Mapping Agency are maintained and distributed to the public. In addition, data such as that from the National Wetlands Inventory Program will be made available through NCIC. Digital elevation models and digital line graphs related to the National Mapping Division's 7.5-minute topographic quadrangle maps are also being released through NCIC.

The NCIC operates its nationwide program through regional offices and, currently, twenty-seven State-affiliated offices in State capitals. It is hoped that every State will establish an affiliated office to better serve the public. Through the various offices over 225,000 inquiries are received and handled each year.

NCIC offices are located at:

Headquarters, National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, VA 22092
(Telephone 703-860-6045)

Eastern Mapping Center
National Cartographic Information Center
U.S. Geological Survey
536 National Center
Reston, VA 22092
(Telephone 703-860-6336)

Mid-Continent Mapping Center
National Cartographic Information Center
U.S. Geological Survey
1400 Independence Road
Rolla, MO 65401
(Telephone 314-341-0851)

Rocky Mountain Mapping Center
National Cartographic Information Center
U.S. Geological Survey
Box 25046, Federal Center
Denver, CO 80225
(Telephone 303-234-2326)

Western Mapping Center
National Cartographic Information Center
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025
(Telephone 415-323-8111 x2427)

National Space Technology Laboratories
National Cartographic Information Center
U.S. Geological Survey
NSTL Station, MS 39529
(Telephone 601-688-3544)

Check with any of these offices for information concerning your nearest State-affiliated office.

The NCIC program office in Reston, Virginia, is comprised of three branches, each responsible for unique aspects of the overall mission.

Systems Branch.--The Systems Branch designs and updates (through contract or in-house) information systems for cartographic and geographic information; designs, maintains, implements, and modifies an integrated map inventory, storage, and distribution system; designs and implements an ordering and accounting system for "sale" products; designs a telecommunications network linking all IDS and other agency offices into both the information and accounting systems; and trains people in the proper use of all systems unique to this activity.

Data Acquisitions and Systems Maintenance Branch.--The Data Acquisitions and Systems Maintenance Branch locates, organizes, and processes cartographic and geographic information into selected information systems; manages and maintains all geographic and cartographic information data bases to maintain accurate data; creates standard output products such as catalogs and indexes from data bases; develops necessary documentation for using the information products; responds to requests for nonstandard information and products; organizes and holds workshops and training sessions for data entry by contributors and affiliates; and provides technical expertise and assistance in the use of graphic and digital mapping products.

User Services Branch.--The User Services Branch provides professional responses to requests for information received by telephone, letter, or during personal visits; conducts indepth information and product research to answer customer inquiries through the use of microfilm, the automated systems, and by analyzing other Federal, State, and private sector products; conducts technical assistance projects which assist customers in learning how to use cartographic and geographic data and information in both graphic and digital form; develops statistics and reports on customer orders; and handles the sale of various cartographic and geographic products, such as digital terrain tapes, aerial photographs, geodetic control, microform products, gazetteers, and land-use tapes.

Public Inquiries Office

The U.S. Geological Survey maintains ten Public Inquiries Offices (PIO's) to provide convenient public contact for obtaining information regarding the work of the Survey and its publications (book reports, maps, nontechnical publications, indexes, catalogs, and open-file reports). PIO's maintain reference libraries of Survey books for public use and serve as depositories for selected open-file reports. Several of them maintain browse files and optical viewers for aircraft and satellite imagery of the United States and some foreign areas.

All PIO's serve as sales agents for the Superintendent of Documents and provide over-the-counter and mail-order service for Geological Survey book reports of their geographic area and selected Survey reports of general interest. Each office is a sales outlet for Geological Survey maps relating to its geographic area and for selected Survey maps of general interest. The PIO's also provide referral assistance to other Geological Survey offices and programs, other Federal and State agencies, and conduct public relations activities at the local level.

The Public Inquiries Offices are located at:

ALASKA
108 Skyline Bldg.
508 Second Ave.
Anchorage, AK 99501
(Telephone 907-277-0577)

DISTRICT OF COLUMBIA
1028 General Services Bldg.
19th and F. Sts., NW
Washington, D.C. 20244
(Telephone 202-343-8073)

CALIFORNIA
7638 Federal Bldg.
300 N. Los Angeles St.
Los Angeles, CA 90012
(Telephone 213-688-2850)

CALIFORNIA
Room 122, Bldg. 3
345 Middlefield Road
Menlo Park, CA 94025
(Telephone 415-323-2817)

CALIFORNIA
504 Custom House
555 Battery St.
San Francisco, CA 94111
(Telephone 415-556-5627)

COLORADO
169 Federal Bldg.
1961 Stout Street
Denver, CO 80294
(Telephone 303-837-4169)

TEXAS
1C45 Federal Bldg.
1100 Commerce St.
Dallas, TX 75242
(Telephone 214-767-0198)

UTAH
8105 Federal Bldg.
125 S. State St.
Salt Lake City, UT 84138
(Telephone 801-524-5652)

VIRGINIA
302 National Center, Room 1C402
12201 Sunrise Valley Drive
Reston, VA 22092
(Telephone 703-860-6167)

WASHINGTON
678 U.S. Courthouse
West 920 Riverside Avenue
Spokane, WA 99201
(Telephone 509-456-2524)

Office of Product Distribution Policy

This office develops policy and procedures for the management of information and distribution activities relating to the Division's program for disseminating published maps, books, and other cartographic and geographic materials. It organizes and maintains sales indexes, catalogs, and operates a Management Information System for inventory control and sales analysis. It collects data needed to establish prices and develops marketing, packaging, advertising, and dealer programs. The office trains and assists non-Geological Survey outlets engaged in selling or distributing the products, publications, or information of the Geological Survey. Currently there are over 1,800 commercial dealers who distribute the topographic maps produced by the Geological Survey. Map dealers are offered a 30% discount rate on our map products as an incentive to participate in the program.

This office is also responsible for the administration of the map depository program. Currently there are over 780 maps libraries included in this program.

Office of Publications Liaison and Review

This office edits technical standards, leaflets, speeches, and publications produced by various organizational components of the Division; reviews manuscripts prepared by Division personnel; maintains liaison with the Government Printing Office (GPO), the Joint Committee on Printing (JCP), and commercial printers to expedite map printing. In addition, the office staff prepares guidelines and directions on editing and publication practices; provides technical assistance for printing services contracts; and coordinates the publications and design program for the Division.

OPEN-FILE SERVICES SECTION

Although not a part of IDS, the Open-File Services Section (OFSS) provides an important related service. Over 7,000 reports, maps and other materials prepared by personnel of the U.S. Geological Survey have recently been placed at a service facility in Denver, Colorado. This facility, known as the Open-File Services Section, provides microfiche or black-and-white paper duplicates of the open-file reports which for many years have been difficult for the public to acquire.

In January 1981 the Survey will begin providing the Government Printing Office with reproducible microfiche masters of these reports so that GPO can release microfiche copies of the reports to requesting Depository Libraries.

For additional information contact:

Open-File Services Section
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225

SUMMARY

For years the Topographic Division of the Geological Survey made maps and the Publications Division printed and distributed them. In addition, both Divisions operated separate information programs and dealer/distributor activities. With the creation of the National Mapping Division, the Survey has combined these associated programs in the public's best interest. For the first time in their history, the Survey's largest and most advanced information activities, NCIC and the PIO's, have been combined and further expanded by the addition of geographic and digital information and data. This allows the National Mapping Division to better serve the public, offer more complete cartographic and geographic data services, avoid duplicate programs, and streamline the public's access to earth-science information.

With the responsibility for the Division's overall product distribution policy in the Office of Information and Data Services, the public will receive a more rapid response to requests and greater access to the products and information produced by the Geological Survey. In addition, new packaging, marketing and advertising techniques will be tested, and an expanded program developed to involve the private sector in the distribution and sale of the various products.

These programs are highly dynamic and continuously changed to reflect national needs. It is critical that the program efforts be continually adjusted and modified to provide customers with information needed to solve increasingly complex problems associated with land use policies, resource studies, and socioeconomic planning.

KEEPING CURRENT IN THE GEOSCIENCES:
CURRENT AWARENESS LITERATURE SEARCHES

Melissa A. Litton

SDC Search Service
5680 S. Syracuse, Suite 300, Englewood, CO 80111

Abstract: Regular SDI (Selective Dissemination of Information, or current awareness) computerized literature searches, generated either manually or automatically against major international databases, provide an important means of keeping current in the geosciences. Sets of terms describing pertinent topics are stored in the computer, then recalled monthly, weekly, or bimonthly against the latest literature input into the computer. These sets of terms can be recalled manually by a searcher at the terminal, who may then generate the listing. Or a set of terms can be automatically recalled by the computer itself whenever updates to designated databases are loaded into the computer.

Suggested databases for comprehensive current awareness in the geosciences are GEOREF (produced by the American Geological Institute) TULSA (from the University of Tulsa), Cold Regions (from the Army Corps of Engineers), and NTIS (produced by the National Technical Information Service). Most major publications by major and regional geoscience societies, as well as items from over 4,000 journals, are included among these four databases.

Procedures and costs for generating an SDIPROFILE are shown.

Selective Dissemination of Information (SDI) literature searches are an effective tool for maintaining current awareness on selected topics in the geosciences. What, then, are SDI searches, why generate them, and how can they be used in keeping current? What is the process itself for generating an SDI? What are SDI costs? These and other questions will be answered in the body of this paper.

The term SDI denotes disseminating information on selected topics at regular intervals. In literature searching, SDI is retrieving references from the latest update of a computerized database of citations to journal articles, technical reports, maps, conference proceedings, theses, books, U. S. government hearings, newspaper articles, speeches, etc. Most technical databases like GEOREF are updated monthly. Many news or government files, like P/E News (Petroleum and Energy News from API) or FEDREG (Federal Register), are updated weekly.

What are these databases of literature? They are the computerized versions of the indexes one finds in a library. In the geosciences, some of these printed indices and their computerized counterparts are Bibliography and Index of Geology (GEOREF), Petroleum Abstracts (TULSA), Antarctic Bibliography (COLD), and Government Reports Announcements (NTIS). These databases are international in scope and cover thousands of publications. In contrast, a news or business database may consist of references from the Denver Post, Houston Chronicle, Oil and Gas Journal, Petroleum Intelligence Weekly, or Wall Street Journal. Government databases are computerized versions of Federal Register (FEDREG), Congressional Record (CRECORD), or U. S. government hearings (CIS).

For comprehensive current awareness on a pertinent topic, it may be most useful to generate a search against news and government, as well as technical files. Papers retrieved from GEOREF can provide technical geological information on, say, a find in a particular area. The same search on the news files can provide articles on who is developing the find, how much is being invested, when, etc. Still another run against the Federal Register (FEDREG) or the U. S. government hearings database (CIS) can retrieve government announcements, regulations, and any new bills impacting the find. Comprehensive searches like these can be especially beneficial to technical managers with fiscal responsibility.

Obviously, the greatest advantage to using a computerized current awareness system is not having to manually check several topics in several printed indexes on a weekly or monthly basis. This process can be generated automatically on the computer. Or, several topics can be stored, and manually recalled at the terminal on a regular basis. In addition, a computerized system can provide access to indices not currently subscribed to by a searcher. One need not subscribe to Government Reports Announcements, for example, to search its computerized counterpart, NTIS.

What is the process for generating a current awareness search on SDC? First, using the STORE or STOREOLD commands, the searcher permanently stores sets of terms designating the desired topic. These sets of terms may be broad subjects, like a popular geologic formation or mineral type. Or they may be sets of synonyms or terms of equal value, "anded" together to retrieve a specific topic, for example: (oil or gas or petroleum) and (Prudhoe or Alaska).

These stored topics, with names assigned by the searcher for easy recall, can be used in two ways for current awareness. A searcher can enter an SDIPROFILE, instructing the computer to automatically generate specified stored searches against designated database updates (weekly or monthly, depending on the database). The bibliography generated is then printed by the SDC computer in Santa Monica, California, and mailed to the requestor. A second option is available to the searcher who prefers to recall the stored searches manually on the computer whenever the latest updates are available. A searcher recalls the stored search within a chosen database, then "ands" that set with the code for the most recent update to that database. This four-digit code always appears upon logging in to the database or can be listed in using the UPDATES command.

The literature searches has total flexibility in inputting and in recalling stored searches. Up to eight groups of up to 30 sets, each of up to 256 characters each, can be stored and recalled against a single userid on a regular basis. In addition, the searcher can generate a display of current SDIPROFILES (using the SHOWSDI command) or delete any SDIPROFILES (using the PURGESDI command).

Costs for SDC/SDI searches are based on a per-run charge ranging from \$2.50 to \$5.00 per update run, plus a per-item charge ranging from \$.08 to \$.50 per citation retrieved. For example, a monthly update on the COLD database costs \$2.50 per-run, plus \$.15 per reference generated.

In sum, SDC current awareness literature searching provides a comprehensive, systematic review process for the geosciences in the technical, business, news, and government areas. Terms and topics searched, length of time a topic is run, as well as all costs generated, are directly controlled by the searcher. An SDC/SDI search can be loaded, generated, modified, and/or deleted at any time by the searcher at the terminal.

Figure 1: The Explanation Which Results from the Command SDI

?SDI

Prog:
SDI (Selective Dissemination of Information) provides automatic searching of updates to user-specified databases for a stored search strategy. Citations are mailed in the form of offline prints. For a list of available databases and prices, enter explain SDI PRICES. To enter an SDIPROFILE, you must first store a search (see EXPLAIN STORE). To initiate the SDI search, enter SDIPROFILE. The system then asks you to enter up to 6 databases for subsequent searching. ORBIT then prompts you to enter the name of the stored search to be used. Next you are prompted to enter a print command. SDI prints can only be produced from the last search statement: do not specify earlier ss numbers. SORT is also unavailable in SDI. Tailored print commands can be used only if they are entered in the database in which the SDI is to be executed. After the PRINT command, the system asks for name, address (unless STORAD has been included), requestor and title. You are then asked to verify the information with y, n, or c. N will return you to the beginning of the SDIPROFILE sequence. The SDI may be cancelled at any point in the sequence by entering a space and carriage return on a new line.

SDIPROFILE	To enter and SDI Search
SHOWSDI	Lists Stored SDI Profiles with task nos.
PURGESDI (followed by task no.)	To delete unwanted profiles

FIGURE 2: Prices for SDI on Databases Relevant to the Geosciences

	Base Charge (Includes Royalties)	Citation Charge
BIOSIS	2.80	.10
CAS77	2.50	.16
COLD	2.50	.15
COMPENDEX	2.82	.10
CONFERENCE PAPERS	4.50	.15
GEOREF	3.00	.20
GRANTS	3.33	.35
INSPEC	5.00	.15
NTIS	2.85	.08
OCEANIC	5.00	.11
POLLUTION	5.00	.15
TULSA (major subs)	3.40	.50
(minor subs)	4.75	.15

GEOREF COVERAGE AND IMPROVEMENTS IN THE BIBLIOGRAPHY AND INDEX OF GEOLOGY

John G. Mulvihill

American Geological Institute
One Skyline Place-5205 Leesburg Pike, Falls Church, VA 22041

Abstract: Of the 640,000 citations in GeoRef, those produced from 1975 through 1980 are analyzed by field of interest, document type-bibliographic level, and publication year. Less detailed analysis is provided for citations prepared prior to 1975.

In 1981, GeoRef coverage will be improved by an exchange of references with Bureau de Recherches Géologiques et Minières and Centre National de la Recherche Scientifique. Early coverage will be extended through addition of references from the Bibliography and Index of North American Geology, 1785-1960 and from the Bibliography and Index of Geology Exclusive of North America, 1933-1966.

Steps to improve the Bibliography and Index of Geology in 1981 relate to authors' names, affiliations, ISDS Key Titles, the lag time for citation publication, and a 10% increase in number of citations.

GeoRef Coverage

Subfiles. The GeoRef data base consists of five subfiles (Table 1). These contain North American citations from 1961 to date and citations to other areas from 1967 to date. Each of these subfiles can be searched separately or they can be searched as a single entity.

Our Backfile Project to add to Subfiles N and E will extend the North American coverage back to 1785 and coverage of other areas back to 1933. This addition, partly funded by a grant from the United States Geological Survey, is scheduled for completion in 1982.

Data Elements. The data elements in GeoRef changed in October 1975 when AGI adopted the format and data elements specified in the UNISIST-ICSU/AB Reference Manual for Machine-Readable Bibliographic Data.

The data elements found in citations numbered below 75-24700 are GeoRef Status 1 records (Table 2). These data elements are fewer and less well-defined than those now in use, but were adequate for production of printed Bibliographies, which was their intended purpose.

The GeoRef Status 2 records (Table 3), citations numbered 75-24700 and higher, include a number of data elements not found in the earlier records. These data elements are Reference Manual data elements plus some added for the GeoRef application. They are better suited for exchange of citations with other data bases, give us greater capacity to produce special publications, and offer more access points for searching. The following data elements are searchable online in Status 2 records but not in Status 1: document type, bibliographic level, affiliation, ISSN, ISBN, country of publication, report number, and, from 1977 on, coordinates.

We have analyzed recent citations in GeoRef by field of interest, document type-bibliographic level, and publication year.

Fields of Interest. Since January 1975, 29 Fields of Interest have been in use in GeoRef. Each citation is assigned to one of the 29. The citation section of the monthly Bibliography and Index of Geology is subdivided into these Fields. Table 4 shows the percentage of references in each Field for the years 1975-1980.

Trends in GeoRef coverage can be seen. Several factors are at work such as the decision on our part to cover geophysics more extensively, growth in the literature of engineering and environmental geology, and our project to continue the Bibliography of Fossil Vertebrates series.

Since each citation is assigned only one field, in estimating the total citations pertaining to a field, related citations in other fields should be considered.

Prior to 1975 there were 21 Fields of Interest. These occur in Subfile B and in Subfile E (1967-1968) only.

Document Type-Bibliographic Level. The ability to isolate document types and bibliographic levels came with the adoption of the Reference Manual, i.e., with Status 2 citations. Type and level are fundamental to the Reference Manual since they are the key to deciding which data elements are appropriate for a given document. The following document types occur in GeoRef: serial, book, thesis, report, map, and conference (Table 5). These are combined with bibliographic levels, i.e. the level of the citation. The levels are: analytic, monographic, collective and serial.

Beginning in 1978 we permitted a citation to have more than one document type. This is because a report or a conference proceedings may also be a serial (and usually is), a book may include a map in a pocket or a fold-out map, etc. In the new edition of the Reference Manual, to be published early in 1981, two basic document types are recognized, serial and monograph. Each citation is one or the other. The remaining document types are to be added to a citation as appropriate.

Document type is used to subdivide Fields of Interest in the Bibliography and Index of Geology. This helps the user to spot theses, meetings, etc. and puts the citations into a context which make them easier to follow.

From October 1975 through 1977, only one document type was permitted per citation, except that the document type conference could not stand alone. It was always used with either document type serial or book.

Prior to October 1975 only the document type thesis can be relied upon, and then only in searches of Subfiles T, E (1967-1968 only) and B. A search of document type thesis currently retrieves 19,579 theses in GeoRef, 1965 through 1980.

Publication Year. Table 6 shows the source document publication year vs the year its citation was added to GeoRef. It gives a rough measure of the currency of the data base. Some of the older citations, especially those to source documents over five years old, result from addition of citations for retrospective bibliographies.

We have taken steps to improve the currency of our citations. These include shifting to online input and editing, validation of newly keyed citations on-the-fly, and adjustments in staff levels. Improvements in turnaround time began to be evident in 1980 and should become more so in 1981.

Influences on GeoRef Coverage in 1981

Agreement with the French. The American Geological Institute has signed a three-year Agreement with France's Bureau de Recherches Géologiques et Minières and the Centre National de la Recherche Scientifique to achieve a more comprehensive coverage of the world's geological literature. The three organizations will contribute to a joint data base, with GeoRef editor/geologists providing citations to North American publications and BRGM-CNRS supplying the European citations. References to their own countries' literature will be furnished by West Germany, Spain, Romania, Poland, Czechoslovakia, Hungary and Finland. Responsibility for covering the literature of other areas of the world has been divided between GeoRef and the French organizations to insure world-wide coverage without duplication.

In preparation for this exchange we have compared serials lists to insure that all serials currently covered will continue to be covered. We have also spent weeks in comparing index terms to achieve a uniform indexing vocabulary in both French and English. And we have agreed on compatible indexing practices which will enable GeoRef to continue the three-level indexing in the Bibliography and Index of Geology and enable the French to produce the indices of the Bulletin Signalétique - Bibliographie des Sciences de la Terre. We have also agreed on a common set of data elements and an exchange format, namely, the UNISIST-ICSU/AB Reference Manual for Machine-Readable Bibliographic Data.

Special Bibliographies and Indexes. GeoRef coverage in 1981 will also be affected by work on:

A catalog of International Geological Correlation Programme publications

Indexes of the U. S. Geological Survey publications

Retrospective bibliographies on Mississippi and Louisiana

The Bibliography of Fossil Vertebrates series

Changes in the Bibliography and Index of Geology for 1981

Authors' Names. Authors' names will appear in the citations in the same form as given in the source document. If the source document gives initials, the citation will do so; if the source document includes full first name plus initial, the citation will do so, etc. But in the Author Index, initials only will be used. Also initials only will appear in the online files. Currently only initials are used in the citations and in the online files.

All authors, primary and secondary, will be given in the citation. Currently only the first three are given.

Author Index. In the Author Index, if a surname has multiple parts, these will be permuted, with an entry for each part of the surname; eg., Van Allen, J. F. will appear in the V's and in the A's. Each entry will refer directly to the citation by number. The unpermuted form will be used in the citations themselves. In the case of Chinese names, this will give an entry under each component of the name. Currently such names appear under one form only in the Author Index and this is determined by our editors.

Affiliations. The affiliations of primary authors will be included in the citations. Currently no affiliations appear in the Bibliography.

ISDS Key Title. The ISDS Key Title, unabbreviated, will gradually replace the title in the form currently used for serials in the citations. In the Serials List, Key Title and Publisher will be given for each serial.

We ask you to bear with us during this transition to ISDS Key Title, which will take at least two years. In this period some serials will have our old form and some the ISDS Key Title. In the monthly Bibliography and Index of Geology issues we will continue the practice begun this year of including for each serial its ISSN and/or CODEN, and the volume, issue and date of publication.

Abstracts. Short factual abstracts will be included in the Bibliography for some of the citations received from BRGM-CNRS. Currently no abstracts are included.

Size and Price. We expect to increase the number of citations in the Bibliography and Index of Geology by about 10%, from 52,500 in 1980 to about 57,750 in 1981.

And as you may already know, the price of the Bibliography is to increase from $750 to $825 in 1981.

TABLE 1 - GEOREF SUBFILES

Abbreviation	Subfile	Years in GeoRef
N	Bibliography and Index of North American Geology (The years 1785-1960 are to be added to GeoRef in 1981. The estimated number of references for this period is 140,000.)	1961-1970
G	Geophysical Abstracts (This is world wide in scope.)	1966-1971
T	Bibliography of Theses in Geology (This covered North American masters and doctoral theses. It was continued in 'B' below. The total number of theses in GeoRef, 1965 through 1980, is 19,579.)	1965-1966
E	Bibliography and Index of Geology Exclusive of North America (The years 1933-1966 are to be added to GeoRef in 1981. The estimated number of citations for this period is 148,000. Abstracts are included with their citations.)	1967-1968
B	Bibliography and Index of Geology (This is world wide in scope and in coverage continues subfiles N, G. T and E.)	1969 to date

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GeoRef presently (November 1980) has a total of 641,533 citations.

An additional 348,000 are to be added in 1981 in N, E, and B above.

TABLE 2 - GEOREF DATA ELEMENTS - STATUS 1 RECORDS

Subfiles N, G, T, E, and B (through No. 75-24699)

Name	Years in Use
Accession Number	1785-9/1975 (all subfiles)
Document type (S & T only)	1965-1966 (T) 1967-1968 (E) 1969-9/75 (B)
CODEN	1971-9/75 (B)
Category Code	1969-9/75 (B) 1967-1968 (E)
Title (Ø, 4)	1785-9/75 (all subfiles)
Author	1785-9/75 (all subfiles)
Inclusive reference	1785-9/75 (all subfiles)
Source (or degree level for DT T)	1785-9/75 (all subfiles)*
Collation (or degree year for DT T)	1785- 9/75 (all subfiles)*
Year of issue (or Degree granting institution for DT T)	1785-9/75 (all subfiles)*
Abstract	1933-1968 (E) 1964-1969 (N)
Index Term	1785-9/75 (all subfiles)
Language	1967-1968 (E) 1969-9/75 (B)
Annotation	1967-1968 (E) 1969-9/75 (B)
Source Note	1967-1968 (E) 1969-9/75 (B)
Year published in BIGENA & BIG	1967-1968 (E) 1969-9/75 (B)

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* This Degree information is in subfiles T, E & B only.

TABLE 3 - GEOREF DATA ELEMENTS - STATUS 2 RECORDS

Subfile B (No. 75-24700 and higher)

Reference Manual Data Elements		Data Elements Added for GeoRef
Document type	Corporate author-monographic	Category code
Bibliographic Level	Corporate author-collective	Abstract
Accession Number	Date of Issue	Index term
ISSN	Date of publication	Annotation
CODEN	Page numbers, inclusive	Illustrations
Serial Title, Abbreviated	Pages, number of	Scale
Volume of serial or volume-collective	Language code, text	Map type
Issue of serial or issue-collective	Language code, summary	Medium
Other issue ID	Publisher	Coordinates (9/77 to present)
Title-analytic	ISBN	Affiliation, other
Title-monographic	Edition	Source note
Title-collective	Conference name	Country of publication, serial
Person-analytic	Conference location	Year published in BIG (10/75 thru 1976)
Person-monographic	Conference date	Accession number in BIG (1977 to present)
Person-collective	Report Number	
Affiliation, primary-analytic	Degree-granting Institution	
Affiliation, primary-monographic	Degree Level	
Corporate author-analytic	Availability	
	References	
	Summary only	

TABLE 4 - FIELDS OF INTEREST

	Field	1975	1976	1977	1978	1979	6-6/80
1.	Mineralogy and crystallography	4.2	3.8	4.1	3.7	3.4	3.1
2.	Geochemistry	4.7	6.3	7.0	6.0	6.4	5.0
3.	Geochronology	1.0	1.8	1.1	.9	1.3	1.1
4.	Extraterrestrial geology	2.7	2.3	3.2	1.9	1.0	2.1
5.	Petrology, igneous and metamorphic	4.9	6.0	6.8	5.2	5.8	5.3
6.	Petrology, sedimentary	3.9	3.3	4.1	3.4	4.2	4.0
7.	Marine geology and oceanography	2.8	3.6	2.8	2.4	2.1	2.3
8.	Paleontology, general	.8	.7	.7	.6	.5	.5
9.	Paleontology, paleobotany	2.3	1.4	1.8	1.5	1.1	1.1
10.	Paleontology, invertebrate	3.5	3.1	2.8	3.1	2.7	2.7
11.	Paleontology, vertebrate	1.5	1.5	1.6	1.5	1.6	2.3
12.	Stratigraphy, historical geology and paleoecology	6.9	5.8	6.2	6.0	6.0	7.0
13.	Areal geology, general	4.0	1.3	1.3	1.6	1.5	1.9
14.	Areal geology, maps and charts	2.5	3.3	3.2	1.6	1.1	1.4
15.	Miscellaneous and mathematical geology	2.1	1.9	1.8	1.5	1.0	1.2
16.	Structural geology	3.6	3.8	4.4	4.1	4.0	3.8
17.	Geophysics, general	1.0	1.5	2.0	1.5	1.2	1.2
18.	Geophysics, solid-earth	2.1	2.6	2.7	2.9	3.0	3.6
19.	Geophysics, seismology	2.0	3.1	3.3	3.5	3.2	3.7
20.	Geophysics, applied	3.2	4.4	5.1	5.2	4.8	3.7
21.	Hydrogeology and hydrology	3.6	4.7	4.3	5.1	5.9	5.6
22.	Engineering and environmental geology	9.6	10.2	7.4	11.7	13.0	12.6
23.	Surficial geology, gemorphology	2.8	3.8	2.4	3.3	3.1	2.7
24.	Surficial geology, Quaternary geology	3.5	4.3	4.8	4.8	4.6	4.3
25.	Surficial geology, soils	1.1	1.9	1.4	2.4	1.6	1.4
26.	Economic geology, general and mining geology	3.6	2.5	1.8	2.2	2.5	2.1
27.	Economic geology, metals	7.5	4.7	5.8	5.8	5.6	5.5
28.	Economic geology, nonmetals	1.8	2.0	1.5	2.0	1.8	1.6
29.	Economic geology, energy sources	6.7	4.9	4.6	4.8	5.7	7.2

TABLE 5 - DOCUMENT TYPE-BIBLIOGRAPHIC LEVEL

	1978	1979	1-11/80
Serial-analytic	71.8	69.8	69.4
Serial-monographic	9.5	8.7	8.7
Book-analytic	10.2	10.2	11.2
Book-monographic	4.3	4.1	4.0
Report-analytic	.5	1.0	1.0
Report-monographic	3.2	5.2	4.7
Conference-monographic	1.0	1.2	1.2
Conference-analytic	28.2	28.2	27.6
Thesis	2.9	4.4	3.2
Map	4.3	5.0	5.7

TABLE 6 - PUBLICATION YEAR

	1976	1977	1978	1979
Current year	10.6	15.4	27.3	20.8
Year minus 1	34.7	38.4	36.0	47.4
Year minus 2	29.7	30.3	17.1	18.2
Year minus 3	11.6	7.0	8.0	8.1
Year minus 4	4.6	4.3	3.4	2.4
Earlier years	8.8	4.6	8.2	3.0

USE OF THE BIOSIS DATA BASE FOR RETRIEVAL OF GEOLOGY-RELATED INFORMATION

Edith S. Crockett and Ann L. Farren

BioSciences Information Service
2100 Arch Street, Philadelphia, PA 19103

Abstract: In recent years, as research activities have become more interdisciplinary, the usefulness of documents indexed and abstracted, by BioSciences Information Service (BIOSIS), to investigators in scientific disciplines other than biology has become increasingly evident. This has been shown to be particularly true in the geosciences, where subjects such as physical anthropology, mining, evolution, geochemistry, environmental studies, oceanography, mineral studies, geography, soil studies, etc., draw on research reports from a wide range of journals and other types of literature.

BIOSIS has been meeting the information needs of the life science community through a variety of products and services since 1926. In 1981 BIOSIS will examine close to 9,000 primary publications from more than 100 countries, as well as symposia, conference proceedings, books, etc., resulting in the indexing of close to 300,000 documents in the coming year. These items will appear in the printed products Biological Abstracts and Biological Abstracts/RRM (Reports, Reviews, Meetings), as well as on-line through the BIOSIS Previews data base. Many of them will be considered by geologists as core to their research interests.

In addition to keywording, BIOSIS assigns specific concept and taxonomic codes to each document; the application of unique codes for specific geologic periods, when appropriate, is just one of several indexing conventions identified by geoscientists as being highly useful for specificity of literature retrieval. The recent introduction of abstract text on-line as a searchable and printable element has further highlighted the value of the BIOSIS data base as an information resource for geoscience researchers and information specialists. A wide range of complementary and complimentary

educational materials and programs have been developed to familiarize scientists and librarians with available BIOSIS literature resources specific to their information needs.

The information services and products of BioSciences Information Service, better known as BIOSIS, may be new to many professionals in the geosciences. Even those to whom the title _Biological Abstracts_ has a familiar but distant ring may find the idea of searching the BIOSIS data base for geology-related subjects unusual. Nevertheless, there is substantial documentation in the BIOSIS file that focuses on the geological literature.

To understand how and why BIOSIS covers a significant portion of the geological literature, it may be helpful to understand the mission of our organization: it is to serve the information needs of the life science community. Biology, therefore, is defined very broadly as the study of all living organisms, emphasizing their identification, internal processes, environmental interactions, and applications. Interdisciplinary and related areas, as they impact on the life sciences, are also included, along with the traditional disciplines of zoology, botany, and microbiology. Thus, BIOSIS' products and services may also be of interest to researchers in a wide range of other scientific areas.

The Philadelphia office of BIOSIS houses a staff of close to 300, including biologists, information professionals, and computer scientists. Supported by an international group of volunteer abstracters and advisory editorial consultants, these individuals produce the BIOSIS data base, the world's largest English language indexing and abstracting service in the life sciences today.

From information in its data base, BIOSIS publishes 2 major reference publications: _Biological Abstracts_ and _Biological Abstracts/RRM_ (Reports, Reviews and Meetings). Three specialty abstract publications, covering entomology, mycology, and environmental pollutants, are also produced. SDI and retrospective searches for scientists who have special requirements are available as well. Magnetic tapes employed in on-line and off-line centers include authority file tapes, abstract text tapes, and _BIOSIS Previews_. The latter combines the information content of both _Biological Abstracts_ and _Biological Abstracts/RRM_.

To fulfill the BIOSIS mission of providing for the information requirements of life scientists, it has been and continues to be necessary to identify _all_ of the basic biological literature, and to establish and apply selection criteria to all published research in the life sciences. Sources include primary journals, books, reports (including unclassified government reports), and meetings. From these sources, the types of material selected for the BIOSIS data base include: full-length journal articles; short communications; notes; reviews; book chapters; maps; and meeting papers and abstracts. In 1981, BIOSIS expects to add 300,000 new items to the data base. Of this total, 60% (or approximately 170,000 entries), represent abstracts from Biological Abstracts and 40% (or about 130,000 citations represent Content Summaries from Biological Abstracts/RRM. BIOSIS monitors more than 8,500 primary publications, from over 100 countries. In addition, synopses of about 1500 books will be provided in the coming year. By the end of 1981, the complete BIOSIS file will touch the 5 million mark, of which 3 million records, or 60% of the data base is available on-line. As may be seen in Figure 1, although it took more than 30 years for the data base to reach its first million citations since publication began in 1926, the second million were added in just slightly over 10 years; recent history shows that the file is growing by more than one million citations every 5 years.

The review and addition of new serials and books to the file is part of an active acquisitions program maintained by BIOSIS. Serial Sources for the BIOSIS Data Base, published annually, reflects the worldwide scope of coverage of the BIOSIS primary serials. Figure 2 shows the geographic coverage by area and by major contributing country for BIOSIS data base source materials. It has been shown that the majority of publications by researchers in most scientific disciplines appear in journals that are not even among those core to the researcher's discipline (Garvey et al 1972). Thus, to include here a listing of "core" geology/geoscience serial titles as an indication of the extensive literature coverage provided by BIOSIS in these areas would be inconclusive and unrepresentative. Nonetheless, a random sampling of geology-oriented journals covered by BIOSIS and appearing in the current edition of Serial Sources may be a helpful starting point Figure 3). BIOSIS also indexes appropriate material from the geological surveys of most countries, and, of course, the publications of the Geological Society of America itself. Soil survey maps down to the county level from the U.S. Department of Agriculture are also indexed. Serial Sources also contains a separate, alphabetic listing of publishers' addresses for all documents, current and archival - a useful tool for identifying the editorial offices of innumerable Annali, Boletins, Cahiers, Memoirs, Mitteilungen, Sborniks, Trudys, and Zeitschriften of various organizations and institutes around the world.

Two types of data elements exist for each item in the

BIOSIS file: derived and added. Derived data elements, identified from information contained within the original research report, include: journal coden; journal abbreviation; bibliographic information (e.g. pagination, volume, issue, year, publisher); author name(s) (up to 10 authors per document are indexed); author title; author affiliation and language of the document. Added data elements are those generated by the BIOSIS staff, and include: a unique citation number for each reference and descriptors, which together with the words in the author's title comprise the keywords of the file. Used to enrich the information content of the author's title, descriptors are generally taken from the full text of the document, and may include: genus-species names; common names of organisms; new record, name, species, status, etc.; bibliographic identifiers (e.g. review, note, abstract, etc.); virus names; geological periods; geographical location, including geological strata; organ system or tissue used or affected; specific chemical affiliation; important chemicals; specific instrumentation, apparatus, or methodology (for example: radio-labeling); specific pathologies; and purpose of experimentation (taxonomic study, side effects, etc.) Other added data elements include Concept Codes, which represent the broad biological topics discussed in the reference, and Biosystematic Codes, which identify specifically higher taxonomic categories of organisms studied in each reference. Abstracts, for Biological Abstracts references, summarize the contents of full research reports indexed. While the previously described derived and added data elements have been available for on-line searching for a number of years, it is only recently that abstracts have 'joined the club'. The attractiveness of this new retrieval field on-line can readily be appreciated, not only as an aid to end-user decision-making regarding the pertinence of retrieved references, but also as a ready search option to information specialists concerned with strategy development for subjects falling outside the BIOSIS Concept Code classifications. New research areas and/or terminology, for which appropriate subject headings may not yet have been determined, may also now be identified through abstract text searching and printing. Figure 4 shows a typical format for a Biologi-Abstracts reference.

It is important to note, however, when developing search strategies and examining printouts resulting from an on-line subject search, that abstracts exist only for references from the Biological Abstracts portion of the data base, and then only beginning with Volume 62, July, 1976. Approximately 40% of the data base consists of references from Biological Abstracts/RRM and from its predecessor, BioResearch Index. These citations, as may be seen in Figure 5, do not contain abstracts, and retrieval of this portion of the file will be on keywords, Concept Codes, and/

or Biosystematic Codes only. In most cases, the application and combination of various Concept Codes, Biosystematic Codes, and/or keywords in on-line search strategies will insure the most effective type of subject retrieval because of the extensive indexing prepared by BIOSIS for each item in the data base. BIOSIS assigns unique numeric codes to the approximately 600 Concept Codes and over 700 Biosystematic Codes used to index items in the data base. These codes provide a convenient method of grouping together closely related research areas. For example, the major concept SOIL SCIENCE, assigned the number 5280$, where $ stands for any variable character, actually consists of several subheadings more specific in their scope (Figure 6). This same system is used for all subjects falling within the BIOSIS coverage criteria. Since BIOSIS indexers assign an average of 10.5 Concept Codes, 1.6 Biosystematic Codes, and 18.9 keywords to each entry in the data base, research publications of interest to geoscientists will be indexed to a significant number of these subject access points.

Some obvious and major interfaces between the biological and geological sciences include:

Physical anthropology
Fossil dating techniques
Zoology, including Paleozoology
Mining
Evolution
Soil Studies
Geography
Geochemistry
Paleoecology
Ground Water Studies
Botany, including Paleobotany
Palynology
Environmental Studies
Energy Sources
Oceanography
Mineral Studies
Toxicology
Archeology

Within these major areas, we find research on biogeography, including studies of health problems as related to land formations, prevailing winds, etc.; studies on the origin of life and gene evolution; bioclimatology and biometerology; sewage disposal; occupational health, including working conditions in mines; subterranean research; soil microbiology; agronomy; aerospace and underwater biological effects; air, water and soil pollution; and many more. A sampling of recent entries under the category entitled Air, Water & Soil Pollution offers the following titles of interest to geoscientists:

* Dynamics of formation of an aureole of contamination in the region of mercury ore deposits.
* Land application of wastewater
* Iron and fluorine content in underground water
* Nutrient effects on microbial solubilization of arsenic from retorted soil shale mixtures
* Chemical residues in streams

* Oily water discharges from offshore installations

BIOSIS has additionally assigned Concept Codes to each of the major geologic periods:

CC64702-General & Unspecified
CC64704-Precambrian
CC64705-Paleozoic
CC64706-Cambrian
CC64708-Ordovician
CC64710-Silurian
CC64712-Devonian
CC64814-Carboniferous
(Mississippian & Pennsylvanian)
CC64716-Permian
CC64717-Mesozoic, General
CC64718-Triassic
CC64720-Jurassic
CC64722-Cretaceous
CC64723-Cenozoic, General
CC64724-Tertiary
CC64726-Pleistocene
CC64728-Recent

However, it is the ability to combine any one or more more than 600 Concept and 700 Biosystematic Codes in logical (Boolean) operations through on-line searching of the BIOSIS Previews data base that offers the researcher the unique ability to retrieve highly specific references. Some examples of actual title retrievals using, in this case, only Concept Codes are shown below:

CC06400 (Subterranean Biology) and CC37013 (Occupational Health)
RETRIEVED: Working conditions in mines
CC14505$(Cardiovascular System) and CC10610 (Electric, Magnetic and Gravitational Phenomena)
RETRIEVED: Heart attacks and geomagnetic activity
CC07512 (Oceanography) and CC10069 (Mineral Studies)
RETRIEVED: Evidence for organically associated iron in nearshore pore fluids.
CC52803 (Soil Science - Genesis, Morphology, Classification) and
CC06502 (Radiation Biology - General Studies) and CC12100 (Movement)
RETRIEVED: The use of soils in estimating the time of last movement of faults.

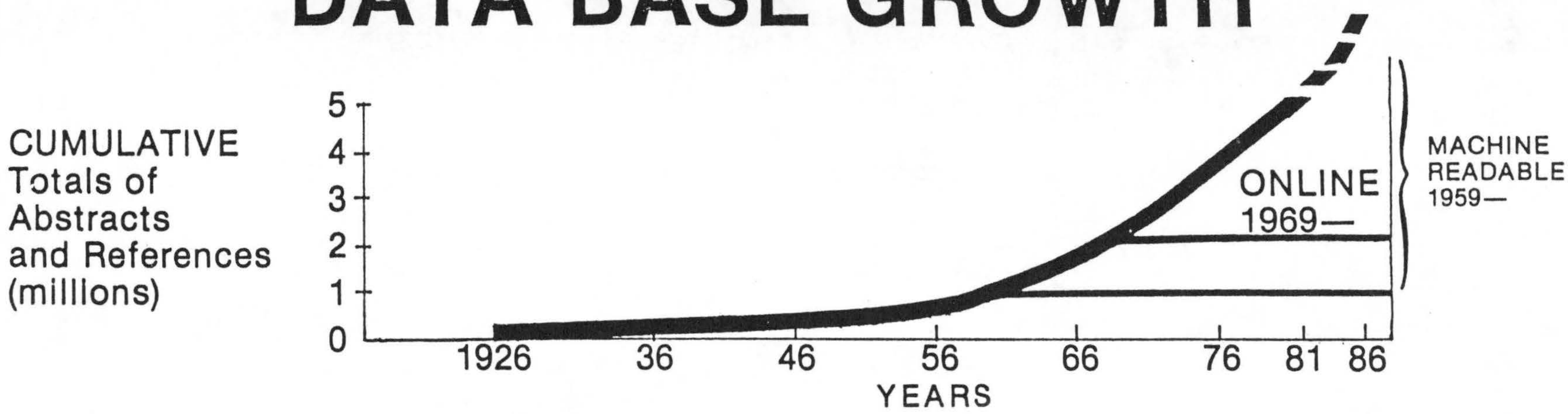
Although we have focused in this paper on subject information retrieval, it is important to note that non-subject data elements of citations, such as author names, language of the report, journal name, etc., may also be used as search entry points.

To enable individuals and organizations to familiarize themselves more fully with the products and services offered by BIOSIS, a number of support programs and materials have been developed, including an extensive range of educational seminars, offered at no charge periodically both nationally and internationally. Complimentary subscriptions to the BIOSIS newsletters, BioScene, BIOSIS Previews Memo (designed especially for the on-line user), and BIOSIS Technical Topics are also available by writing to: BIOSIS, User Communications Section, 2100 Arch Street, Philadelphia, PA 19103. Guidance in search strategy development, information about printed or microform services, and registration for training seminars may also be obtained by calling the BIOSIS toll free number: (1) 800-523-4806, or by telex: 831739.

References

Garvey, William D. et al. 1972. Research studies in scientific communication, IV: the continuity of dissemination of information by productive scientists. Information Storage and Retrieval v. 8 (3), p. 265-276

DATA BASE GROWTH



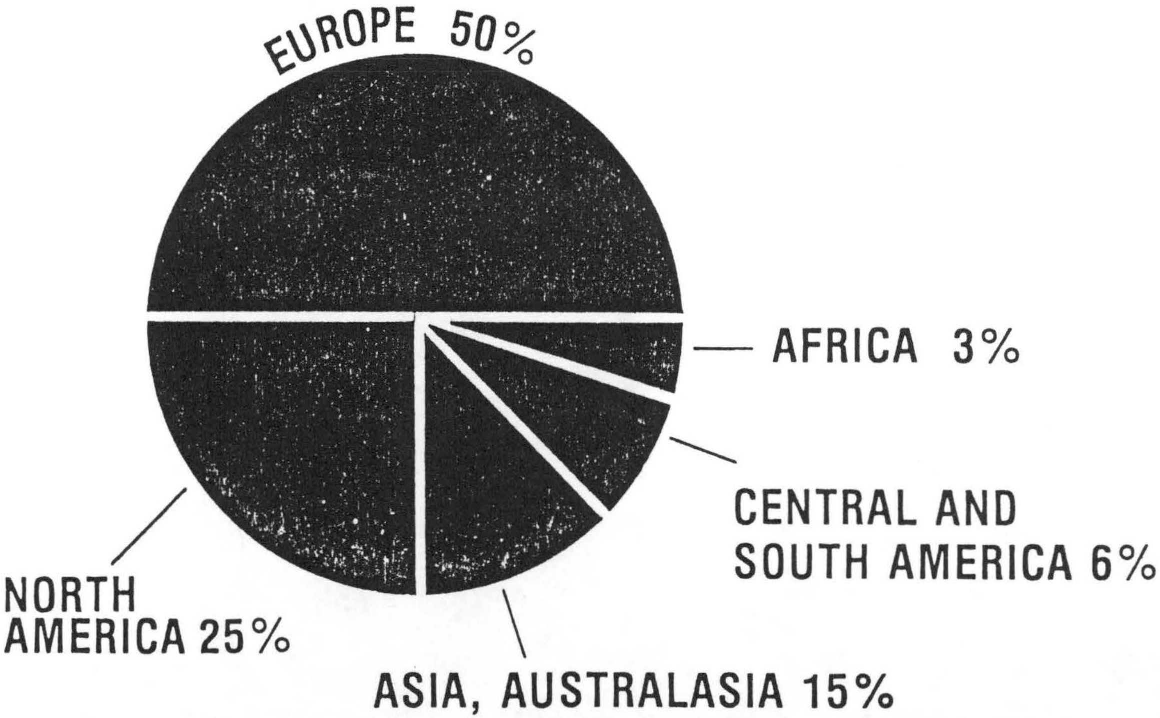
ON-LINE AVAILABILITY

YEARS	ITEMS ONLINE	% of TOTAL DATABASE
12 YEAR PERIOD 1969-80	3,000,000	60 %

FIG. 1

GEOGRAPHIC COVERAGE PROFILE

BY GEOGRAPHICAL AREA



BY MAJOR CONTRIBUTING COUNTRY

USSR — 8%
UK — 7%
W. GERMANY — 5%
FRANCE — 4%

USA — 23%

JAPAN — 7%

FIG. 2

- ACTA GEOLOGICA SINICA
- AMER. ASSN. OF PETROLEUM GEOLOGISTS

  _____ MEMOIRS

  _____ STUDIES IN GEOLOGY
- ANNALS OF ARID ZONE
- BIOGEOGRAPHICA
- BULLETIN OF MARINE SCIENCES
- BULLETIN DE LA SOCIETE GEOLOGIQUE DE FRANCE
- CANADIAN GEOGRAPHER
- DEEP SEA RESEARCH & OCEANOGRAPHIC ABSTRACTS
- ESTUARINE GEOLOGY
- GEOBIOS
- GEOCHEMICAL JOURNAL
- GEOCHIMICA ET COSMOCHIMICA ACTA
- GEOLOGIE ALPINE
- GEOLOGICAL MAGAZINE
- GEOTIMES
- JOURNAL OF GEOLOGY
- JOURNAL OF GEOLOGICAL SOCIETY OF LONDON
- JOURNAL OF GEOPHYSICAL RESEARCH
- JOURNAL OF GREAT LAKES RESEARCH
- JOURNAL OF WATER POLLUTION CONTROL
- MARINE GEOTECHNOLOGY
- MARINE MINING
- MARITIME SEDIMENTS
- PALEONTOLOGY
- PALYNOLOGY
- QUAESTIONES GEOBIOLOGICAE
- REMOTE SENSING OF ENVIRONMENT
- SCOTTISH JOURNAL OF GEOLOGY
- SEDIMENTARY GEOLOGY
- SOCIETY OF ECONOMIC PALEONTOLOGISTS & MINERALOGISTS

  _____ SPECIAL PUBLICATION
- SOIL SCIENCE
- SOVIET SOIL SCIENCE
- WATER AND SEWAGE WORKS

FIG. 3

ECOLOGY (ENVIRONMENTAL BIOLOGY) ← MAIN CONCEPT HEADING

OCEANOGRAPHY ← SUBHEADING

REFERENCE NO. → 56520.

AUTHORS → THOMPSON, M. JOHN* AND LEWIS E. GILLILAND.

AUTHOR AFFILIATION → (ALL POINTS REALTY, 1116 N.W. FED. HIGHW., STUART, FLA. 33494, USA.)

BIBLIOGRAPHIC DETAIL → SOUTHEAST GEOL 21(2): 155-164. 1980.

56520. THOMPSON, M. JOHN* AND LEWIS E. GILLILAND. (ALL POINTS REALTY, 1116 N.W. FED. HIGHW., STUART, FLA. 33494, USA.) SOUTHEAST GEOL 21(2): 155-164. 1980. <u>TOPOGRAPHIC MAPPING OF SHELF EDGE PROMINENCES OFF SOUTHEASTERN FLORIDA, USA.</u> - A ZONE OF TOPOGRAPHIC PROMINENCES ALONG FLORIDA"S EASTERN CONTINENTAL SHELF WAS MAPPED, USING SIDE-SCAN SONAR AND FATHOMETER TRACINGS. THIS ZONE, DESIGNATED SEBASTIAN PINNACLE SYSTEM, IS EXTREMELY COMPLEX AND CONTAINS A CONCENTRATION OF MAJOR SHELF EDGE FEATURES RESULTING FROM COMBINED GEOPHYSICAL AND BIOLOGICAL FORCES. SUBSTRATE DISTRIBUTION PATTERNS INDICATE STRONG DEPOSITIONAL AND EROSIONAL ACTIVITY BY THE FLORIDA CURRENT. NUMEROUS HOLES AND CRATER-LIKE DEPRESSIONS LOCATED THROUGHOUT THE AREA REFLECT DIFFERENTIAL EROSION AND/OR SAPPING OF THE UNDERLYING LIMESTONE DURING PERIODS OF LOWER SEA LEVEL. A SERIES OF SUBMERSIBLE DIVES WERE MADE TO INVESTIGATE SPECIFIC BOTTOM FEATURES SEEN ON THE SONOGRAPHS AND FATHOMETER TRACINGS. THESE DIVES CONFIRMED THE COMPLEXITY OF THE OVERALL SYSTEM, AND OBSERVATIONS MADE AT SEVERAL KEY LOCATIONS INDICATE THE MAJOR RELIEF RESULTS FROM 2 TYPES OF DROWNED TOPOGRAPHIC FEATURES, MOUNDS OF OOLITIC LIMESTONE AND RELICT CORAL REEFS.

ABSTRACT → (the passage beginning "A ZONE OF TOPOGRAPHIC PROMINENCES")

DESCRIPTORS: CORAL REEF OOLITIC LIMESTONE DEPOSITION EROSION
SIDE SCAN SONAR FATHOMETER TRACING

CONCEPT CODES: AEROSPACE & UNDERWATER BIOLOGICAL EFFECTS - GENERAL; METHODS (06002)
ECOLOGY - OCEANOGRAPHY (07512)
ECOLOGY - WATER RESEARCH, FISHERY BIOLOGY (07517)
EXTERNAL EFFECTS - SONICS, ULTRASONICS (10608)
SOIL SCIENCE - GENESIS, MORPHOLOGY, CLASSIFICATION (52803)
SOIL SCIENCE - PHYSICS, CHEMISTRY (52805)

BIOSYSTEMATIC CODE: CNIDARIA (41000)

FIG. 4

BA 70(9) 1980

ECOLOGY

(ENVIRONMENTAL BIOLOGY) ← MAJOR CONCEPT HEADING

REFERENCE NUMBER

ANIMAL ← SUBHEADING

AUTHOR

BIBLIOGRAPHIC DETAIL

AUTHOR ADDRESS

2140. CORLISS, BRUCE H. (WOODS HOLE OCEANOGR. INST., WOODS HOLE, MASS. 02543, USA) NATURE (LOND) 282 (5734): 63-65. 1979 [RECD. 1980].
RESPONSE OF DEEP-SEA BENTHONIC FORAMINIFERA TO DEVELOPMENT OF THE PSYCHROSPHERE NEAR THE EOCENE-OLIGOCENE BOUNDARY. /NOTE, OSTRACOD, ROSS SEA, ANTARCTIC, TEMPERATURE, CURRENT, SEDIMENT

SUBJECT TERMS (DESCRIPTORS) →

SUBJECT CONCEPTS →

CON: COMPARATIVE & EXPERIMENTAL CRUSTACEA / EXTERNAL COLD EFFECTS /
COMPARATIVE & EXPERIMENTAL PROTOZOA / OCEANOGRAPHY /
GENERAL & SYSTEMATIC PROTOZOA / PHYSICAL & MECHANICAL EFFECTS

TAX: PALEOZOOLOGY / OSTRACODA / SARCODINA

← TAXONOMIC NAMES

FIG. 5

SOIL SCIENCE (5280$)

52801 GENERAL; METHODS: SOIL SURVEYS; APPARATUS, METHODS TO STUDY SOIL; TRACERS IN SOIL STUDIES
(CHEMICAL & TOXIC STUDIES, EX.SOIL FORMATION, MINERAL COMPOSITION OF DESERT SANDS)

52803 GENESIS, MORPHOLOGY & CLASSIFICATION (INCLUDES ASSOCIATED GEOLOGY)
SOIL DEVELOPMENT; DESCRIPTIONS OF SOIL PROFILES (STUDIES ON PREBIOTIC CONDITIONS OF THE EARTH; LAND CAPABILITY EVALUATIONS)

52805 PHYSICS & CHEMISTRY
STUDIES OF CLAY MINERALS; CATION EXCHANGE PROPERTIES; CHEMICAL & PARTICULATE COMPOSITION (EX GEOCHEMISTRY OF SOILS OF FAULT ZONES).

52807 FERTILITY & APPLIED STUDIES
NUTRIENT AVAILABILITY, FERTILIZERS, ETC.,IRRIGATION & SOIL IMPROVEMENT

FIG. 5

PART II

CONTRIBUTED PAPERS

A DIRECTORY OF INFORMATION RESOURCES IN THE UNITED STATES: GEOSCIENCES AND OCEANOGRAPHY

John F. Price

Science and Technology Division, Library of Congress, Washington, D.C. 20540

Abstract: This directory is the first in a new series aimed at exploiting subject areas that are reasonably well-represented in the National Referral Center's subject-indexed, computerized data base, which describes some 13,000 organizations with information capabilities in virtually all subjects (called "information resources" by the Center). Each organization is described in terms of its special fields of interest and the types of information service it is willing to provide. Maintained by professional analysts, the file is used primarily by the Center's referral specialists to provide a free referral service that directs those who have questions concerning any subject to organizations that can provide the answer. It is also accessed by the Congress and its staffs and by readers at the Library of Congress through computer terminals liberally scattered around Capitol Hill and in various reading rooms in the Library itself; furthermore, many Federal agencies have access to it nationwide through the DOE/RECON computer network poerated by the Department of Energy.

The directory will describe 1,000 information resources in the geosciences and oceanography, including not only information and documentation centers, and abstracting and indexing services, but also such sources as professional societies, university research bureaus and institutes, Federal and state agencies, industrial laboratories, museums, testing stations--even hobby groups and grass-roots citizens' organizations. It will be sold through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The National Referral Center (NRC) was established in 1962 on the initiative of the National Science Foundation (NSF), which also provided the funding. Set up at the time as a separate division of the Library of Congress, it opened its doors for business on March 1, 1963.

As it always does sooner or later, NSF eventually withdrew its funding support. In August 1967, the Center was absorbed into the Library's Science and Technology Division, where it operated as a function rather than a unit of that division. Since 1969, funding of the Center has been appropriated by Congress directly to the Library. This will continue (we hope) after a reorganization that will bring NRC full cycle, so that it will soon once again be operating as a separate division within the Library.

The Center has three basic tasks: (1) to inventory significant U.S. information resources; (2) to provide any organization or individual, on request, with information regarding these resources; and (3) to compile and publish directories and other listings of information resources.

Regarding the first task (the inventory task), NRC defines "information resource" in the broadest possible terms. Included is any facility, collection, or service maintained on a continuing basis that provides data or material of any kind in any form that may help satisfy the information needs of a requestor; in short, any organization, group, service, library, center or even unique individual from which or from whom authoritative information is available.

In compiling its inventory of information resources, the Center has mailed many thousands of solicitation letters, together with specially-designed questionnaires, to organizations known or believed to be sources of information. Those found, on the basis of a review of the returned questionnaires, to be able and willing to provide information to persons outside their own organization have been registered in the Center as information resources.

At present, the National Referral Center data base of information resources describes nearly 13,000 organizations that have indicated a capability and willingness to answer questions in the physical, biological, engineering, and social sciences as well as the arts and humanities--in other words, virtually any subject. Continuously maintained by a specialized staff of analysts and editors, this nonbibliographic file, in its most basic form, consists of folders containing filled-out questionnaires and related descriptive material, one for each organization. Each organization is also written up and subject-indexed in machine-readable form. Aside from the name, address, and phone number, a typical record describes an organization's areas of interest, its holdings (books, journals, data files, specimen collections, maps, etc.), major titles that it publishes, and its information services, with special mention of any service limitations or fees (see Figure 1).

The data base may be searched by subject, name, city, and state through the SCORPIO system available to the Congress through numerous computer terminals located in House and Senate offices, and to the public through terminals located in the major reading rooms of the Library (file name NRCM). It may

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American Geological Institute
GeoRef Information System

American Geological Institute
5205 Leesburg Pike
Falls Church, Va. 22041 Tel: (703) 379-2480

GeoRef is a bibliographic data base providing access to the geological literature of the world.

AREAS OF INTEREST: All subjects relating to geology and the earth sciences.

HOLDINGS: Over 600,000 bibliographic references, going back to 1961, stored on magnetic tape, with about 4,000 references added each month. Coverage includes more that 3,000 journals from all over the world, as well as books, monographs, symposia proceedings, government documents, theses, and maps.

PUBLICATIONS: Two bibliographies are regularly produced by the GeoRef system: the Bibliography and Index of Geology and the American Museum of Natural History's Bibliography and Index of Micropaleontology. Both are printed each month from computer photocomposed pages. The former has an annual cumulation. GeoRef also provides the annual indexes to 13 primary journals of geology published in the United States and Europe. Special bibliographies, e.g., on the geology of states, are photocomposed on demand.

INFORMATION SERVICES: GeoRef is searchable on-line at System Development Corp. (SDC). A requester can submit a search directly, via terminal and telephone, to SDC. Alternatively, a requester can mail or phone a search to AGI or to any of several search centers authorized to sell GeoRef searches. AGI or the center will select appropriate index terms for the search, process the search, and send the requester a list of resulting references. For those wanting to run searches on their own computers, the GeoRef data base is available for license.

Figure 1: Typical record

also be searched by subject, name, city, state, zip code, free text words in certain selected fields, and some other special codes through the DOE/RECON system available to the Department of Energy and its major contractors through a nationwide online network originating from a computer located in Oak Ridge, Tennessee.

But for the vast majority of the public who have no access to either of these online systems, the Center maintains a staff of six referral specialists who stand ready to handle all requests for referral service. These requests may be made by phone, mail, or personal visit to the Center. It should be emphasized at this point that the Center's function is not to provide substantive answers to questions, but instead to serve as an equivalent to the telephone directory's "yellow pages," directing those who have a question concerning a particular subject to organizations or, in some cases, specific individuals with specialized knowledge of that subject.

Thus, the Center's second task--giving out information about resources on demand--is mainly carried out by its referral specialists through direct contact with the public.

In response to requests for assistance in locating specific information, the Center provides the inquirer, free of charge, with a printout or list of appropriate information resources. For each inquiry, the response is individually tailored to the inquirer's special interest. The Center's referral specialists, each of whom has competence in some subject area, make a special effort to establish the most direct contact possible between the person seeking the information and the places and/or people who can provide it. The Center has established a goal of answering all referral requests within five working days. Some, of course, can be answered in minutes, particularly if the question, or one closely related, has been asked previously.

The most identifiable users of the service are librarians. They generate 20 percent of the 6,000 requests received annually. Additional heavy users include engineers, scientists, administrators, other professionals, and students at the graduate and even undergraduate levels. One example that illustrates how we can help librarians occured recently in the Reference Section of our Division. A midwestern library needed an article from the <u>LNG Journal</u>. A check of the LC Serial Records came up negative, and so did a search of the nationwide OCLC database. At this point, someone thought of searching the NRC file under "natural gas" and came up with the Gas Appliance

Manufacturers Association, Inc., located nearby in Arlington, Virginia. A call to their library determined that, sure enough, they had the journal and were willing to provide the necessary material directly to the original requesting library.

The third task--to compile and publish directories and other listings--is the primary reason for my being here today; it is actually an extension of the Center's referral services although, in a sense, it competes with them. The original intent for the publication and distribution of directories was to increase general familiarity with existing information sources and thereby to decrease reliance upon individual requests to the Center. Experience has shown, however, that referral requests are stimulated by the publication of directories.

Rather early in its existence, once it had managed to build up a fairly substantial inventory of resources, NRC began its publishing program. Its first two published directories were general. The first, a hurry-up job compiled at the insistence of the National Science Foundation, came out in January 1965 and, in 1,100 entries, purported to cover information resources in the United States in the physical sciences, biological sciences, and engineering. That might be laughable were it not that in the six years of its availability in print that directory was twice reprinted by the Government Printing Office (GPO) and sold more than 18,000 copies. The second directory, Social Sciences, appeared in October 1965; it sold 12,400 copies in five and a half years. A third general directory, published in June 1967, cut across all subjects and described more than 1,600 information activities within or supported by the federal government.

From the outset, the National Referral Center planned to issue directories relating to specific subject areas of timely interest. As the problems of energy and the environment were already beginning to attract attention, it is not surprising that the only two formally published special directories that NRC has compiled to date were entitled Water (September 1966) and General Toxicology (June 1969), the latter produced with funding support from the Toxicology Information Program of the National Library of Medicine.

In those early days, directories were put together manually. Entries were typed, mailed out for approval, retyped to reflect changes, and finally marked up and sent to GPO for "hot lead" typesetting.

In the late 1960's the National Science Foundation provided funding for four additional directories (actually revisions of the earlier broad-coverage volumes). Utilizing the Library of Congress computer facilities, tapes were produced to drive GPO's Linotron high-speed photocomposition equipment. The computer-produced directory in Physical Sciences, Engineering appeared in June 1971; Biological Sciences in September 1972; Social Sciences in June 1973; and Federal Government in April 1974. And now, after six years, we are returning to a more specific focus with Geosciences and Oceanography (G&O).

The intervening years have not been idle ones. In January 1975, the data base from which the series is published became available for online computer searching, as I described earlier. These new modes of access provided the impetus to keep the data base very much alive; not only did it grow in size but, more importantly, it was brought to a new level of overall currency. To ensure currency and textual accuracy, each entry is periodically printed out by computer and submitted for review to the organization covered. By and large, the entries in the G&O directory were reviewed and approved in 1980 or late 1979; a few entries reviewed in early 1979 or late 1978 were given a later summary verification by telephone. As in the Center's previous directories, some significant resources could not be included because they did not respond to requests for descriptions of their activities.

For the purposes of the new volume, "geosciences" and "oceanography" have been defined quite broadly. Also, one should keep in mind that the range of interests of organizations are often diffuse, compared to the subject scope, say, of books or journals.

The directory will describe 1,000 information resources in the geosciences and oceanography, including not only traditional sources of information such as technical libraries, information and documentation centers, and abstracting and indexing services, but also such sources as professional societies, university research bureaus and institutes, federal and state agencies, industrial laboratories, museums, testing stations--even lobby groups and grass-roots citizens' organizations (see Table 1). By the way, the 1,000 figure just happened that way--we made no special attempt to cut off at a round figure.

For ease in browsing, the NRC directories are all arranged so that sub-units within a larger organization appear together. For example, the various components of the National Oceanic and Atmospheric Administration

Organizational aspect	Number	Percent
Federal government	149	14.9
State government	191	19.1
Local government	31	3.1
College or university	365	36.5
Society	64	6.4
Association	37	3.7
Commercial	54	5.4
Non-profit institution	79	7.9
Other	20	2.0
	1,000	100.0

Functional aspect	Number	Percent
Administrative office	314	31.4
Documentation center	17	1.7
Information center	79	7.9
General library	42	4.2
Special library	160	16.0
Public information office	10	1.0
Referral center	3	0.3
Laboratory	43	4.3
Research institute	148	14.8
Museum	57	5.7
Observatory	5	0.5
Other collection	10	1.0
Other activity	112	11.2
	1,000	100.0

Table 1: Analysis, by organizational aspect and by functional aspect, of the 1,000 resources listed in Geosciences and Oceanography

appear together as a major listing under the Department of Commerce, next to other Commerce agencies, such as the National Bureau of Standards. While this gives a nice overview, it is not always a convenient arrangement for finding the entry for a specific known resource, especially some of the government ones. To overcome this, we are trying out something new in the G&O directory called the "Organization Locator," where names at any organizational level can be looked up directly in a single alphabetic array. For example, a reader will now be able to turn directly to the entry for the National Oceanographic Data Center (NODC) without needing to know that NODC is part of the Environmental Data Service, which is part of NOAA, which, in turn, is part of the Department of Commerce. Citations in both the "Locator" and the subject index will be to entry number rather than to page number.

As to further publishing plans by the NRC, I believe a new edition of Federal Government is under serious consideration. I say "I believe," because, as I said earlier, the Center is about to become a separate division again, while I am likely to remain with the Science and Technology Division, of which I am currently the chief. The G&O directory, therefore, is kind of a parting shot for me. I hope you will like it.

BIBLIOGRAPHY OF FOSSIL VERTEBRATES:
COOPERATIVE VENTURE FOR A SPECIALIZED SERVICE

Judith A. Bacskai

Museum of Paleontology
University of California, Berkeley, CA 94720

George V. Shkurkin

Museum of Paleontology
University of California, Berkeley, CA 94720

John G. Mulvihill

American Geological Institute
One Skyline Place-5205 Leesburg Pike, Falls Church, VA 22041

Abstract: The Bibliography of Fossil Vertebrates, as published by the Geological Society of America, ceased publication in 1972. Recently the American Geological Institute (AGI), the Society of Vertebrate Paleontology (SVP), and the University of California Museum of Paleontology (UCMP) at Berkeley agreed to revive the old publication and jointly produce and publish this bibliography, beginning with the literature of 1978, followed by annual volumes. A retrospective volume to cover 1973-1977 will close the gap between the old and the new series.

The new publication is computer produced from AGI's GeoRef data base. In addition to the work done by GeoRef's staff editors, the bibliography includes citations, editing and zoological systematic indexing contributed by the vertebrate paleontology editorial group at Berkeley. As a consequence of this joint effort, a wider and fuller coverage of the world literature is possible.

The bibliography is soft bound in the Bibliography and Index of Geology cumulative index format and includes list of serials, citations, subject and systematic indices. The potential for on-line searches of vertebrate systematic data is an important feature of this system.

An outline of the procedures used, and the role of each organization participating in this project are discussed.

Introduction

Professor Charles L. Camp, at the University of California Museum of Paleontology (UCMP), Berkeley, began to publish his personal collection of references in the field of vertebrate paleontology in 1940. The first volume of the Bibliography of Fossil Vertebrates (BFV), covering the literature of 1928-1933, appeared as Geological Society of America Special Paper No. 24, to be followed by eight successive volumes published at five year intervals. Vertebrate paleontologists depended on this unique publication covering the world literature for 45 years, and no other reference work provided a satisfactory replacement when it ceased publication in 1973.

In 1977 the Society of Vertebrate Paleontology (SVP) decided to find a way to resume publication of the BFV. Collaboration with the American Geological Institute's (AGI) Bibliography and Index of Geology was the logical and most desirable means to this end, as it already covered the bulk of the world's vertebrate paleontology literature. The UCMP, original home of the BFV, with excellent library facilities, had all the old files and trained staff available for the specialized needs of this project. Thus a tripartite agreement was worked out, whereas

SVP actively participates in decisions concerning coverage, content and format of the Bibliography of Fossil Vertebrates. Assists in the promotion and sale of the publications. Makes every attempt to raise funds for the project.

UCMP includes the BFV as one of its on-going projects, provides staff, bookkeeping, office and library facilities. The vertebrate paleontology editors at UCMP are responsible for covering a list of about 180 serials for AGI, preparing new input in GeoRef format, systematic index entries for all vertebrate paleontology publications, and editing of references intended for the BFV.

AGI prepares citations from the materials scanned for GeoRef which are not covered by UCMP. Reviews, keys and validates BFV citations and indexing. Provides programs and computer processing. Publishes the BFV.

The bibliography is soft bound in the Bibliography and Index of Geology format and includes list of serials, citations, subject and systematic indices.

Procedures

The general guidelines for coverage give AGI responsibility for most serials in the earth sciences, mixed paleontology, life- and general sciences.

The VP group is responsible for all the vertebrate paleontological and zoological publications, popular natural history, numerous anthropological, biological and evolutionary journals, and publications of the local academies of the USSR. In addition, AGI requests the VP unit to index book monographs, serial monographs and journal issues that deal predominantly with vertebrate paleontology.

The systematic index contains all zoological names, including new ones, discussed in a publication. This section is the most distinguishing feature of the BFV, in relation to other types of bibliographies. Although the inclusion of this section proved to be the most troublesome for AGI, it is the most important one for the vertebrate paleontologist.

A broad outline of the processing and flow of data between the GeoRef data base and the VP editorial group is shown in Fig. 1. (Fig. 1 explained).

Records and Files

While the 10,000 most recently keyed citations in the data base are accessible by terminals at AGI headquarters in Falls Church, Virginia, the geographical distance, use of a batch system, and simultaneous work on several BFV volumes necessitate the maintenance of considerable manual files and records at UCMP.

1) A log is kept of all AGI-requested abstracts.
2) Computer proof sheets of individual bibliographic records are filed, separated into binders by BFV coverage year, and arranged alphabetically by journal. Monograph records are filed separately by author.
3) A copy of all VP input code sheets is filed alphabetically until it is input in the data base and a corresponding proof sheet of that record is returned to UCMP. At that time the code sheet is pulled, edited, item number transferred from the proof sheet, and the code sheet is refiled in the:
4) Numeric file. Copies of systematic index items added to records input by AGI are also filed here in computer record number order.
5) The serials card file contains bibliographic data, ISSN, CODEN, call number, library branch or availability, and detailed records of issues searched and processed. The VP staff systematically searches every issue of a serial, while at GeoRef material is

selected for input as it is received at AGI and the USGS Library in Reston, Virginia. These different approaches complement each other, assuring more complete coverage with a minimum of duplication.

Conclusion

The support and cooperation of AGI, SVP and UCMP staff during the past two years has been extremely enthusiastic. The success of such an approach indicates the potential feasibility of similar types of bibliographic projects, such as invertebrate paleontology, paleobotany and other sub-disciplines of the earth sciences.

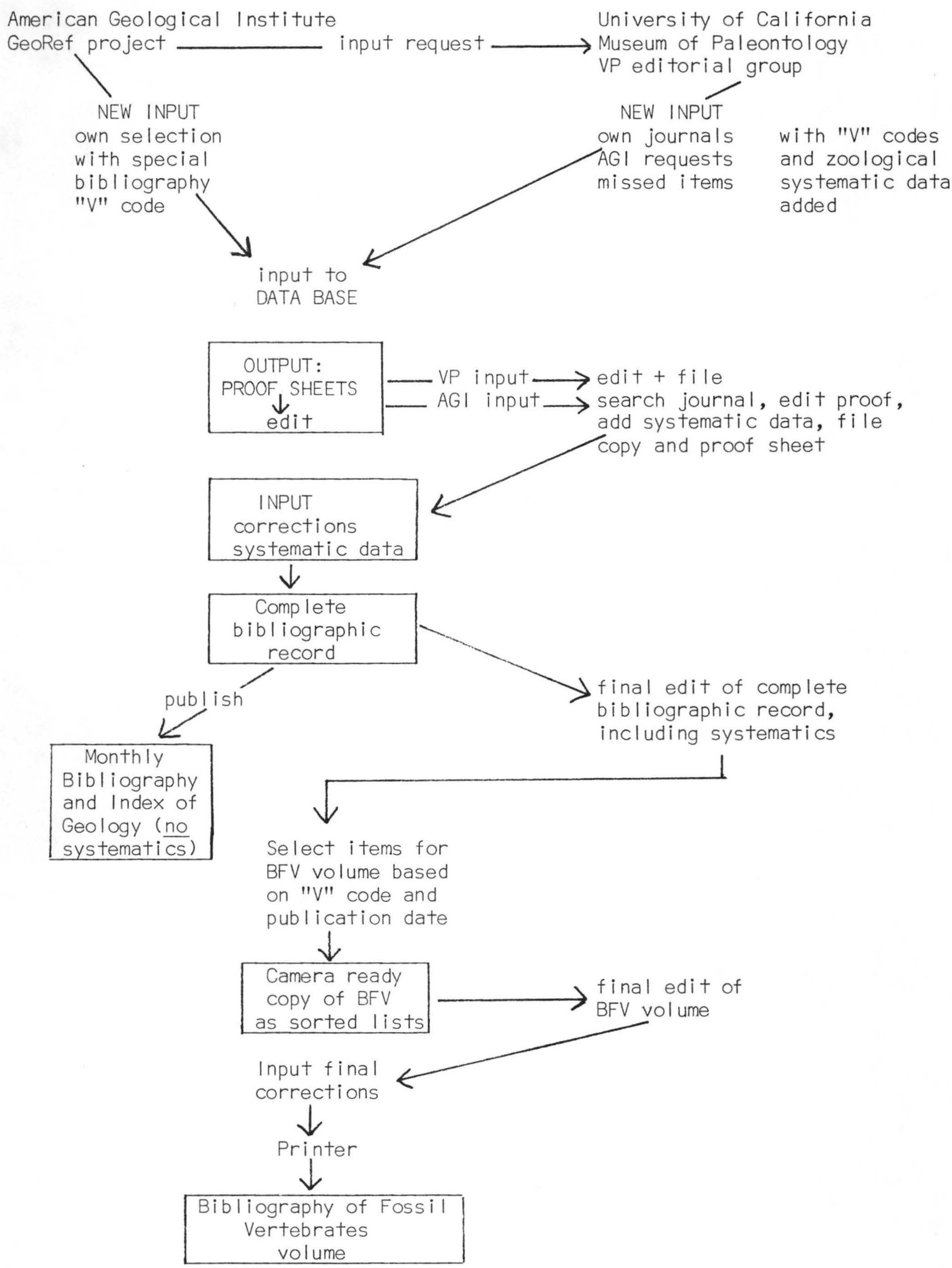


Fig. 1. Outline of data flow; or how the papers get pushed around.

THE BUREAU OF MINES MINE MAP REPOSITORY: SERVICES AND ACTIVITIES

Robert Heidlage
University of Missouri Geology Library
Columbia, MO 65211

Abstract: In 1963 the Bureau of Mines began a program for microfilming maps of abandoned coal mines in the anthracite fields of eastern Pennsylvania. Customarily, mine owners have detailed maps prepared of their mine works; in Pennsylvania, this is required by law. Declining demand for coal through much of the twentieth century caused the abandonment of many mines. It was thought that valuable information on the underground excavations in the frequently heavily populated coal field regions would be lost unless steps were taken to preserve mine maps. In 1970, the program was reorganized; it was given expanded objectives and a national scope. In addition to the original repository at Wilkes-Barre, repositories were added at Pittsburg, Denver, and eventually at Spokane. Through 1978, approximately 85,000 mine maps had been microfilmed.

The Repository staff first locates the maps and acquires the necessary consent for duplication from the mine owner. Maps are then transported, microfilmed, and returned. A computerized catalog is produced from the numbered microfilm documents.

Repository holdings are generally available to the public. Photocopies may be produced. Users may be required to bear the cost of extensive copy requests.

This paper is a review of the services and activities of the Bureau of Mines Mine Map Repository. It consists of three parts, background information, applications of archival mine map data, and administration of the repositories. Additional information is given in two appendices following the list of references. Appendix 1 is a list of published mine map catalogs. Appendix 2 is a list of addresses and telephone numbers of the mine map repositories.

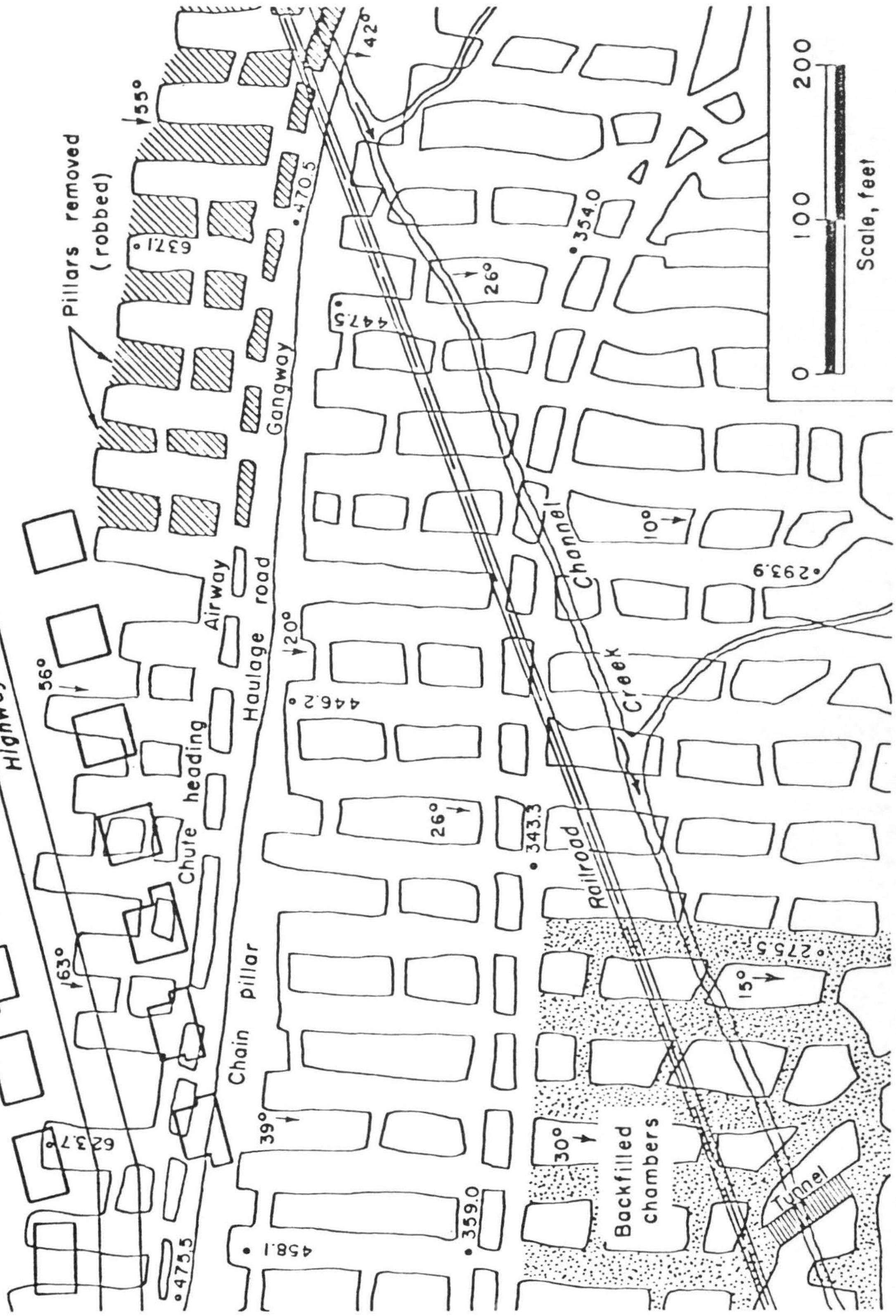
Background Information

Most states have some regulations governing the construction of mine maps. These maps constitute the engineering record of the mine operation.

"The maps...show the inclination of the strata and the tidal elevations wherever appropriate. In actual practice, surface maps are also made of the mine property showing important buildings, streams, roads, railroads, and other features. The surface and bed maps usually show enough common land lines and corners to permit the maps to be fitted one above the other, thereby making it possible to observe the workings of a given bed in true vertical relationship with workings in other beds of the mine and with surface features." (Whaite, 1965:9). An example of a mine map is given in Figure 1.

Developments in the coal mining industry in eastern Pennsylvania brought about a need for the preservation of mine map information. The coal industry expanded through the early part of the twentieth century, and has declined since then. "The anthracite industry grew slowly at first but increased throughout the nineteenth century. By 1900, production reached 57 million tons, and output continued to increase in the ensuing years until a peak of almost 100 million tons was reached in 1917. Dependable supplies of heating oils beginning in the 1930's and natural gas in the 1940's brought about a consistent decline in demand for anthracite. Production declined from 44 million tons in 1950 to 19 million tons in 1960, to 10 million tons in 1970, and to 6 million tons in 1975." (Westerstrom, 1976:67-68). At the same time the industry was undergoing such a decline, a transition from underground to surface mining occurred. In 1955, 55.3% of production from the eastern Pennsylvania coalfields was from underground mines. In 1974, this figure was 9.9%. (Westerstrom, 1976:70). These two trends caused the abandonment of many of the underground mines. Neglect, loss, and destruction of the mine maps and other graphic engineering records of the mining operation sometimes followed the abandonment of the mine. "At some mine offices the set of maps that represents the official engineering record of the mine is kept intact and maintained in good condition, but the maps of many abandoned mines do not fare as well. In one instance, borehole records, traverse books, and field books of a number of abandoned mines belonging to one company had been deposited on the floor of an unused repair shop at the mine office the maps were destroyed by fire." (Whaite, 1965:9-11).

Figure 1: Example of Mine Map
(from Whaite, 1965:10)



Even after it ceases, mining activity leaves its' mark on an area. Some problems associated with ceased mining activity, for which mine map information is essential, are discussed below.

Applications of Archival Mine Map Data

Mine maps have both civil and mining engineering applications, and public health applications. Three specific problem areas are:

Mine Water

Mines tend to fill-up with water; either from precipitation, surface runoff, or seepage. Active mines are drained by pumping, or, where the terrain permits, by conveyance of the water to the surface through tunnels. The costs of mine drainage operations are high, so abandoned mines are frequently allowed to fill with water. The presence of many flooded, abandoned mines increases the operating expenses and safety risks of adjacent active mines. "Active mines are thus burdened with water infiltrating from abandoned mines in addition to that normally present in the active mines. As more and more mines are abandoned..., the problem becomes cumulatively more serious...(Ash, et al., 1949:1). Concerning safety: "Many workers...have had narrow escapes and a few have lost their lives by drowning when their mine unexpectedly broke into older mine workings filled with water." (Ash, et al., 1949:41).

Mine water frequently becomes highly acidic. Acid mine water is a product of a chemical reaction between iron sulfide compounds and air and water. Drainage from abandoned mines can pollute nearby rivers and groundwaters. "Government agencies have spent considerable money and time sealing off old mines from surface and subsurface waters..." (Howard, 1978:295).

Mine Fires

Sometimes parts of abandoned mines do not fill with water, either because they are above the water level in the mine, or because the shafts or tunnels are backfilled with mining waste material. Subsided or backfilled waste material in abandoned mines can spontaneously ignite. These mine fires are extremely difficult to fight. "Residents of the oncethriving coal-mining city of Shamokin in central Pennsylvania can look forward to possible relief from acrid fumes...that have plagued them for more than 25 years. A mine fire detected as long ago as 1951, has since spread through six coalbeds of the abandoned Cameron Colliery mine, which was in operation from about 1866 to the mid-1930's. Pollution from the fire has posed serious health hazards to Shamokin residents... The Bureau of Mines estimates that completion of the project (i.e., extinction of the fire-auth.) would take about three years." (Kebblish, 1979: 634). Suffocation is one method of fighting mine fires. "To shut off the fire's air supply, surface cracks will be sealed by plowing and compacting the earth." (Kebblish, 1979:634).

Land Subsidence

Subsurface removal of any substance, solid, liquid, or gas, in sufficient quantities, can cause surface movement or settlement. Any shallow mining operations that take place in relatively unconsolidated material are likely to have this effect. Subsidence can be nothing more than a gradual settling, or it can be a sudden and dangerous collapse due to the effect on surface supports of groundwater flow through underground mine works. "...there are on record many serious accidents due to the subsidence of the ground above mining cavities... Somewhat unusual was the loss of a steam locomotive that was working on the (old) Furness Railway of England in September of 1892. While wagons were being shunted in a freight yard, the ground suddenly opened up and the engine disappeared into the hole, the driver just having time to escape. Although the tender was hauled out, the locomotive itself disappeared into the old coal workings that caused the disturbance; it is believed now to be about 60 m below the surface." (Legget, 1973:453). Humorous perhaps, but most cases of subsidence aren't this way. "As recently as 1968, ...serious property damage took place in the borough of Ashley, ...south of Wilkes Barre, Pennsylvania, streets, bridges, water and gas lines, homes, and churches being affected in various ways." (Legget, 1973:453). If mine maps have been lost or are otherwise unavailable, the methods used to make up for the lack of data are often very expensive. "One method has been to drill from the surface 15 cm diameter holes into the mine workings, then lower a special rotating borehole camera down the hole that, with appropriate fittings, can be operated from the surface to photograph the area around the bottom of the hole." (Legget, 1973:454).

Clearly, knowledge of the extent and location of underground mine works is essential to intelligent efforts at coping with the effects of ceased mining activity.

Administration of the Repositories

In 1963, the Bureau of Mines Environmental Field Office at Wilkes Barre, Pennsylvania began to microfilm maps of abandoned coal mines. It was not long before it was realized that the demand for mine map information exceeded the boundaries of the eleven county area in eastern Pennsylvania associated with the anthracite industry. In 1970, in response to this demand, the Bureau established repositories at Pittsburg and at Denver. In the mid-1970's, an additional repository was established at Spokane, Washington. The first repository at Wilkes Barre collected only anthracite mine maps. Now, the repositories collected all kinds of mine map records, both underground and surface, although with a continuing emphasis on the former.

The Mines Bureau has no centralized administration of the repositories; each repository is a constituent part of the field operations center at which it is located. The Wilkes Barre repository, located at the Environmental Field Office, collects mine maps for the eastern Pennsylvania region. The Pittsburgh repository, located at the Eastern Field Operations Center, collects mine maps for areas east of the Mississippi River excluding the eastern Pennsylvania region. The Denver repository, located at the Intermountain Field Operations Center, collects mine maps for areas west of the Mississippi River excluding a six state region consisting of Washington, Oregon, California, Idaho, Nevada, and Montana. The Spokane repository, located at the Western Field Operations Center, collects mine maps for this six state western region.

As of 1978, approximately 85,000 mine maps had been microfilmed, 53,000 of these at the Pittsburg repository. (U.S. Bureau of Mines Research 1978:111-112). For comparison, it is estimated that there are in existence 500,000 mine maps in the eastern part of the United States. (Edgerton, 1974:8).

Because of the decentralized administration of the repositories, some variation in procedure is in evidence. In general, the workflow is as follows: The maps are first located and consent is obtained from the holder or mine owner for microfilming. Maps are then transported to the repository and repaired if necessary. A document or accession number is established for the maps of each mine. Following microfilming, the maps are returned to the contributor.

Catalogs/Indexes

Using the document numbers established in the microfilming process, separate catalogs are produced at each of the repositories. The catalog of the Wilkes Barre repository is qualitatively different from the catalogs of the other repositories. Map records are listed serially by document number in the catalog; the document number must be located by reference to printed indexes of the mines and mine fields superimposed on the U.S. Geological Survey topographic index sheets for eastern Pennsylvania. Catalogs of the other repositories are computerized. Records are arranged by state and then county. Mines are listed in alphabetical order within the county by mine name. Additional information given in the catalogs includes the company name and commodity produced, the document number and number of exposures for the complete map, the U.S. Geological Survey topographic quadrangle sheet on which the mine is located, and the UTM coordinates for the geographic center of the mine works. (Edgerton, 1974:7).

Availability

There is no union catalog to the holdings of the four mine map repositories. The catalog of the Wilkes Barre repository is the only one that has been published (see Appendix one). Inquiries regarding the availability of mine maps in regions administered by other field operation centers must be addressed to that center (see Appendix two).

Confidentiality

All holdings of the mine map repositories are accessible as open-file materials. Photocopies may be made of a great many of the microfilm maps on file. Some maps may not be photoduplicated however. Mine owners may consent to the microfilming of the maps of their mines contingent upon the exclusion of the distribution of copies. Some mine owners retain the right to review each request for access to the microfilm copies of their mine maps. This type of restriction is becoming increasingly rare as more maps are being acquired from state mining agencies, rather than private industry. It is estimated that less than ten percent of the holdings of the Pittsburg repository have copy or access restrictions. (Bursic, 1980).

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Kebblish, William, 1979. Mineral industry of Pennsylvania. Minerals Yearbook 1976. Volume II. Area reports: Domestic.

Legget, Robert F., 1973. Cities and geology. McGraw-Hill Pub. Co.

U.S. Bureau of Mines, 1979. Bureau of Mines Research 78.

Westerstrom, Leonard W., 1976. Anthracite. U.S. Bureau of Mines Bulletin 667.

Whaite, Ralph H., 1965. Microfilming maps of abandoned anthracite mines-Mines of the Eastern Middle Field. U.S. Bureau of Mines Information circular 8274.

Appendix 1

List of Published Mine Map Catalogs

Eaton, W., 1968. Microfilming maps of abandoned anthracite mines-Mines in the Wyoming Basin. U.S. Bureau of Mines Information circular 8379.

Gait, G., 1970. Microfilming maps of abandoned anthracite mines-Mines in the Lackawana Basin. U.S. Bureau of Mines Information circular 8453.

Gait, G., 1978. Microfilming maps of abandoned anthracite mines-Mines in the Southern Anthracite Field. U.S. Bureau of Mines Information circular 8779.

Gait, G., 1971. Microfilming maps of abandoned anthracite mines-Mines in the Western Middle Anthracite field. U.S. Bureau of Mines Information circular 8519.

Whaite, R., 1965. Microfilming maps of abandoned anthracite mines-Mines of the Eastern Middle field. U.S. Bureau of Mines Information circular 8274.

Appendix 2

Addresses and telephone numbers of the mine map repositories

Environmental Field Office
Mine Map Repository
20 N. Pennsylvania Avenue
Wilkes Barre, PA 18701 (717) 826-6333

Eastern Field Operations Center
Mine Map Repository
4800 Forbes Avenue
Pittsburg, PA 15213 (412) 621-4500

Intermountain Field Operations Center
Mine Map Repository
Building 20, Denver Federal Center
Denver, CO 80225 (303) 234-3918

Western Field Operations Center
Mine Map Repository
E. 315 Montgomery Avenue
Spokane, WA 99207 (509) 484-1610

RETRIEVAL OF TECTONIC PROCESS MODELS FROM GEOLOGICAL MAPS AND DIAGRAMS

Kerry L. Burns

Heroy Geology Laboratory, Syracuse University,
Syracuse, New York 13210

Abstract: Graphic geologic information on maps, well logs and sections can be treated in computer-compatible form as graphs in which the spatial distribution and rock unit relationships are contained in a common structure as dual forms termed the spatial or cartographic form and the tectonic or process model. Stratigraphic and tectonic keys, diagrams and other synopses can be derived by formal operations on one form or the other with conversions between them. Tectonic domains can be found as spatial partitions by mapping partitions of the process model into the dual form and competing tectonic models can be tested for compatibility with primary data sources.

The procedures developed to date probably have their greatest utility in compilations at continental scale in studies of global tectonics and regional metallogenesis, but have also been employed to resolve contradictions in compilations of exploration data where the structure is equivalent to the process model but no cartographic dual exists.

Introduction

There are many different types of information in exploration geology and geophysics, the "type" being defined by the rank of material property, whether it is extensive or intensive, whether a finite object or a continuum, and so on. The design of any system of information storage and retrieval requires the definition of data properties and an analysis of whether those properties are preserved on mapping into a computer storage and out again. This review describes progress in dealing with one particular data form found in thematic maps in Geography and in formation maps, stratigraphic keys, sections and tectonic diagrams in Geology. Variants are also found which are not in map form, for example, certain structured grammars used in field note books and high-level languages.

Progress in the computer storage and retrieval of cartographic information has been dispersed and erratic. It seems that each group of workers has operated independently with little reference to previous work at other computer laboratories. The results are not generally widely reported, often appearing in manuals of limited circulation. This review is not, therefore, comprehensive.

Despite the erratic and unconcerted nature of the work, the stage has been reached where cartographic data can be converted into digital form and retrieved, so that it is now feasible to regard a thematic map as simply one form of display of information in a data file. The principal contributions towards that result are described in Cook (1967), Bickmore and Kelk (1972), Bouille (1974, 1976a,b), Burns (1975), Burns and Remfry (1976). The work has been influenced by concurrent work in mathematics (Appel and Haken, 1977).

This report is a general review which aims to explain the conceptual basis of present methods without excessive technical detail and some aspects are simplified.

Digitization of thematic maps

A thematic map of a region is a mosaic, or partition of the region into non-overlapping domains separated by boundaries of several kinds. The domains are homogeneous in some observational property. The map can be described in digital form in one of two ways.

In one method, the region is digitized into an array of elements termed cells or, in image processing, pixels. A classification character is then assigned to each pixel according to the classification of the region in which the pixel lies. This method is used in remote sensing, areal geophysics and in certain branches of resource mapping, an example being the specialized image processor (IIS, 1975). The technique has been favoured in remote sensing because of the direct correspondence between the data base and display devices with matrix addressing. However, it is extremely costly in storage requirements and has poor boundary definition.

Another method is to store, not the domains, but the boundaries between the domains. The boundaries are divided into lines termed segments which terminate at junctions with other segments. The combination is termed a segment-junction graph. Each segment separates two dissimilar domains. The method of digital storage is to first, determine the location (chart coordinates) of all junctions, second, to record the coordinates of a series of points on each segment. In practice, surprisingly few points are needed to accurately define a segment, which is reconstructed on retrieval by an interpolation procedure such as cubic splines. The advantage of this representation is economy and accuracy: in both respects the result is considerably superior to the first method. However it involves a much higher acquisition cost in that it is necessary to manually determine a system of indices for domains, segments and junctions which describe how the system fits together. This method was described by Cook (1967), Bouille (1974, 1976a,b), Loudon et al (1980), and is in commercial use for map production under the name automated cartography (Bickmore and Kelk, 1972).

Properties of thematic maps

The result of map digitization by this method is to generate three sets of indices. There is a linear set of domain indices, D, a linear set of junction indices, J, and a two-dimensional set of segment indices, S. In set-theoretic terms, in the segment-junction graph, the segment indices are the Cartesian product of the junction indices, that is S is a subset of {JxJ}, since each segment joins two different junctions. The map M is then written in the symbolic form $M = \langle S, J \rangle$ where $S \subset \{J \times J\}$

Each index in S and J refers to a block of one or more coordinates in storage, so that retrieval consists of recalling blocks on various indices. To recall on the indices J is to generate a set of points representing the location of junctions. To recall on an index in S is to generate a set of coordinates along a line, and with a suitable interpolation procedure, the segment can be reconstructed.

If we conduct various operations on the indices to produce a new linear set, A, and a new two-dimensional set B, such that $B \subset \{A \times A\}$, then the result is another graph which represents another map denoted M'. This immediately opens up the possibility of treating operations on maps, such as syntheses of several maps into a small-scale compilation, the construction of keys and tectonic diagrams, as a series of operations on the original index sets.

Reduction to normal form

There is a preliminary word of caution. A map cannot be represented as a plane graph unless it is in normal form (Appel and Haken, 1977), which means that each segment has two distinct endpoints and no more than three segments meet at a junction. Since many geological and geographic maps are not of this form, it is necessary to convert them to this form prior to digitization. The procedures are termed normalization and were described by Cook (1967), Bouille (1974). The process of normalization is not reversible, that is, any map can be normalized, but if we reverse the process we find there are several choices.

Reduction to logical form

The set of indices can be reduced to logical form by replacing the set of coordinates corresponding to an index by 0 or 1 according to whether the set is empty or not. The resultant tables then contain entries from a single binary variable and Boolean operations can be applied. Tests of contradictions and ambiguities are developed in this form.

Dual of a map

The segment-junction graph has a dual termed here an arc-node graph in which each node of the arc-node graph corresponds to a face in the segment-junction graph, that is, to a domain in the original map. Conversely, each junction in the segment-junction graph corresponds to a face in the arc-node graph, that is, to a circuit of domains around a junction. The terms face, circuit are used in their usual graph-theoretic sense. The arc-node graph may be denoted $P = \langle T, D \rangle$ where $T \subset \{DxD\}$.

This duality is well-known in cartographic sciences. For example, in a "one-dimensional map" such as a drill-core or stratigraphic section, the segment-junction graph corresponds to the spatial succession, the dual is the temporal sequence. In maps prepared as a series of plates for multiplate colour reproduction, the black line plate corresponds to the segment-junction graph, while the colour separates correspond, in a fashion, to the dual form.

Bouille (1974) was the first to recognize that the stratigraphic legend of a map is the dual of the logical form of the segment-junction graph, which defines the stratigraphic key, formation legend, or theme index, as a derivative of the map. Burns (1975), reasoning on different grounds, showed that the sequence of events, geological history, or tectonic process model was a structure of this form which could be obtained from map-reading (Burns, 1975) or from syntheses of field notebooks (Burns et al, 1977).

Accordingly, it now seems appropriate, with geological maps, to describe the segment-junction graph as the cartographic form and the dual of the logical form of that as the process model. The process model is a formalized description of the succession of geological events that occurred in creating the rock types and their mutual interrelationships in the region of the map or text.

This duality is well-known and has been exploited by mathematicians in solution of the four-color problem (Appel and Haken, 1977) and is incorporated in some modern graphics systems where the arguments of shade functions are region boundaries expressed in segment-junction form. The dual form has meaning in geology because, since the time of Hutton, it has been known that formation boundaries have process significance. This is not necessarily true in all thematic maps, for example, county boundaries on an urban map do not have a physical significance comparable to that of unconformities, intrusive boundaries, sedimentary contacts or metamorphic fronts. So what distinguishes a geological map from other thematic maps is the process significance that attaches to the dual.

Applications Examples

Cook (1967), Bouille (1976a), show how to construct the data file corresponding to the map.

Bouille (1976a, 1976b) shows how to derive a stratigraphic process model from the data bank. He terms this the stratigraphic summary graph. This model should have the same structure as the stratigraphic legend and can be used to check for logical contradictions between the map and legend. Burns and Remfry (1976) showed that some published maps do contain such contradictions and provide a method for deriving a stratigraphic legend which is consistent with the map.

A method of constructing a process model using data other than stratigraphic, such as igneous, structural, metamorphic data, using maps, notebooks and thin sections, is described in Burns (1975), Burns et al (1977), Krishnanath (1979).

In some complex terrains, particularly in poorly-exposed Archeaean terrains, some of the rock relationships may be obscure and the compiler of a regional study may have to go to press with an interpretation that cannot be verified. Burns and Remfry (1976) show how two different interpretations of the tectonic history may both be consistent with the same map.

In compiling regional surveys between different maps or different field geologists, the compiler may face problems in that different geologists produce different interpretations in different regions. Burns et al (1977) give an example where it was possible to detect and to resolve differences between a number of observers in the names they were assigning to field observables; thus providing a basis for compilation by resolving contradictions between different observers.

Sometimes a single observer may make an error and contradict himself, an error which is extremely difficult to locate in a voluminous data file. Burns et al (1977) give an example where it was possible to detect an error of this type in a data file and to determine the outcrop (of several hundred) at which the error was made.

Tectonic profiles or diagrams, which are diagrams resembling cross-sections which are not geometrically accurate but purport to show the rock interrelationships at depth, are a mapping of the process model P into cartographic form. Since this transformation is not unique, it means that all we can do with tectonic profiles is verify them: that is, the dual P' derived from a tectonic profile should be the same as the dual P derived from the source geological maps or texts.

Tectonic maps, which divide a region into subregions of common origin or history of development, can be described as the mapping of partitions of P back into the cartographic form M. For example, subduction event might be recognized as a sequence of stratigraphic and structural events in P forming a process subgraph. Regions to which this subgraph applies are then delineated as fossil subduction zones. This concept offers one means of finding target areas appropriate to various models of metallogenic process.

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THE USE OF JOURNAL CITATIONS IN THESES AS A COLLECTION DEVELOPMENT METHODOLOGY

John D. Crissinger

Geology Library, Virginia Tech, Blacksburg, VA 24061

Abstract: Inflation has taken a heavy toll on library budgets. Spiraling serial costs have forced bibliographers to reevaluate their purchasing methodologies. The impact of rising prices and declining "free" services is increasingly being felt by geoscience libraries. One methodology which may help counter the situation is the review of journal citations used in theses' bibliographies to assist in collection development. This practice has been done in various subject fields and is quite applicable in the geoscience area.

This paper attempts to explore journal citation analysis as a viable collection development methodology to aid in alleviating misapportioned monies in the serial selection process. The age of owning "everything" and obtaining all serials listed in the *Bibliography and Index of Geology* or by *Chemical Abstracts* is past. The era of interlibrary cooperation and resource sharing has become mandatory. Theses from each geoscience field reflects a pattern that is both interesting and useful in planning. By reviewing the journal citations in the theses a pattern will emerge that assists the bibliographer in deciding which serials to purchase for his/her local library and which ones to rely upon via cooperative borrowing.

INTRODUCTION

As Kriz (1978) so aptly stated, "A library must serve the local group of authors, not a subject field. Thus a librarian needs to know what is being used and cited by those who use the library, not what is being cited by those who publish in a particular set of journals." A university library has as one of its primary missions the support of the curriculum of that university.

This paper attempts to employ Kriz's statement as it applies to a moderate sized geoscience collection supporting a nationally recognized graduate program in the geological sciences. Selection and de-selection, therefore, become important aspects of the geoscience librarian's job. To more fully comprehend the intracacies of collection development a knowledge of the user's needs must be taken into account. The graduate student body is one of the primary user groups utilizing journals in support of research for the thesis requirement, thereby suggesting journal titles needed on a local scale to complete this basic research. Analysis of theses citations, therefore, can be an invaluable collection development tool.

LITERATURE REVIEW

Escalating costs of journals (see Clasquins and Cohen for example) coupled with inflation-fed, spiraling monographic prices (see Picard, etc.), have made the librarian's job of collection development increasingly more difficult. Kriz (1975) comments that "the particular way in which a library adjusts to a budget restriction will depend strongly on local conditions, such as the current state of the collection, current and projected use of the collection, and previous budget adjustments."

Brown and Phillips point out that journal prices in geology have risen nearly 15% in the past year with 53% of the titles increasing in price. Garfield (1972) and others have shown that a small percentage of titles satisfies most journal citations with the majority primarily from recent volumes. However, the fact that geology relies more on older materials than many of the other sciences has been verified by Craig. Flynn has defined the three options we, as geoscience librarians, face: first is to acquire or not acquire; second is to continue or discontinue a subscription; and third is to weed or not weed a backset. Associated with these decisions is the importance of the value aspect of use, i.e., some titles are more valuable, some users are more valuable (hobby vs research), and some purposes or projects for which a journal is intended are of more importance. Studies on cost per citation such as those by Goehlert have raised interesting considerations on subscription and retention. Questions involving retention and storage problems have been addressed by Rice in her work on serial use. White has presented ideas on how to accept dwindling financial resources rather than just giving an appearance of action while Broude has set forth a journal de-selection model for the journal collection.

Actual serial citation analysis in geology has been investigated by Craig, Fenner and Lloyd, Garfield (1974) and Thruston and in crystallography by Hawkins. Work on the thesis aspect of citation analysis has been basically restricted to Chambers and Healey in education, Kriz (1977) in engineering, and Farrar in geology. The objective of this paper, then is to determine the value of citation analysis in theses as a journal collection development methodology.

METHODOLOGY

Virginia Polytechnic Institute and State University, also known as Virginia Tech, is a state supported, land grant institution located in the Southern Appalachians in southwestern Virginia. The student body numbers 20,000 supported by a library of 1 1/4 million volumes. The Department of Geological Sciences presently has about 80 graduate students in its M.S. and Ph.D. programs, the only university offering such a program in the state. This study considered the 102 theses in geology completed between 1970 and 1979. Table 1 shows the division of theses by degree and basic field of study.

TABLE 1. THESES BY FIELD OF STUDY AND DEGREE

	M.S. theses	Ph.D. Theses	Total Theses
Paleontology	10	3	13
Seismology	12	1	13
Geology	32	7	39
Mineralogy	22	9	31
Other	5	1	6
Total	81	21	102

A total of 6,443 citations were analyzed and divided between journal and non-journal. Journals consisted of regularly published serials or serials with a consistent number of issues per volume, thereby including the GSA Abstracts With Programs but not the British Museum (Natural History) Bulletin. The study began with the intent of evaluating the theses of four different universities; however, although the comparison may be of interest, based upon the results of the data collected from Virginia Tech, justification could not be made for investigation of another "local area." Shown in table 2 is the division of citations by field of study and degree.

TABLE 2. NUMBER OF CITATIONS BY FIELD OF STUDY AND DEGREE

	M.S.	Ph.D.	Total	Average Per M.S.	Average Per Ph.D.
Paleontology	1282	500	1782	128	67
Seismology	447	28	475	37	28
Geology	1700	699	2399	53	100
Mineralogy	941	583	1524	43	65
Other	192	71	263	38	71
Total	4562	1881	6443	56	90

CONCLUSIONS

Two types of results were obtained. First, the majority of highly cited journals were as expected - GSA Bulletin, American Mineralogist, and so forth - with the most cited M.S. journal being American Journal of Science (223 citations) and Ph.D. journal being American Mineralogist (96 citations). The American Journal of Science ranking is largely attributed to the Cooper volume which dealt extensively with Appalachian geology. This volume was dedicated in memory of Byron Cooper, the chairman of the Geology department at Virginia Tech in the 1960's and early 1970's. Table 3 presents the citation frequency of journals for both degrees in the field of study used.

TABLE 3. NUMBER OF JOURNAL CITATIONS BY FIELD OF STUDY AND DEGREE

	#/MS	%/MS	#/PhD	%/PhD	Total #	Total %
Paleontology	741	58	288	58	1029	58
Seismology	244	55	20	-	264	56
Geology	841	49	276	39	1117	47
Mineralogy	642	68	419	72	1061	70
Other	76	40	15	-	91	35
Total	2544	56	1018	54	3562	55

Journal citations accounted for 56% of the M.S. references and 54% of the Ph.D. references. These two combined gave an overall journal citations rate of 55% or 3,562 journal citations out of a total number of 6,443 citations. The interesting aspect of table 3 is the journal citations by field of study.

The comparison of M.S. to Ph.D. citations reveals a close similarity; there appears to be little difference in the rate of journal use between a master's student and a doctoral student. However, the contrast of the fields of study is quite striking.

Students working on traditional geologic topics (here defined as "the geology of ____ quadrangle" for example) list nonjournal references more often than journal ones. They do, however, use other serials therefore keeping the overall serial count quite high but their reliance on journals is not as great as the other fields of study.

Paleontologists are noted for the extensive lists of references compiled and the great diversity of language and age of citation. Because of the reliance upon plates for the various fossil subjects dealt with, their literature is both the most difficult to purchase or borrow. Citations from paleo theses, although not reflected in the data presented here, covered a wide span of years and languages in sources that are difficult to borrow under present interlibrary loan restrictions on journal lending.

Mineralogy which included crystallography and geochemistry depended greatest on journals (70%). This can best be explained by the currency of information required when researching into a mineral that comes mostly through journal publications.

Local journals such as Virginia Minerals were not cited nearly as often as expected while local journals for other regions (such as the Corpus Christi Geological Society Bulletin) were virtually never cited. Popular journals had few citings coupled with no historical value. Newsletters were rarely cited as could be expected. Interestingly, abstracts were heavily referenced with the GSA Abstracts With Programs being the 4th most cited journal, even though it ranked 13th in the Ph.D. theses. Master's candidates appear to rely quite heavily on abstracts. Table 4 lists the top journals cited by masters' candidates while table 5 lists those of the doctoral students. The American Journal of Science alone filled 5% of all M.S. references while American Mineralogist filled 5% of all Ph.D. references. The top five journals satisfied 35% of all M.S. journal citations and 31% of all Ph.D. journal citations. Seventy-five percent of all M.S. journal citations and 66% of all Ph.D. journal citations were filled by the top 25 titles used.

As shown in table 6, the composite of the two lists displays the top 25

TABLE 4. TOP TWENTY-FIVE JOURNALS CITED IN MS THESES BETWEEN 1970-1979

Citation Rank	Title	# of Citations
1	Am. J. Sci.	223
2	Geol. Soc. Am., Bull.	203
3	Am. Mineral.	143
4	Geol. Soc. Am., Abstr. Programs	134
5	J. Paleontol.	120
6	Seismol. Soc. Am., Bull.	86
7	Am. Assoc. Pet. Geol. Bull.	82
8	J. Geol.	79
9	Econ. Geol.	71
10	Contrib. Mineral. Petrol.	69
11	J. Sediment. Petrol.	67
12	Palaeontogr. Abt. A & B	62
13	J. Geophy. Res.	58
14	J. Petrol.	48
15	Acta. Cryst.	45
16	Neues Jahrb. Geol. Palaeontol.	41
17	Geophysics	39
18	Min. Mag.	37
19	Palaeontology	33
20	Am. Geophys. Union. Trans.	32
21	Southeast Geol.	29
22	Micropaleontology	28
23	Science (AAS)	22
23	Z. Kristallogr.	22
23	Geochim. Cosmochim. Acta	22

TABLE 5. TOP TWENTY-FIVE JOURNALS CITED IN PH.D. DISSERTATIONS BETWEEN 1970-1979

Citation Rank	Title	# of Citations
1	Am. Mineral.	96
2	Acta. Cryst.	63
3	Geol. Soc. Am., Bull.	60
4	J. Sediment. Petrol.	48
5	Am. J. Sci.	46
6	J. Geol.	42
7	Am. Assoc. Pet. Geol. Bull.	27
7	Z. Kristallogr.	27
9	Contrib. Mineral. Petrol.	26
10	J. Paleontol.	25
11	Min. Mag.	24
12	Palaeontogr. Abt. A & B	21
13	Geol. Soc. Am. Abstr. Programs	20
13	Neues Jahrb. Geol. Palaeontol.	20
15	J. Petrol.	19
16	Micropaleontology	16
17	Am. Geophys. Union. Trans.	12
17	Palaeontology	12
17	Science	12
20	Geophysics	11
20	Neues Jahrb. Min.	11
22	J. Chem. Soc.	10
22	Econ. Geol.	10
22	J. Geophy. Res.	10
25	Can. J. Earth Sci.	8
25	Geochim. Cosmochim. Acta	8

TABLE 6. TOP TWENTY-FIVE JOURNALS CITED BETWEEN 1970-1979

Citation Rank	Title	# of Citations
1	Am. J. Sci.	269
2	Geol. Soc. Am., Bull.	263
3	Am. Mineral.	249
4	Geol. Soc. Am., Abstr. Programs	154
5	J. Paleontol.	145
6	J. Geol.	121
7	J. Sediment. Petrol.	115
8	Am. Assoc. Pet. Geol. Bull.	109
9	Acta. Cryst.	108
10	Contrib. Mineral. Petrol.	93
11	Palaeontogr. Abt. A & B.	83
12	Econ. Geol.	81
13	J. Geophys. Res.	68
14	J. Petrol.	67
15	Min. Mag.	61
15	Neues Jahrb. Geol. Palaeontol.	61
17	Geophysics	50
18	Z. Kristallogr.	49
19	Palaeontology	45
20	Micropaleontology	44
20	Am. Geophys. Union Trans.	44
22	Science	34
23	Geochim. Cosmochim. Acta.	30
24	Southeast. Geol.	29
25	Neues Jahrb. Min.	28

most used journals in the Geology Library at Virginia Tech for support of the graduate thesis requirement. American Journal of Science is the most heavily cited journal filling 8% of all journal citations and 4% of citations overall. The top three journals satisfy 22% and 12% respectively while the top 5 fill 30% and 17% respectively. The list of 25 journals fills 67% of all journal citations and 37% of all citations used.

Generally the results and listings are what basically would be expected after reviewing Craig, Garfield, Fenner, Thruston, or Hawkins' research. So why pursue such a study, and should other librarians do it in their own library? The answer to this is yes and lies in the second set of results - those which were not part of the original intent of the paper but which have become the more important aspect of the study.

UNEXPECTED CONCLUSIONS

The unexpected conclusions are those not part of the original intent of the paper but arrived at independently. Subsequently, these have become the more important aspect of the study.

One is a statement of fact. Computer assisted citation analysis is the only method by which to pursue citation analysis - sanely that is.

Secondly, the importance of maintaining an adequate budget for the purchase of monographic and non-standing order type serial titles is demonstrated quite well.

Thirdly, one's philosophy on collection development, binding, and retention policies will be altered.

An important fourth point is the greatly increased awareness gained of local geology and research within the department.

Fifth is the acquired knowledge of new or other materials needed in the library such as theses, reports, and articles in "offbeat" journals - for example, the University of Missouri (Rolla) Journal made up .3% of the M.S. journal citations based solely on one article by Byron Cooper.

The sixth point addresses involvement in library education. References apparently receive less review evaluation than the text of the theses and this is reflected in the quality of the citations. Spot checks from several universities reveal frequent bibliographic errors. Therefore, librarians should become involved in the review of the references used, making a notable contribution to their department and greater exposure for their library.

Seventh is the fact that some journals are retained to provide financial support for geological societies in other areas of research.

Eighth raises the question of collection sharing - who is going to purchase and store the relatively unused journals so others may borrow them? An example here is a Russian journal at Virginia Tech which has been used only once in three years and that was for an interlibrary loan.

Ninth is that the study aids the researcher in maintaining an awareness of current library literature which is usually difficult. An example here is the journal Serials Librarian which is quite interesting and useful for collection development.

Tenth is unsubstantiated, but mineralogists appear to rely more on the use of a few titles for a large number of their references per thesis. Although this may be an interesting topic to investigate, these titles would differ from thesis to thesis.

Eleventh is the fact that this project has great value for a newly established department or degree program to assist in identifying key titles in the same local region; as an example, the identification of titles in geography theses from the University of North Carolina at Chapel Hill would be very beneficial as a collection development aid for Virginia Tech's new graduate program in Geography.

SUMMARY

Based on this study, no suggestion of massive journal cancellations is being made; but, as Garfield continues to point out, a few titles do satisfy the large majority of needs. Doing without a number of titles will cause little if any inconvenience to the student. In contrast, the duplication of heavily used monographic titles for improved service may be the better investment. Budget cuts will force a reallocation of our resources which, more often than we maybe believe, will be less painfully felt by journal cancellations than be lack of monographic duplicates.

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USING GEOREF, GEOARCHIVE, SCI, AND SSIE IN UNDERGRADUATE TEACHING

Donald B. McIntyre

Department of Geology
Pomona College, Claremont, CA 91711

Abstract: For ten years I have taught an undergraduate class in which students use primary literature as they study topics related to global tectonics. Because the library does not assist with online searching, I collaborate with the class in designing and performing searches. I consider the experience an essential part of the training needed by students preparing for a career in geology.

The databases that proved most useful were GeoRef, Science Citation Index, and Smithsonian Science Information Exchange, but when Lockheed made GeoArchive available we began using this also. It is not a simple matter to compare competitive databases, such as GeoRef and GeoArchive, that are supported on different computer systems, but I was forced to try to do so. My experience with the four databases is the subject of the paper.

1. GeoRef is the database I find most useful. It provides high quality coverage of the literature I need, and the indexing is thorough. Rapid progress is being made to include older literature.

2. GeoArchive is less comprehensive than GeoRef. Certainly this is so as far as the years covered is concerned, and I frequently need references that are too old for GeoArchive. The numeric indexing system may have some theoretical advantages, but my preference is for the flexibility provided by the large number of index terms used by GeoRef.

3. Science Citation Index is invaluable for finding recent papers that refer to already known older articles.

4. Smithsonian Science Information Exchange provides an index to work in progress. This is useful to students who are choosing a graduate school.

I. INTRODUCTION

> "Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it. When we enquire into any subject, the first thing we have to do is to know which books have treated of it. This leads us to look at catalogues, and the backs of books in libraries." ("Boswell's Life of Johnson", Edited by George Birkbeck Hill, 1887, Vol. 2, p.365: April 18, 1775.)

Samuel Johnson, the author of the first Dictionary of the English Language, recognized the importance of indexing information for later retrieval. He would doubtless have been happy could he have seen the tools that online bibliographic databases have placed at the disposal of today's researchers.

In teaching an undergraduate course on aspects of global geology, I constantly find that I must deal with topics sufficiently new or out of my normal concern that I need help in compiling a bibliography. I do not usually need a complete bibliography, but rather a short list of references that provide entry into the subject matter.

The four bibliographic databases discussed in this paper are those I use most commonly; namely,

Database	Source	Supplier
GeoRef	AGI	SDC Orbit
GeoArchive	Geosystems	Lockheed Dialog
SCI	ISI	Lockheed Dialog
SSIE	SSIE	SDC Orbit

AGI	American Geological Institute
SDC	System Development Corporation
SCI	Science Citation Index
ISI	Institute for Scientific Information
SSIE	Smithsonian Science Information Exchange

Note: It is expected that Lockheed will make GeoRef available early in 1981.

Interested readers should obtain detailed information on these databases directly from the organizations that produce them or make them available. I am not a spokesman for the editors, producers, or suppliers, and I do not intend to describe here either the scope and structure of the databases or the command languages by which they can be searched online through SDC's Orbit or Lockheed's Dialog. In this paper I report my own experience.

The following documents are useful to anyone searching these databases:

I. GeoRef:

1. GeoRef Thesaurus and Guide to Indexing. 2nd Edition, 1978. (A new edition is in preparation). American Geological Institute.

2. Serials in GeoRef and KWOK Index to Serials in GeoRef. 1978. American Geological Institute.

3. Microform Index Listing for GeoRef. 1979. System Development Corporation.

4. Orbit User Manual. 1979. System Development Corporation.

5. GeoRef User Manual. 1979. System Development Corporation.

II. GeoArchive:

1. Geosaurus: Geosystems' Thesaurus of Geoscience. 3rd Edition, 1978. Geosystems.

2. Guide to Dialog Searching. 1979. Lockheed Dialog Information Retrieval Service.

3. GeoArchive: File 58. Preliminary Edition, 1978. Dialog Information Retrieval Service.

Note: In January 1978 Geosystems advertised the "GeoArchive Users' Guide", 2nd Edition, 1978, and "Geosources: Geoserials and Geopublishers", 3rd Edition, 1978. However, although I ordered these publications in March 1978, I have not received them or seen copies.

III. Science Citation Index:

1. User's Guide to Online Searching of SCISEARCH and SOCIAL SCISEARCH. Not dated. The Institute for Scientific Information.

2. Guide to Dialog Searching. 1979. Lockheed Dialog Information Retrieval Service.

3. How to Search the Science Citation Index. 1977. The Institute for Scientific Information.

IV. Smithsonian Science Information Exchange:

1. Guide to SSIE Subject Indexes and Vocabulary. 1975. Smithsonian Science Information Exchange.

2. Orbit User Manual for SDC/SSIE. 1975. SDC Search Service.

3. SSIE Subject Terms and Synonym List. Not dated. Smithsonian Science Information Exchange.

II. GEOREF and GEOARCHIVE

To create a bibliography, one formerly had to use printed sources, the most important of which is the "Bibliography and Index of Geology", but today one can search GeoRef online. GeoRef not only covers the "Bibliography and Index of Geology", but is adding references from the "Bibliography and Index of North American Geology", "Bibliography of Theses in Geology", "Geophysical Abstracts", and the "Bibliography and Index of Geology Exclusive of North America". It is expected that the addition of these references will be completed by October, 1981. GeoRef will then contain about 970,000 references covering the period 1785 to the present for North America and 1933 to the present for other areas.

In using a printed index, the searcher ought to know the key words and their hierarchy. The "Bibliography and Index of Geology" uses three levels of indexing, which means that a 'set' (or complete index entry) has three parts; a first-level, a second-level, and a third-level term. The following examples illustrate this:

'Earthquakes' is used on levels 1 and 2 for studies emphasizing individual earthquakes, and on level 2 under the first-level terms 'Geologic hazards', 'Seismology', and 'Mantle'; e.g. the papers in the Symposium on "Volcanism and Upper Mantle Earthquakes" (Inter. Union Geod. and Geophysics, Moscow, 1971) are indexed under Mantle (1), Earthquakes (2); whereas the paper on "Multiple SCS Travel Times in the Western Pacific: Implications for Mantle Heterogeneity" (Jour. Geophys. Res. 85, 1980, p.853-861) is indexed under Seismology (1), Mantle (2), and S-Waves (3), and also under Pacific Ocean (1), Seismology (2), and Mantle (3), but it is not indexed under Mantle as a first-level term.

'Borates' includes use on level 2 under the first-order term 'Minerals', and on level 3 as a commodity term under first-level term 'Boron'; e.g. Boron (1), Production (2), and Borates (3). It is also indexed on level 3 under first-level term 'Sediments' and second-level term 'Chemically precipitated sediments'.

'Boudins' includes use on level 3 under the first-level terms 'Deformation', 'Structural analysis', and 'Lineation'.

To search for papers dealing with ore-deposits at plate boundaries one can use the terms 'Mineral deposits, genesis' (1), 'Processes' (2), and 'Plate tectonics' (3); 'Mineral deposits, genesis' (1), 'Copper' (2), 'Plate tectonics (3); or 'Plate tectonics' (1), with second-level terms such as 'Concepts' or 'Effects', and third-level terms such as 'Metallogeny', 'Metallogenic provinces', 'Mineralization', or 'Ore deposits'.

The key to this hierarchy is the "GeoRef Thesaurus and Guide to

Indexing", without which the investigator cannot expect to perform a thorough search. In using the online file, GeoRef, one must still know what terms are appropriate (e.g. 'earthquakes' rather than 'earthquake', 'seismic', or 'temblor'), but one is not dependent on a hierarchy. There are times, however, when it is useful to restrict a search by designating that a key word be recognized as a first-order term, and this can be done when desired by prefixing a *; e.g. *Mineral deposits AND *Genesis AND *Plate tectonics. It is advisable to allow the imagination free rein while one makes a preliminary list of index terms, and then to check each of these in the Thesaurus to be sure that one uses the best possible terms in the search. Another resource is the microfiche listing of index terms with their frequencies. This can be consulted offline and used to determine suitable truncated (abbreviated) terms.

An advantage of online searching is that the search is always in the current version of the file. A number of Journals (including the Bulletin of the Geological Society of America, the Bulletin of the Seismological Society of America, Geochimica et Cosmochimica Acta, and the Journal of Sedimentary Petrology) are indexed for GeoRef directly from page proofs. Moreover an online search covers any time-span within the limits of the database, whereas searching in the printed Bibliography must be done year by year, or in the case of the current year, month by month.

GeoRef is produced by the American Geological Institute; GeoArchive by Geosystems, London, England. At the present time GeoRef is publicly available in the United States only through SDC, and GeoArchive only through Lockheed, although Lockheed will have both databases on its Dialog system early in 1981. Comparison between two competitive databases is not easy, especially when they are supported on different computer systems. The indexing systems used on GeoRef and GeoArchive are quite different; the set of terms that gives a successful search on one database is not necessarily successful on another, even though the required references may be present in both. Furthermore the database can be tested only through the computer system, and SDC's Orbit and Lockheed's Dialog are so different that a user who is very familiar with one may not know that he is making poor use of the other.

As an illustration of the differing responses of GeoRef and GeoArchive, consider a search for Granite. On GeoRef, if we enter 'Granite' we get 12,618 hits; if we enter the truncated term 'Granit:' (to include such terms as 'Granitic', 'Granitoid', or 'Granitization') we get 17,752 hits. On GeoArchive 'Granite' gets 909 hits and the truncated form 'Granit?' gets 3,182. (Note that truncation is effected by : in SDC's Orbit and by ? in Lockheed's Dialog). GeoArchive uses a strictly hierarchical set of index terms, documented in "Geosaurus: Geosystems' Thesaurus of Geoscience", 3rd Edition, 1979. Each descriptor is identified by a 6-digit descriptor code.

The following is a sample:

541400	Migmatites and migmatitic structures
541500	Granitisation
541600	Granite series
542000	Igneous intrusions
542200	Plutons, stocks, and bosses
542300	Batholiths
542400	Ring Intrusions
542900	Igneous rocks
543000	Plutonic rocks
543100	Granites and adamellites
543200	Granodiorites
543300	Pegmatites and aplites
543400	Syenites

The following representative searches illustrate the way in which this numeric hierarchy of descriptor codes can be used:

Search	Set number	Number of hits
DC=543100	1	2751
DC=5431?	2	2751
DC=543200	3	218
DC=543100:DC=543299	4	2924
DC=541600	5	33
DC=541600:DC=541999	6	106
DC=541400:DC=541599	7	422
1 or 2	8	2751
8 or 4	9	2924
9 or 6	10	2987
10 or 7	11	3274
(DC=541400:DC=541699) or (DC=543100:DC=543299)	12	3238
Granit?	13	3182

The postings that do not overlap between sets 12 and 13 are rocks such as Migmatites, Granodiorites, or Diorites, that are not indexed under 'Granit?'. Or they are Granitoid Gneiss and the like that have not been indexed by the descriptor codes for Migmatites or Granite Series, etc, probably because the source citation is indexed under general terms such as 'Petrogenesis', 'Igneous geochemistry', 'Magmatic provinces', 'Plutons', 'Gneisses', etc.

Suppose we wish to search for Adamellite, which is grouped with Granite as Descriptor Code 543100 in GeoArchive's Geosaurus. Using GeoRef, the truncated term 'Adamellit:' yields 339 hits; 'Adamellite' being a third-level term under 'Igneous rocks' (1) and 'Granite-granodiorite family' (2). Knowing that many citations in GeoRef do not occur in the smaller GeoArchive file, and because GeoArchive on October

31, 1980, had coverage only from 1974 through April 1980 (unlike GeoRef that ranged from 1961 through November 1980), I restricted the GeoRef hits by confining the result to publication years 1976-78 (64 hits), and not Abstracts (49 hits), and English Language (42 hits). After inspecting the first 15 of these postings, I chose the two I thought most likely to be included in GeoArchive. One has 'Adamellite' in the title and the other does not.

The two postings are:

Facer, R.A. Geochemistry and Heat Generation in the Durandal Adamellite at Yetholme, New South Wales. Linn. Soc. N.S.W., Proc. (Aus) 102, No. 449 (1977) p.26-35.

Max, M.D. and others. The Galway Granite. Irel. Geol. Surv., Bull. 2, No. 3 (1978) p.223-233.

Turning now to GeoArchive, I made the following searches:

Search	Set number	Number of hits
DC=543100	1	2751
Adamellit?	2	2757
1 and 2	3	2751
Yetholme/Ti	4	1
Galway(W)Granite/Ti	5	5

The single posting with 'Yetholme' in the title is a discussion, published in J. Geol. Soc. Aust. 24/1-2 p.121-123, of a paper by R.A. Facer in J. Geol. Soc. Aust (23) 76 p. 243-248. The paper retrieved in GeoRef is apparently not in GeoArchive. None of the five postings with 'Galway Granite' in the title correspond to the paper retrieved in GeoRef. A search on the Authors of that paper also failed to find the citation in GeoArchive. GeoArchive is not sufficiently complete for me to finish the comparison of postings of papers on 'Adamellites' in the two databases.

Because 'Granites and adamellites' is a single descriptor in GeoArchive, every paper indexed under 'Adamellites' is necessarily indexed also under 'Granites'. It is therefore impossible to distinguish between 'Granites' and 'Adamellites' in searching GeoArchive. There is no such built-in restriction for GeoRef.

Spelling is, of course, important, as the following example on GeoArchive illustrates: 'Granitization' 31 hits; 'Granitisation' 194 hits; 'Granitiʔation' 199 hits.

It is a simple matter to determine the number of entries in a database on SDC's Orbit by a command like 'Granite or Not Granite'. On October 29, 1980, the number of postings in the database was 636,428. Because Lockheed's Dialog system does not permit the search 'Granite or Not Granite', one cannot use this technique on GeoArchive. However, one can list the number of citations for each publication year and add these together to determine the size of the GeoArchive file. This also yields interesting information about GeoArchive's coverage as of November 1, 1980, when the total number of items in GeoArchive was 269,382, and the last update was April 1980.

Years	Number of Citations
Invalid years	39
Before 1960	16
1960 through 1968	123
1969 through 1972	16,241
1973	15,452
1974	38,792
1975	44,084
1976	46,668
1977	40,535
1978	35,211
1979	28,923
1980	3,298

The size of a file can, of course, be misleading as an indicator of quality. I have found that many of the entries that I retrieve from GeoArchive turn out to be in a category that might be called news items. Rather often GeoArchive gives me an item from the program of a meeting when what I am looking for is the formal publication. The following posting is an example of this:

> "Cadomian or Hercynian Main Deformation in Central Brittany. The Hercy nian (sic) Granites, Reply" in J. Geol. Soc. (London) 137/2 (1980) p. 213.

This is a brief abstract of a paper presented at a conference, but in searching GeoArchive one cannot exclude Abstracts as one can do in GeoRef. It might be remarked that the correct title of this reference is "Cadomian or Hercynian main deformation in central Brittany? The Hercynian granites reply!". I have found errors of this sort to be much more frequent in GeoArchive than in GeoRef, though it would be difficult to provide statistics.

Categories indexed by GeoArchive but not by GeoRef include book reviews and the 'News and Views' section of Nature. When these articles are new, they are often very valuable to me and to my students, but it would be unusual for me to search for them online. If you want to find them, you have to use GeoArchive, but to include them in the total count gives a biased figure for the size of the database. It is, of course, a matter of opinion whether news items like these should be included or not; so the point is that comparison of size is by itself inadequate as a criterion of the quality or utility of a database. It does not matter to me how many items that I do not need are included; all that counts is that I successfully retrieve what I am looking for when I make my searches.

I have seen reports of studies in which supposedly identical searches were performed on both GeoRef and GeoArchive, and ratios were computed involving the number of 'relevant' hits. But what is a 'relevant' hit? Surely it is in the eye of the beholder that a hit is recognized as relevant or not, and besides if the number of supposedly relevant hits is disappointingly small, this may be due to an inadequate strategy, to inadequate knowledge of the command language, or even to a difference in the effectiveness of the way in which the database has been loaded on the computer system. It is not certain that it means that the database itself is defective.

At an Online Conference in London in December 1979, C. Oppenheim and S. Perryman, both of the Centre for Information Science, City University, London, gave a paper comparing GeoRef and GeoArchive. The GeoRef searches were repeated by Dr. G.N. Rassam, of the American Geological Institute, with astonishing results (The GeoRef Newsletter, Vol.3, No.1, May 1980). By using better strategies the number of references retrieved in the six searches increased from as little as 147 percent to as much as 334 percent. This illustrates dramatically how much more a skilled user can get out of a file, and how dangerous it is for an inexperienced person to suppose that he can compare two databases by attempting to repeat the same searches on each of them.

A full comparison of the databases should take into account the completeness of the information given for a typical citation, and whether supplementary information is included that could be used for searching. For example, GeoRef allows the user to search for references that include a map, and the scale and character of the map are part of the GeoRef citation. For references added since September 1977, one can even search by latitude and longitude. SDC's Orbit does not have the ranging capability needed to make full use of the coordinate information in GeoRef, but Lockheed's Dialog permits searches based on full ranging of coordinates. The following example illustrates a search performed on a test subset of GeoRef (108,503 items) on the Dialog system:

Search	Set number	Number of hits
LT=N320000:LT=N420000	1	4041
LN=W1140000:LN=W1243000	2	1297
1 and 2	3	906

The latitude (LT) and longitude (LN) fields provide two digits each for minutes and for seconds. The set that results is confined to California and its immediately neighboring areas. An example of a hit is:

"Geochemistry of Dry Stream Sediment and Bedrock Samples, Turbinella-Gambel Oak Instant Study Area, Mohave County, Arizona" (USGS Open-file Report No. 80-136, 1980), which was indexed in GeoRef with coordinates N341500; N370000; W1123500; W1144500.

III. SCIENCE CITATION INDEX

Science Citation Index is a multidisciplinary index, which like Social Sciences Citation Index is available both in printed form and online. At Pomona College the printed form of SCI is available, but the five-year cumulation volumes are not. Whereas users of the printed "Bibliography and Index of Geology" commonly refer to volumes from earlier years, it is more likely that users of SCI will use only the volumes for the current year. But if previous years are also to be searched, the advantage of searching online is very great. SCI is printed in small type.

Unlike GeoRef, SCI's index terms come only from the title. They can be searched through the Permuterm Subject Index (PSI), in which permuted pairs of words are arranged as a two-level alphabetical index; i.e. under any one word is an alphabetical list of other words that occur in association with it in the title of an indexed article.

SCI consists of three indexes: the Source Index, which is an author index to the more than 420,000 articles covered each year; the Permuterm Subject Index, already described; and the Citation Index. Although each is a valuable resource, I find that I use the Citation Index much more often than I do either of the others. The reason is that GeoRef is such a good index for geological literature that it is the obvious first choice. Because GeoRef is more specialized than SCI, it is more complete in its coverage of geological periodicals, and it is indexed far more thoroughly than SCI can be by merely taking words from the titles. With its multidisciplinary scope, SCI could never be indexed as GeoRef is.

The unique feature of the Citation Index is its inclusion of every paper, no matter how old, that has been cited by an article published during the year covered. The online version, SCI, is divided into a file covering 1974-1977, and a file covering 1978 to the present. If you know a paper that can be considered a key reference for a concept, it is likely that later writers will have cited it; and if they have done so, you can find them through the Citation Index.

For example, anyone doing serious work on the measurement of earthquake magnitude is likely to cite C.F. Richter's classic paper: "An Instrumental Earthquake Magnitude Scale", Seismological Society of America, Bulletin v.25, 1935, p.1-32.

Using the Citation Index we find a number of recent papers that cite Richter's 1935 paper. They include:

Kanamori, H.: "Quantification of Earthquakes", Nature v.271, 1978, p.411-414.

Bloom, E.D., and R.C. Erdmann: "Frequency-Magnitude-Time Relationships in the NGSDC Earthquake Data File", Seismological Society of America, Bulletin v.69, 1979, p.2085-2099.

In the first of these, Kanamori introduces a major modification of Richter's 1935 scale. The second cites papers proposing alternative ways of measuring earthquake magnitude, including the use of seismic body waves or seismic surface waves (Gutenberg and Richter, 1954; Richter, 1958), and the concept of seismic moment (Kanamori, 1977) to relate event size to the size of surface faulting.

At a meeting on Computers and Geology held at Syracuse University in October 1979, one of the speakers discussing remote sensing referred to the work of Crain on the distribution of craters on Mars. During a coffee break in the sessions I used my portable terminal to access GeoRef and found the following reference under (CRAIN:/AU OR CRANE:/AU) AND MARS

Crain, Ian K.: "Statistical Methods for Geotectonic Analysis", Int. Geol. Congress, 24th Session, Canada. 1972. Abstracts. vol.24, p.70-71.

Connecting to SCI on Dialog, I found a paper that cited a 1972 publication by Crain:

Buckley, P.A. and F.G. Buckley: "Hexagonal Packing of Royal Tern Nests", Auk, v.94, 1977, p.36-43.

The paper in Auk contains 17 references, some of which are interesting to a geologist concerned with random patterns, such as might occur on Mars or be observed by remote sensing of the Earth.

A feature of Science Citation Index that I find of great interest is the possibility it offers for discovering and mapping interconnections in the literature on a given topic. This has been discussed by Cawkell (1977); and Scrutton (1977) has applied the method to the literature formulating the sea-floor spreading and plate tectonic hypotheses.

IV. SMITHSONIAN SCIENCE INFORMATION EXCHANGE

According to SDC, "SSIE covers research in progress and recently completed research sponsored by over 1,300 Federal, state, and local government agencies; associations and foundations; individual investigators; universities and colleges; and some industrial and non-U.S. organizations. Includes basic and applied research in all areas of the life, physical, social, behavioral, and engineering sciences." The file is available online through SDC; it covers fiscal year 1974 to date, with approximately 108,000 projects per fiscal year of coverage, and it is updated monthly. Because the file is built from sources in the public domain, the amount of information under any one item is much more extensive than is the case for GeoRef, GeoArchive, or SCI, which are usually indexing copyrighted journals or books. This means that in addition to using the set of index terms, one can search on key words from an abstract that may be several paragraphs in length.

I use SSIE when I wish to find out who is presently doing research on a particular topic. For example, one may wish to find out the current research activity of someone whose published work you already know. SSIE has an obvious use, too, for a researcher who is planning a project. One can determine whether any similar work is currently being funded, and so not only avoid unwitting duplication, but possibly learn about someone with similar interests with whom one ought to be communicating. One may even look for a granting agency that might sponsor the project being considered. I use SSIE when advising students who are looking for a graduate school where work along certain lines is being done; or simply to discover something about the research activity of a person or a department.

As an example, consider an enquiry to find out who is currently doing funded research on Mylonites. The truncated term 'Mylonit:' gave me four postings, whose titles and funded amounts were:

1. An experimental study of the rheology of crustal rocks. $64,994.

2. A study of mylonitic rocks from major fault zones. $35,000.

3. Age studies of structures in the Nagssugtoqidian Mobile Belt, West Greenland. $2,832.

4. Structural-petrological study of the Whipple-Buckskin-Rawhide Mountains dislocation terrane, California and Arizona. $70,300.

The full postings are too long to include here, though they are interesting reading. At Brown University the work includes the effect of water on both brittle and ductile deformation; the relationship of the flow law for granite and diabase to those of their consituent monomineralic aggregates; the textures seen in naturally deformed rocks exposed along ancient faults; the effect of annealing on those textures; and optical and transmission electron microscopic study of natural mylonites from ancient faults.

A study of the mylonites within the San Andreas fault system of California is being conducted at the State University of New York at Binghamton. A geologist at Miami University, Ohio, is collaborating with the University of Liverpool in a study of mylonites and pseudotachylites in an ancient zone of weakness in West Greenland. At the University of Southern California two geologists are working on a thrust complex in which the rocks of the lower plate are mainly mylonitized gneisses.

A search on 'Mylonit:' is, of course, a very unsophisticated strategy. If one expected completeness it would be advisable to search on related terms such as 'Cataclastic rocks', 'Pseudotachylite', or 'Thrusting'. But perhaps the scope achieved by the search is sufficient for the purpose intended. A search for 'Cataclast:' AND NOT 'Mylonit:' yielded the following postings:

1. The Batesburg-Edgefield cataclastic zone - a fundamental tectonic boundary in the South Carolina Piedmont.

2. Greenville 2 Degree Quadrangle.

3. Glacier Bay National Monument Wilderness Study Area.

Further information about the investigators who are working on projects of interest can be obtained by looking up their names in current issues of the printed "Bibliography and Index of Geology", or, of course, in the online GeoRef.

V. CASE STUDIES

GeoRef and GeoArchive are the two files of special interest for comparison. The approach I take here is this: first perform a search on one of them; next determine which of the citations found are useful; and finally look for these in the other database by the surest way of finding them (e.g. by author, title, or source). If these citations are found in the second database, then print them in full to determine in retrospect which search strategies would have been successful in finding them. Most of the examples arose in my undergraduate classes during the first two months of the academic year 1980-81.

1. Ore Deposits and Plate Boundaries

On a weekend, when online searching was unavailable, we wanted references that would be a good introduction to the topic of the relationship between Ore deposits and Plate boundaries. First we must think of possible synonyms and use the Thesaurus to determine their status. Once a first-level term is chosen, the Thesaurus usually gives guidance regarding second-level terms to use with it. Because the latest annual compilation of the "Bibliography and Index of Geology" was for 1979, we began with this year, looking under: 'Mineral deposits, genesis' (1), 'Processes' (2), and 'Plate tectonics' (3). (The second-level term, 'Concepts', also includes useful references). The first reference is: Hamilton, W., "An overview: Plate Tectonics - its influence on Man", California Geology, v.31(10), 1978, p.223-228. For further reading Hamilton suggested: Sawkins, F.J., "Sulfide ore deposits in relation to plate tectonics", Jour. Geology, v.80, 1972, p.377-397.

This paper by Sawkins was one of the earliest to treat the topic, and it is therefore a good one to use for a citation search. Referring to the printed Citation Index for 1979 (the latest complete year), we find several recent articles that cited the Sawkins paper. They include: Francheteau, J., and others, "Massive deep-sea sulphide ore deposits discovered on the East Pacific Rise", Nature, v.277, 1979, p.523-528. The Citation Index for Jan.-Feb. 1980 gives: MacGeehan, P.J., and MacLean, W.H.: "Tholeiitic basalt-rhyolite magmatism and massive sulphide deposits at Matagami, Quebec", Nature, v.283, 1980, p.153-157; and Sillitoe, R.H. "Are porphyry copper and Kuroko-type massive sulfide deposits incompatible?", Geology, v.8, 1980, p.11-14. Both refer to ore deposits that probably had their origin at either constructive or destructive plate boundaries.

Under 'Mineral deposits, genesis' (1), 'Processes' (2), and 'Plate tectonics' (3), the 1978 Bibliography gives: Tarling, D.H., "Some economic implications of continental drift", Naturwissenschaften, v.64, 1977, p.16-22, which also cites Sawkins' 1972 paper. Under 'Mineral deposits, genesis' (1), 'Processes' (2), and 'Hydrothermal processes' (3), the 1978 Bibliography gives: Bonatti, E., "The origin of metal deposits in the oceanic lithosphere", Sci. Amer. v.238(2), 1978, p.54-61. This is not only a good introduction, but it cites an earlier review article by Bonatti on "Metallogenesis at oceanic spreading centers", Ann. Review of Earth and Planetary Sciences, v.3, 1975, p.401-431. (This reference is incorrectly given in GeoRef as by Bonnatti.) Under the same set of index terms we also find: Rona, P.A., "Plate tectonics, energy and mineral resources: basic research leading to payoff", EOS Amer. Geophys. Union, Trans. v.58(8), 1977, p.629-639. (This reference is cited in GeoRef as an abstract, although it is 11 pages long and has an extensive and useful bibliography.)

After consulting the bibliographies in these eight papers, I was able to list about 20 references, all of which were available in our library. Among the most useful additional references found were these:

Garson, M.S., et al, "Mineralization at destructive plate boundaries; a brief review", In "Volcanic processes in ore genesis", Inst. Mining Metallurg., London, 1977, p.81-97.

Sillitoe, R.H., "A plate tectonic model for the origin of porphyry copper deposits", Econ. Geol., v.67(2), 1972, p.184-197.

Sillitoe, R.H., "Tin mineralisation above mantle hot spots", Nature, v.248, No.5448, 1974, p.497-499.

Strong, D.F., "Metallogeny and plate tectonics", Geol. Assoc. Canada, Sp. Paper 14, 1976, 660p.

Walker, W., "Metallogeny and global tectonics", Benchmark vol. 29, 1976, 413p., Dowden, Hutchinson and Ross.

Wright, J.B., "Mineral deposits, continental drift and plate tectonics", Benchmark vol. 44, 1977, 417p., Dowden, Hutchinson and Ross.

If we took every reference from each of these sources, and used the more important of them as citation entries in SCI, the resulting bibliography would be extensive. But for my present purpose we have sufficient to compare the treatment of these references by GeoRef and GeoArchive.

I found fourteen papers by starting with GeoRef and SCI and then consulting the bibliographies given in the original documents. The papers forming the test set are by Bonatti (1975, 1978), Francheteau (1979), Garson (1977), MacGeehan (1980), Rona (1977), Sawkins (1972), Sillitoe (1972, 1974, 1980), Strong (1976), Tarling (1977), Walker (1976), and Wright (1977). All fourteen are in GeoRef, but the misspelling of Bonatti would prevent the 1975 paper from being found if the search depended upon the author's name. Likewise Rona's paper would not be found if the search excluded abstracts, though the paper is a substantial one.

Searches based on the author's name or words taken from the title show that half of the references are not in GeoArchive; namely, Bonatti (1978), Rona (1977), Sawkins (1972), Sillitoe (1972), Tarling (1977), Walker (1976), Wright (1977). The last two are indirectly represented in GeoArchive by book reviews.

Seven of the fourteen are found in both GeoRef and GeoArchive. To aid comparison, they are listed here in pairs, one from each database, in alphabetical order of the first author's name.

Abbreviations used by GeoRef under SDC's Orbit system are: TI Title; AU Author; OS Organizational Source; SO Source; DT Document Type; CC Category Code; IT Index Term; ST Supplementary Term; CORD Coordinates; NO Notes; LA Language.; AB Abstract. The prefix * indicates a first-level term.

GeoArchive's descriptor codes are numeric forms of the descriptors. Because they do not include new information, they are omitted from the examples that follow.

GeoRef:

TI - Metallogenesis at oceanic spreading centers

AU - Bonnatti, E. (sic)

OS - Lamont-Doherty Geol. Obs. Palisades, N.Y. USA

SO - Annu. Rev. Earth Planet. Sci. (AREPCI), v.3, p.401-431, 1975, Tables, Sketch maps

DT - S (Serial); ANL (Analytic)

CC - 2-27 (Economic geology, metals)

IT - *Mineral deposits; *Genesis; Metals; Plate tectonics; Sea-floor spreading; Hydrothermal processes; Chemical composition; Crust; Mantle.

GeoArchive:

Metallogenesis at oceanic spreading centers

Bonatti, E

Annu Rev Earth Planet Sci (Palo Alto) AREPS

1975 3 p401-431

Language: English

Descriptors: Sea floor spreading; Ore genesis; Subject reviews

GeoRef:

TI - Massive deep-sea sulphide ore deposits discovered on the East Pacific Rise.

AU - Francheteau, J.; Needham, H.D.; Choukroune, P.; Juteau, T.; Seguret, M.; Ballard, R.D.; Fox, P.J.; Normark, W.; Carranza, A.; Cordoba, D.; Guerrero, J.; Rangin, C.; Bougault, H.; Cambon, P.; Hekinian, R.

OS - Woods Hole Oceanogr. Inst. Woods Hole, Mass. USA; State Univ. N.Y. at Albany USA; U. S. Geol. Surv. USA

SO - Nature (GBR) (NATUAS), Vol. 277, No. 5697, 00280836, p. 523-528, 1979, 26 Ref., Illus., Table, Sketch map

DT - S (Serial); ANL (Analytic)

CC - 2-27 (Economic Geology, Metals)

IT - *Pacific Ocean; Economic Geology; Metals; *Mineral Deposits; *Genesis; Processes; Plate tectonics.

ST - Northeast Pacific; East Pacific Rise; Deep-sea environment; Ore deposits; Sulfides; Massive deposits; Occurrence; Mid-ocean ridges; Grade; Zinc; Copper; Iron; Cyprus-type; Metallogeny; Crust; Oceanic type; Mineralization; Geochemistry; Major elements; Minor elements; Trace elements; Mineral deposits, genesis; Halmyrolysis

CORD - N205300; N205500; W1090200; W1090400.

GeoArchive:

Massive deep-sea sulphide ore deposits discovered on the East Pacific Rise

Francheteau, J.; Needham, HD.; Choukroune, P.; Juteau, T et al

Nature (London) 277/5697p523-528 1979 JRNL Code: NATULG

Language: English

Descriptors: Sulphide deposits; Mineral discoveries; Geochemistry of mineral discoveries; Ocean ridges

Auxiliary descriptors: East Pacific Ridge

GeoRef:

TI - Mineralization at destructive plate boundaries; a brief review (In, Volcanic processes in ore genesis)

AU - Garson, M.S.; Mitchell, A.H.G.; Anonymous

SO - Inst. Mining Metallurg., London, GBR, p.81-97, 1977, 128 Ref., Illust., Sketch map (Joint meeting of the Geological Society of London, Volcanic Studies Group, and the Institution of Mining and Metallurgy, London, Jan. 21-22, 1976)

DT - B (Book); C (Conference publication); ANL (Analytic)

CC - 2-27 (Economic geology, metals)

IT - *Mineral deposits; *Genesis; Environment; *Plate tectonics; Processes; Mineralization; *Metals; Ore deposits.

ST - Mineral deposits, genesis; Subduction zones; Review; Island arcs

GeoArchive:

Mineralization at destructive plate boundaries a brief review

Garson, MS; Mitchell, AHG

Conf. Dates: 21 January to 22 Janua No: 76-0018

Spec Publ Geol Soc Lond (London) 1977 7 p81-97 SPGSLI Language: Conference proceedings (sic)

Descriptors: Tectonic control of mineralisation; Destructive plate margins; Subject reviews

GeoRef:

TI - Tholeiitic basalt-rhyolite magmatism and massive sulphide deposits at Matagami, Quebec

AU - MacGeehan, P.J.; MacLean, W.H.

OS - McGill Univ., Dep. Geol. Sci. Montreal, Que. Can

SO - Nature (GBR) (NATUAS), vol. 283, No. 5743, 00280836, p.153-157, 1980, 46 Ref., Illus., Geol. sketch map

DT - S (Serial); ANL (Analytic)

CC - 2-27 (Economic geology, metals)

IT - *Quebec; Economic geology; Polymetallic ores; *Canadian shield; *Mineral deposits; *Genesis; Affinities; *Metamorphic rocks; Metavolcanic rocks; Trace elements; *Rare earths; Abundance.

ST - Canada; Matagami; North America; Archean; Lower Precambrian; Precambrian; Greenstone belts; Noranda-type; Iron; Zinc; Copper; Metals; Ore deposits; Massive deposits; Sulfides; Volcanism; Exhalative processes; Stratiform deposits; Tholeiitic composition; Exploration; Geochemistry; Major elements; Mineral deposits, genesis; Basaltic composition; Rhyolitic composition; Hydrothermal alteration; Metasomatism

CORD- N490000; N500000; W0770000; W0780000.

GeoArchive:

Tholeiitic basalt-rhyolite magmatism and massive sulphide deposits at Matagami, Quebec

MacGeehan, PJ; MacLean, WH

Nature (London) 283/5743p153-157 1980 JRNL code: NATULI

Language: English

Descriptors: Tholeiitic basalts; Andesites and rhyolites; Magmatism; Sulphide deposits

Auxiliary descriptors: Quebec

GeoRef:

TI - Tin mineralisation above mantle hot spots

AU - Sillitoe, Richard H.

SO - Nature, (NATUAS), vol. 248, No. 5448, p.497-499, Sketch maps, 1974

DT - S (Serial)

CC - 1-02 (Economic geology)

IT - *Tin; *Genesis; Ore deposits; Belts; Mineralization; Plate tectonics; Mantle; Hot spots; Precambrian; Phanerozoic; *Mineral deposits; Processes; Igneous processes; Plumes; Global.

GeoArchive:

Tin mineralisation above mantle hot spots

Sillitoe, RH

Nature (London) 1974 248/5448p497-499 NATUL

Language: English

Descriptors: Tin ores; Mantle hotspots

GeoRef:

TI - Are porphyry copper and Kuroko-type massive sulfide deposits incompatible?

AU - Sillitoe, R.H.

SO - Geology (Boulder) (USA) (GLGYBA), Vol. 8, No. 1, 00917613, p. 11-14, 1980, 40 Ref.

DT - S (Serial); ANL (Analytic)

CC - 2-27 (Economic geology, metals)

IT - *Metals; *Genesis; Volcanism; *Copper; *Polymetallic ores; *Mineral deposits; Processes; *Plate tectonics; Concepts; Metallogeny; *Volcanology.

ST - Ore deposits; Porphyry copper; Massive deposits; Sulfides; Mineral deposits, genesis; Island arcs; Submarine environment; Subaerial environment; Cauldrons; Stratovolcanoes; Volcanoes; Calc-alkalic composition; Volcanic rocks; Igneous processes; Hydrothermal processes; Kuroko-type; Environment

GeoArchive:

Are porphyry copper and Kuroko-type massive sulfide deposits incompatible (sic)

Sillitoe, RH

Geology (Boulder) 8/1 p11-14 1980 JRNL Code: GEOLWI

Language: English

Descriptors: Ore genesis; Porphyry copper ores; Kuroko deposits; Volcanism; Island arcs; Sulphide deposits

GeoRef:

TI - Metallogeny and plate tectonics

AU - Strong, D.F. (Ed)

SO - Geol. Assoc. Can., Spec. Pap. (Can) (GASPBY), No. 14, 660P., 1976, Illus., Plates, Sects., Geol. sketch

LA - (Summaries in: Fr)

NO - Individual papers are cited in this bibliography under the separate authors

DT - S (serial); MON (Monographic)

CC - 2-26 (Economic geology, general and mining)

IT - *Plate tectonics; Concepts; Metallogeny; *Metals; *Genesis; Ore deposits; *Mineral deposits.

GeoArchive:

Metallogeny and plate tectonics. Proceedings of a special symposium held at the Joint Annual Meeting of the Geological and Mineralogical Associations of Canada, St Johns

Strong, DF

Conf. Dates: 21 May to 01 June No: 74-0120

Spec Pap Geol Assoc Can (Toronto) 1976 14 SPGACI

Language: Conference proceedings (sic)

Notes: Conference proceedings

Descriptors: Conference proceedings; Ore genesis; Plate tectonics; Tectonic control of mineralisation

My object is to demonstrate a method by which a user can compare databases. I recommend that, rather than simply counting the total number of postings in each database, the user should list several references known a priori to be of importance, and search for these in each database. To ensure that the searches are unbiased, they must be based on known titles, authors, and dates of publication. In this manner, the searcher's skill in using particular indexing methods is not confounded with the comparison, whose objectivity is therefore made as great as possible. The user can then compare the number of retrievals, and can consider how serious it is that certain references of known value were not found in one or another of the databases. A measure of relative quality is provided by comparing the searchable information included with each individual posting in a pair, one member from each database. The effects on searching that result from different indexing methods and different computer systems can be evaluated when information gathered in this way is available to the user. Readers of this paper can compare GeoRef and GeoArchive either by examining the parallel citations included here or by using the same method on another set of references of their own choice.

2. Crystal Structure of Borates

While teaching an introductory mineralogy class, I noticed that the formulas of the borates Kernite and Tincalconite given by Bragg and Claringbull (1965, p.161, 164) seemed to be incorrect. A search of GeoRef immediately gave two crucial references. (For the present purpose, and with consideration of the requirement for space, neither the search strategy nor the full citations need be given here). "The Crystal Structure of Kernite NA 2 B 4 O 6 (OH) 2 TM3H 2 O" (Giese, R.F., Jr, 1966); "The Crystal Structure of Tincalconite" (Giacovazzo, C., et al, 1973). These references are not in GeoArchive.

We can use these sources along with SCI to obtain a bibliography of later work on the two minerals. As the source documents were readily accessible, I found that Giacovazzo had cited two key papers, one by C.L. Christ and R.M. Garrels (1959), and the other by C.L. Christ (1960). These references are in neither GeoRef nor GeoArchive, because GeoRef's principal coverage at present goes back to 1961 and GeoArchive's only to 1974.

After reading the two papers by Christ, it was natural to search for all of his publications on borates, and therefore the following search was performed on GeoRef:

```
1   CHRIST, C:/AU                                   (52 postings)
2   1 AND (BORATE: OR KERNITE OR BORAX OR TINCALCONITE OR
                    COLEMANITE OR B)                (19 postings)
```

Eighteen of these postings are independent. They range in publication date from 1962 through 1977; some contain abstracts, one of which has a length of about 120 words.

Because I had to look for references that could be more than 6 years old, 'Borates' alone might not retrieve all the postings that are in the database. I therefore broadened the search by including the names of common hydrated borates, and tried to find boron in the chemical formulas by searching for 'B'. The inclusion of 'B' found 3 references that would otherwise have been missed. They are: "Crystal structure of Strontioginorite", Amer. Miner. v.55, 1970, p.1911-1931; "Substitution of boron in silicate crystals", Norsk Geol. Tidsskr., v.45, 1965, p.423-428; and a third that is remarkable enough to give in full:

TI - Crystal structure of Veatchite

AU - Clark, Joan R.; Christ, C.L.

SO - Naturwissenschaften, v. 55, No. 12, p. 648, Table, 1968

IT - *Crystal structure; Veatchite; *Mineral data; Structure.

AB - The chemical formula of Veatchite has long been a subject of controversy. Solution of the structure shows a structural formula corresponding to 4SRO.11B 2 O 3 .7H 2 O, which agrees with an early chemical analysis. The space group is AA and cell dimensions are A = 20.86A, B = 11.74A, C = 6.652A, Beta = 92.10 degrees. Coordinates of the atoms are given in the table. Veatchite is dimorphous with P-Veatchite for which the structure was reported recently. Both minerals contain two infinite polyanion sheets; independent B(OH) 3 groups in the presence of these sheets were observed for the first time.

It happens that in the formulas as given, boron never appears as a B separated by spaces from other symbols. Examination of the listing shows that it could be retrieved as a reference to a boron mineral only by a specific search for 'Veatchite'. Its retrieval in this case is a coincidence; 'B' belongs to 'B axis' and not to Boron! It would have been interesting to see how the reference had been indexed in

GeoArchive, but unfortunately GeoArchive begins 6 years too late to include it.

I had sufficient confidence in my work with the GeoRef Thesaurus and Orbit system to think that I probably did not miss many relevant postings present in the database. But if I attempt the same search on GeoArchive, I might not use the hierarchical index correctly. To avoid this, I printed in full every GeoArchive posting that had 'Christ, CL' as an author; first making sure with Dialog's EXPAND command that there were no alternative ways of referring to Christ's name.

I retrieved eight postings in GeoArchive, but only one relates to boron:

> A crystal-chemical classification of borate structures with emphasison (sic) hydrated borates
>
> Christ, CL; Clark, JR
>
> Conf. Dates: 08 December to 12 Decem No: 75-0408
>
> Phys Chem Miner (Berlin) 1977 2/1-2 p59-87 PCMINI
>
> Language: Conference proceedings (sic)
>
> Descriptors: Other borate arsenite and antimonite minerals; Chemistry of minerals

In contrast, GeoRef indexes the same paper under *Minerals; Borates; *Crystal chemistry; Classification; *Crystal structure;

Principles; Definition.

GeoArchive had one posting with 'Tincalconite' in the title:

Tincalconite from Larderello (Tuscany)

Quagliabella -/ F; Vurro, F (sic)

Period Mineral (Rome) 1973 42/3 p583-589 PMINE

Language: Italian

Descriptors: Colemanite Group

Auxiliary descriptors: Toscana and Emilia-Romagna

The structure of Tincalconite is related to that of Borax; it is not correctly classified under 'Colemanite Group'. The searcher can find this reference only by looking for 'Tincalconite' in the title. The source is presumably "Periodico di Mineralogia: Rome", which is included in the "Bibliography and Index of Geology" list of serials for 1973 and 1978, but not for the years between. I failed to find the citation in GeoRef when I searched for 'TINCALCONITE/TI AND LARDERELLO/TI'. Not having access to the source, I cannot comment further on the reference.

The latest comprehensive paper I found on the borate minerals is Christ, C.L., and Clark, J.R., "A crystal-chemical classification of borate structures with emphasis on hydrated borates" (Phys. Chem. of Minerals, v.2, 1977, p.59-87). Searching on SCI for papers that have cited it, I found four references. It is therefore unlikely that any other significant paper has been published up to the time of the last update of the SCI file (which on September 15, 1980, was Week 32).

As a final enquiry, I determined from SSIE whether funded research on the borates was being performed. The search 'BORATE: AND CRYSTAL:

AND MINERAL:' resulted in three postings. One has the title "Ferrous slag technology - Minimizing minerals and metal needs"; the other two both have the title "Solutions - Mineral equilibria", and list the Investigator as C.L Christ, of the U.S.G.S. In his abstract Christ wrote: "Increasing attention is being given to the influence of crystal structures, and the kinetic difficulties in forming these, and the way these factors influence the natural behavior of minerals. This latter work is carried out mostly on borate minerals for whose structures and geochemistry there exists a considerable body of knowledge."

It is sad to note that this distinguished contributor to the understanding of the crystal structure of the borate minerals died of a heart attack on June 29, 1980.

3. Leaky Transforms

A report appeared in Science (v.206, 12 October 1979, p.214-216) with the title "Continental breakup by a Leaky Transform: the Gulph of Elat (Aqaba)". Although the term 'leaky transform' is used in the title, it is not in the abstract or text, and no reference is made to it in the bibliography. What exactly does it mean? And who first used it?

The term is sufficiently new that it is not in the Thesaurus, but on October 16, 1979, a search on GeoRef for 'LEAK: AND TRANSFORM' gave 5 references. One, on leaky artesian aquifers, is included because mathematical methods including Fourier and Laplace transforms were applied to a groundwater problem. Another (Tectonophysics, v.45, 1978, p.323-339) is on marine magnetic anomalies, but it only hints at what a leaky transform might be and gives no reference. Two are abstracts of papers given at the Geological Society of America's Annual Meeting in 1978. The fifth is an abstract by N.D. Watkins and others on "The Azores: a leaky transform fault?" (EOS, Amer. Geophys. Union, Trans., v.50, 1969, p.181).

A search on GeoArchive on September 17, 1980 for 'LEAK? AND

TRANSFORM' gave the Science report and abstracts of two papers given at the Geological Society of America's 1978 Annual Meeting. Because its coverage begins in 1974, GeoArchive does not refer to the Watkins 1969 abstract.

Watkins' abstract contains the sentence: "The Menard-Atwater concept of the 'leaky transform' fault is, however, consistent with the characteristics of the area around the Azores". On October 16, 1979, I therefore searched GeoRef using 'MENARD:/AU AND ATWATER:/AU and TRANSFORM'. There were three postings, but only two cited papers. One is included twice, because the citations came from two older printed indexes; namely the "Bibliography and Index of Geology" and the "Bibliography and Index of North American Geology", which also explains why one GeoRef posting contains the abstract and the other does not. The two papers are:

Origin of fracture zone topography
Nature, v.222, No. 5198, P. 1037-1040, Illus., 1969

Changes in direction of sea floor spreading
Nature, v.5, No. 5153, p. 463-467, Illus., (Incl. sketch maps), 1968

The 1969 reference contains these three sentences: "When a change in plate motion is persistent and large, the spreading may become reoriented to form a short new section of ridge bounded by new transform faults. When the change in direction is small or brief the spreading in the transform fault lacks the space and time to become reoriented. It becomes a 'leaky' transform fault."

4. Aulacogens

The term 'Aulacogen' is one with which many geologists are not familiar. The following search on GeoRef was intended to provide an entry to the literature on the subject:

1	AULACOGEN:	(179 postings)
2	1 AND NOT ABSTR	(144 postings)
3	2 AND FROM 1900-69	(10 postings)
4	3 AND FROM 1900-66	(2 postings)

The two references earlier than 1967 are: V.N. Gordasnikov, Sov. Geol. No. 12, p.50-58, 1966, and A.A. Bogdanov, Soc. Geol. Fr., Bull., Ser. 7, Vol. 4, No. 7, p.898-911, 1962 (published 1963). Both are given in GeoRef with considerable abstracts. In the Gordasnikov abstract, for example, we read: "Aulacogens, the name given to linear, grabenlike depressions in the crystalline basement of the Russian platform ..."; and in the Bogdanov abstract: "Shatsky's theory of aulacogenes (ancient platforms formed in initial evolutionary stages) is discussed in detail." This is a good start to the enquiry.

'Aulacogens' is used as an index term in GeoRef, and I found it in postings of papers published as early as 1973.

On October 1, 1980, 'AULACOGEN:' retrieved 134 postings. In contrast, 'AULACOGEN?' is not an index term in GeoArchive, and postings can be found only if the word is used in the title. On September 24, 1980, 'AULACOGEN?' retrieved 44 postings in GeoArchive.

The search 'AULACOGENS AND REVIEW' in GeoRef retrieves an important paper by K. Burke, and we can force the retrieval from GeoArchive after we know the title and source ("Aulacogens and continental breakup", Annu. Rev. Earth and Planet. Sci., v.5, 1977, p.371-396).

GeoRef indexes the paper under *Plate tectonics; Rifting; Rift valleys; Continental genesis; Ancient; Distribution; Aulacogens; Mechanism; Concepts, Review. GeoRef also notes that the paper contains sketch maps and 100 references. GeoArchive uses only three descriptors: Rift valleys; Autochthons; Continental Drift.

A related paper is: K. Burke and J.F. Dewey, "Plume-generated triple junctions: key indicators in applying plate tectonics to old rocks", J. Geol., v.81, 1973, p.406-433. GeoRef indexes it under: *Tectonophysics; Plate tectonics; Movement; Triple junctions; Mechanism; Plumes; Rift valleys; Evolution; *Crust; Concepts; Fractures; *Mantle; Processes; *Tectonics; Structure; *Faults; Systems; Mechanics. Although I found this reference in Burke's review paper, I believe that it could have been retrieved from GeoRef by a search which, while not employing the term 'Aulacogen', used a judicious set of terms such as 'Rift valleys', 'Faults', 'Fractures', and 'Tectonics'. Because GeoArchive does not extend before 1974, it does not contain the Burke and Dewey reference. I confirmed this by searching for words from the title.

Although this Burke and Dewey paper of 1973 is not indexed under 'Aulacogens' in GeoRef, the word appears in the text: "rifts (failed arms) aulacogens of Soviet authors" (Abstract, p. 406).

In order to bring our knowledge of the literature up to date, we can use SCI to find who has cited Burke's 1977 review paper. Nine citations are listed as of September 20, 1980. They include:

Review of plate tectonics
Burke K; Sengor AMC
Reviews of Geophysics and Space Physics, v17, n6, p 1081-1090

Rifts at high angles to orogenic belts - tests for their origin and upper Rhine Graben as an example.

Sengor, AMC; Burke, K; Dewey JF
American Journal of Science, v278, n1, p24-40, 1978

Comments and replies on collision-deformed Paleozoic continental margin, Western Brooks Range, Alaska
Crane RC
Geology, v8, n8, p354, 1980

The last reference (which is really to P.A. Metz on p.360) has the phrases: "The bimodal volcanism, stratigraphy, and metallogeny ... fit well within the parameters of rifting and aulacogen development as modelled by Burke (1977) and Sawkins (1976a, 1976b). ... in Alaska the rifted arm was aborted, forming a true aulacogen."

It is interesting that a paper by F.J. Sawkins ("Sulphide ore deposits in relation to plate tectonics", Jour. Geology, v.80, 1972, p.377-397) was a starting point for the search on the topic Ore Deposits and Plate Boundaries, and another paper by Sawkins appears now as a reference on Aulacogens. This illustrates the interconnection of themes.

VI. CONCLUSIONS

With the literature doubling in 10 years or less, it is essential that today's students learn how to find for themselves the information they need. They should be taught how to use both printed and online bibliographic tools.

Online searching has many advantages compared with searching printed indexes. The online search does not have to be dependent on a hierarchy of terms, though it is possible to use the power of a hierarchical index when this is desired. First-level terms can be designated with a * in GeoRef; numeric descriptor codes can be used with GeoArchive. The file being searched online is always the most up to date existing, and the search crosses the arbitrary time boundaries imposed on printed materials. Online searching can be controlled by categories, such as language, coordinates of latitude and longitude, as well as document type. For example, GeoRef can exclude references to Abstracts, or restrict the search to Reviews.

In this paper a procedure is described whereby a user can fairly compare two competitive databases. Its application to the comparison between GeoRef and GeoArchive shows that for my purposes GeoRef is much superior. Readers can draw their own conclusions by studying the results presented here, or by using the same procedure on topics of their own choosing.

GeoRef has been available only through SDC's Orbit, but in 1981 it will be available also through Lockheed's Dialog system. Lockheed will make a number of significant improvements when it loads GeoRef: full coordinate ranging will be possible, and users will probably be able to search new fields, such as country of publication. Dialog's LIMIT command will be used to make efficient selection by language.

Science Citation Index is a valuable tool for bringing a bibliography up to date. SSIE enables the user to learn about funded research currently in progress.

Although it is too expensive to allow undergraduates to do their own searching, much can be gained by having a group participate in a search, especially if the students are already familiar with the printed "Bibliography and Index of Geology" and the use of the Thesaurus. I see online searching becoming a generally recognized tool with which every scientist should be familiar.

VII. ACKNOWLEDGEMENTS

I am grateful to many people for helping me learn how to use online bibliographic searching: John Mulvihill and Ghassan Rassam of AGI have been most generous in making their extensive experience available to me; Rosalind Charles of Geosystems very kindly discussed the indexing system used in the GeoSaurus; Harry Boyle introduced me to SDC's Orbit system; and George Baranoski permitted me to experiment with the test file of GeoRef on Lockheed's Dialog system. In expressing my thanks to these people, I must make clear that they bear no responsibility for any errors in this paper. The views expressed are my own, and the search strategies described are not necessarily those that would be used by those responsible for creating the databases and making them available.

References

Bragg, Sir L., and Claringbull, G.F. 1978. Crystal Structure of Minerals. The Crystalline State, v. 4, 1965, Cornell Univ. Press.

Cawkell, A.E. 1977. Science perceived through the Science Citation Index. Endeavour, v. 1, p. 57.

Scrutton, R.A. 1977. Fragments of the Earth's continental lithosphere. Endeavour, v. 1, p. 58.

GEOLOGY LIBRARY REFERENCE TRAINING FOR STUDENT LIBRARY ASSISTANTS

Jim O'Donnell

Geology-Geophysics Library
University of California
Los Angeles, California 90024

Abstract: It is necessary to define the level of reference unsupervised student assistants working nights and weekends in a university geology library should be expected to give, and to train the students accordingly.

There are three areas of knowledge in which an unsupervised student should be proficient. These are: 1) Familiarity with library procedures and records that enable the assistant to determine the library's cataloged and uncataloged holdings, and to identify serial citations. 2) A basic knowledge of geology and other science reference sources, including guides to the literature, dictionaries, indexes and abstracts. 3) Recognition of certain items which geology students and faculty are already familiar with: e. g., major journals in the field and abbreviations of journal and professional society names.

A training program has been devised that will allow a student to perform in these areas with at least a minimum level of proficiency. It includes three elements which correspond to the three areas of knowledge discussed: training in and review of library procedures based upon a procedure manual; participation in seminars for graduate students in the use of reference tools in the field; and familiarization with a reference manual and lists of information. The manuals and lists are also available for consultation on the job.

INTRODUCTION

The quality of reference service given in a library is always of concern to those responsible for that library's operation. In many small branch libraries on a university campus staffing in the evenings and on weekends consists of a lone student. The demand for reference service does not stop when a librarian goes off duty, however, and what kind of reference service that student should give is of concern to his superiors. A patron appreciates any attempt to answer a question, but the student assistant needs to know how to answer questions, or at least how to go about trying to answer them. The assistant also needs to know when to acknowledge the question as beyond his (or her) abilities and refer it to professional staff.

A look at the kinds of questions asked at the desk allows an analysis of the kinds of information the student assistant needs to know. From that analysis can be fashioned a training program to satisfy identified needs.

The object of this paper is to outline the needs defined for one library, and to sketch a training program developed to fulfill these needs.

NEEDS

It was first necessary to define exactly what student employees should be expected to know. Given that these students are usually not majors in either earth sciences or library science, an assumption was made that they would have no prior knowledge of the field or of library procedures. Three distinct areas of knowledge seemed to warrant specific attention:

1) familiarity with library procedures and records that enable a library staff member running the circulation desk to also answer many questions that arise during evening and weekend hours, such as those pertaining to library holdings and identification of serial citations;

2) basic knowledge of reference sources in geology, geophysics and related fields;

3) recognition of items, such as abbreviations of society names and journal titles, that are common knowledge to specialists in the field.

With these three needs defined, a training program of three phases, each focussing on one need, was developed.

THE TRAINING PROGRAM

Phase one in the training program is instruction in basic library procedures: how to check out a book; how to find out if a book is missing; etc. This is done in a series of training and practice sessions held over a six- to eight-hour period. Since students generally work shifts of two or three hours, this may take a week or more.

Students first read a procedure manual on their own. The manual gives detailed instructions for individual tasks in the library: how to read a Library of Congress call number; checking out a book; discharging a returned book; finding if the library has a book, journal or map; using the shelf list to determine bound holdings of a journal; doing a preliminary search for an item not on the shelf; receiving and processing "hold" requests; understanding the circulation policy, with its various lending periods, including those aspects pertaining to special categories of materials, such as maps, reference books and non-circulation items; recognizing categories of users from their library cards; sending recall notices; giving directions to other libraries; using microfiche lists of serials and uncataloged books that will help in finding out where a journal or a new book is held on campus; giving directions to pay phones, department offices and rest rooms.

Included, too, are detailed instructions and explanations of the uses of library-specific files:

-the in-process file (to find out whether a book is on the new book shelf, at cataloging, or somewhere in between)

-the on-order file (for books)

-the circulation file

-the "at bindery" file

-the serials visible file-check-in records (both current and retired titles)

-the "newly cataloged items" file

-the Slavic monographs brieflist.

All instructions in the manual give specific directions, using a flow chart-like sequence of events to help the student through each procedure. For instance, the instructions for answering the question, "Do you have this book?" take into account the possibility, at each step, of finding or not finding the item, and instructions for dealing with either event. (See Appendix A.) There is an instruction in each procedure that tells the student to refer unanswerable questions to the librarian. The student is frequently instructed not to answer questions in the negative: to give a positive answer if one is available, otherwise to refer the question to someone else. This often means leaving messages for followup by full-time staff, and it means that the patron may leave unsatisfied, but he (or she) will not receive incorrect information.

The student spends about an hour reading this manual. Then the supervisor goes over the manual with the student, clarifying what may not be clear, and leading the student step by step through each of the procedures outlined. This review usually takes two or three hours.

For the remaining three to five hours of phase one, the student staffs the circulation desk under close supervision, using both the manual and the supervisor as resources to reinforce what has been learned in studying the manual. By the end of this period, the student is competent to staff a circulation desk alone.

Phase one trains the student to look for answers to questions. Phase two simply moves the assistant from asnwering questions from library files to answering questions from bibliographic sources. This phase begins with required participation in library orientation and instruction seminars held quarterly for major and graduate students in the academic departments the library serves. These sessions are in two parts: an overview of reference sources in the field, and instructions for finding out if the library has specific items. For the student assistants, this latter part is a quick review, and it will not be discussed here.

The review of reference sources begins with an introduction to guides to the literature (especially Ward and Wheeler's *Geologic Reference Sources*) and special encyclopedias (such as the *McGraw-Hill Encyclopedia of Science and Technology* and the Rhodes Fairbridge *Encyclopedia of the Earth Sciences* series) as starting places for doing research. Students are taught both how to use these tools, and what kind of tools these will lead them to for further help. They are then introduced to the following examples of these various types of tools.

Indexes and abstracts. Examples discussed include the *Bibliography and Index of Geology, Geophysical Abstracts, Chemical Abstracts,* and *Science Citation Index.* Special worksheets giving examples of search strategies are reviewed for the *Bibliography and Index* and *Science Citation Index.*

Special bibliographies or catalogs. Examples include *Publications of the U.S. Geological Survey, Available Publications of the California Division of Mines and Geology, Catalog of the United States Geological Survey Library,* and the *Union list of Field Trip Guidebooks of North America.* The usefulness of these tools to gain access to materials not individually cataloged in the library is stressed.

Bibliographies of theses and dissertations. *Dissertation Abstracts International* is mentioned, but most emphasis is put on specialized lists such as the *Indexes to Graduate Theses and Dissertations on California Geology* published by the California Division of Mines and Geology, and the various bibliographies of theses in geology published by the American Geological Institute and the Geological Society of America.

The subject catalog. The filing order used in the library's public catalog is explained briefly, as well as examples of headings which can be confusing to users. For instance, the headings GEOLOGY-CALIFORNIA-LOS ANGELES COUNTY and GEOLOGY-CALIFORNIA-SANTA MONICA MOUNTAINS coexist, although one might be thought to include the other. It is also explained at this time that the card catalog is not helpful for either journal articles or items in series.

References at the end of articles that have already been found. These references as sources of research materials often come as a surprise to student assistants, but should not be overlooked.

Other campus libraries. It is made clear that collections in other campus libraries often are more helpful to a patron that what our library may have in that field. For instance, ***Biological Abstracts*** and ***Zoological Record*** are excellent reference sources for paleontology information, but are held at the Biomedical Library; ***Engineering Index*** is a valuable source for rock mechanics literature, but is held at the Engineering and Mathematical Sciences Library; and ***Chemical Abstracts***, perhaps the best source for geochemistry literature, is available at the Chemistry Library.

All participants in these seminars are given brief instructions in the use of these tools, and the student assistant participates in the learning process just as do the graduate and major students who are the primary focus of these programs. A one-to-one followup on this necessarily brief introduction is then carried out with each assistant, including more detailed perusal of the ***Bibliography and Index of Geology*** and its predecessors; a detailing of the use of the ***GeoRef Thesaurus and Guide to Indexing*** as a guide to the ***Bibliography***; a closer examination of ***USGS Publications*** and the ***Catalog of the USGS Library***. Also examined and discussed are ***Union List of Serials*** and ***New Serials Titles***, both of which are necessary tools for verifying serial citations.

Test questions (What articles did Leon Knopoff publish in 1976? Was a book on the Saint Francis Dam failure published recently? Does this library have the Kern River Oilfield guidebook published by the AAPG Pacific Section?) are asked, and the student is followed through the steps taken to answer the question. Copies of the bibliography and the handouts about indexing services are included in a "Reference" section of the Procedure Manual. (See Appendix B.) Also included are special bibliographies prepared for individual classes, with more information on a specific topic than the general bibliography.

The third area in which training is required is that of information that is second-nature to specialists in the earth sciences. Phase three of the training program covers abbreviations of society names and journal titles, as well as shorthand titles of reference tools. These are more "bits of information" than anything else, and are defined on an ever'growing list of such items, kept in the "Reference" section of the Procedure Manual. (See Appendix C.)

This list is actually a mini-acronyms dictionary, and is organized in two sections: "Society names" and "Other." While the former is self-explanatory, the "Other" category really is a catch-all, with such information as what "Geol. Assoc. London., Proc." means (it does not stand for "Geological Association . . ."), what JGR and Palaeo are short for, and what the "AGI directory" and "the guidebook list" refer to. While this list is by nature spotty (often an item will be added to it only when a question has become a regular occurence at the desk), difficult to keep up, and a little difficult to keep neat (some attempt to maintain alphabetical order is made), it is still helpful to the staff at the desk. Some of it duplicates information in other places (especially Gale Research Company's ***Acronyms, Initialisms & Abbreviations Dictionary***), but a lot doesn't, and having all this information in one place has proved successful, allowing a student assistant without special knowledge to answer specialized questions.

CONCLUSION

The problem set before us was to maintain a minimal level of reference service in an earth science library during all hours of service. The analysis that three areas of expertise existed (library procedures and files; reference sources in the field; and earth science abbreviations and jargon) led to a three-phase training program designed to instill in student employees basic levels of knowledge in all three areas.

While no formal evaluation of this program has been done, student employees seem better able to serve the public than before the program was instituted, including the essential ability of knowing when to refer a question. Sections of the Procedure Manual are still being revised and added as needed. and as bibliographies are updated. This program is not seen as static. but continues to evolve as new ideas are suggested. It is a continuing program, and is even of benefit to long-term employees, since the longer a student remains in the library's employ, the more information will be absorbed, and the better the reference help the student assistant can give.

APPENDIX A

BIBLIOGRAPHY

OF REFERENCE SOURCES IN

GEOLOGY AND GEOPHYSICS

compiled by

Nancy J. Pruett

and

Jim O'Donnell

UCLA Geology-Geophysics Library
4697 Geology Building
405 Hilgard Avenue
Los Angeles, California 90024

October, 1980

I. GUIDES TO THE LITERATURE

MacKay, John W. Sources of Information for the Literature of Geology, second edition. London, Geological Society of London, 1974.
Ref *QE 26 M192s 1974
A good 59-page summary, with annotations. Especially good on indexing services.

Pearl, Richard M. Guide to Geologic Literature. New York, McGraw-Hill, 1951.
Ref Z 6031 P31g
Old and dated, but classic. Good on early material.

Ward, Dederick C. and Marjorie W. Wheeler. Geologic Reference Sources. Metuchen, N.J., Scarecrow Press, 1972.
Ref Z 6031 W211g 1972
This guide is divided into 4 sections: general, subject, regional and maps. Few annotations. The regional approach is especially helpful. There is a new edition in press.

Wood, David N. Use of Earth Sciences Literature. Hamden, Conn., Archon Books, 1974.
Ref QE 26 W85u
Chapters by different people on types of literature and subject areas. Descriptive and British.

II. DICTIONARIES AND ENCYCLOPEDIAS

Fairbridge, Rhodes W. (ed.). Encyclopedia of Atmospheric Sciences and Astrogeology. New York, Reinhold, 1967.
Ref QC 854 F156e

______. Encyclopedia of geochemistry and Environmental Sciences. New York, Van Nostrand Reinhold, 1972.
Ref QE 515 F156e

______. Encyclopedia of Geomorphology. New York, Reinhold, 1967.
Ref GB 10 F156e

______. Encyclopedia of Oceanography. New York, Reinhold, 1966.
Ref GC 9 F156e

______. Encyclopedia of World Regional Geology, Part I: Western Hemisphere (including Antarctica and Australia). Stroudsburg, Pa., Dowden, Hutchinson & Ross, 1975.
Ref QE 5 F156e v. 1

Fairbridge, Rhodes W. and Joanne Bourgeois (eds.). Encyclopedia of Sedimentology. Stroudsburg, Pa., Dowden, Hutchinson & Ross, 1978.
Ref QE 471 E56 1978

Fairbridge, Rhodes W. and David Jablonski (eds.). Encyclopedia of Paleontology. Stroudsburg, Pa., Dowden, Hutchinson & Ross, 1979.
Ref QE 703 E52 1979

Glossary of Geology, second edition. Falls Church, American Geological Institute, 1972.
Ref QE 5 G37 1980

McGraw-Hill Encyclopedia of Ocean and Atmospheric Sciences. New York, McGraw-Hill, 1980.
Ref GC 9 M32 1980

McGraw-Hill Encyclopedia of Science and Technology. New York, McGraw-Hill, 1977. 15 v.
Ref Q 121 M17 1977

McGraw-Hill Encyclopedia of the Geological Sciences. New York, McGraw-Hill, 1978.
Ref QE 5 M178 1978

Runcorn, Keith (ed.). International Dictionary of Geophysics. Oxford, Pergamon, 1967. 3 v.
Ref QD 801.9 I61

III. INDEXES AND ABSTRACTS

Bibliography of North American Geology. Washington, U.S. Geological Survey, 1785-1970.
Ref Z 6034 U49U5
Ceased. Coverage continued by Bibliography and Index of Geology (see below.)

Bibliography and Index of Geology Exclusive of North America. New York, Geological Society of America. 32 v., 1933-1968.
Ref Z 6031 N53b
Continued by Bibliography and Index of Geology (see below.)

Bibliography and Index of Geology. Boulder, Geological Society of America, v. 33-42, 1969-78. Falls Church, American Geological Institute, v. 43- , 1979- .
Ref Z 6031 N53b
This index covers the worldwide earth science literature. It is the print version of a machine-readable data file maintained by the American Geological Institute, and is searchable on-line as GEOREF.

It is published monthly, with annual cumulations. Citations in the monthly issues are numbered, and arranged within broad subject categories. An author index (which refers the user to the numbered citations) is included. The annual cumulations are in 2 parts: an alphabetical Bibliography and a Subject Index referring the user to the author's name in the Bibliography. (The 1977 annual cumulation differs in that it retains the numbered bibliography sections from the monthly issues, and its Subject Index refers to the number of a citation rather than to an author's name. While this was undoubtedly cheaper for the publisher, because the Bibliography didn't need to be reprinted, it's not as easy to use, and in 1978 the format reverted to its earlier state.)

This publication continues the volume numbering of the Bibliography and Index of Geology Exclusive of North America. However, in subject coverage, it supersedes that title, the Bibliography of North American Geology, and Geophysical Abstracts.

GEOREF Thesaurus and Guide to Indexing, second edition. Falls Church, American Geological Institute, 1978.
Ref Z 695.1 G43G293 1978
This book serves as an index to the broad subject headings that are used in the Bibliography and Index of Geology.

Annotated Bibliography of Economic Geology. Lancaster, Pa., Economic Geology Publishing Company. 38 v., 1929-65.
Ref Z 6033 E4A6

Geological Abstracts. New York, Geological Society of America. 6 v., 1953-58.
Ref QE 1 G285

III. INDEXES AND ABSTRACTS (continued)

Geoscience Abstracts. Washington, American Geological Institute.
8 v., 1959-66.
Ref QE 1 G286

Geophysical Abstracts. Washington, U.S. Geological Survey, 1929-71.
Ref QE 500 U58g

Geophysical Abstracts. London, GeoAbstracts, Ltd., 1977- .
Ref QE 500 G29155
Actually two entirely different publications, these titles leave a gap of 6 years that is filled (but without abstracts) by the Bibliography and Index of Geology. Both index and abstract the geophysics literature.

Meteorological and Geoastrophysical Abstracts. Boston, American Meteorological Society, v. 1- , 1950- .
Ref QC 851 M561
This title was discontinued at the Geology-Geophysics Library with volume 22 (1971). The Engineering and Mathematical Sciences Library still subscribes to it.

Mineralogical Abstracts. London, Mineralogical Society of Great Britain and the Mineralogical Society of America. v. 1- , 1922- .
Ref QE 351 M662
This title abstracts periodicals and books worldwide covering mineralogy, geochemistry and petrology. Published quarterly, each issue is arranged by broad subject areas with an author index. There are annual cumulated author and subject indexes. No list of indexed periodicals. Abbreviations pertaining to publications indexed are listed in front of each issue.

Science Citation Index. Philadelphia, Institute for Scientific Information, 1960-
Chemistry Library
This index covers all of science, not just earth sciences. It is published quarterly, cumulated annually, then quinquennially. There are actually three indexes: the Source Index (by author, both personal and corporate), the Permuterm Index (by subject), and the Citation Index.

In addition to these indexes and abstracts, there is geoscience information available in the following periodical indexes, held at various other libraries on campus: Chemical Abstracts, Engineering Index, Biological Abstracts, Government Reports Announcements and Index, Zoological Record.

IV. BIBLIOGRAPHIES AND OTHER SPECIAL TOOLS

Publications of the Geological Survey. Washington, U.S. Geological Survey.
Ref Z 6034 U49U5p

This consists of two main volumes, 1879-1961 and 1962-1970, and yearly and monthly supplements. The monthly supplements are called New Publications of the Geological Survey. It lists books, maps, charts, circulars, open-file reports, etc, published by the U.S.G.S. The two main volumes and the yearly supplements have author and subject indexes. New Publications does not.

Each state and nation has a government organization responsible for geologic mapping. The list of publications of this agency is a reference source. We have a collection of these lists in our publishers' catalog file. Ask at the Circulation Desk for these.

Catalog of the United States Geological Survey Library. Boston, G.K. Hall, 1964. Supplements to 1976.
Ref Z 6035 U58c

This 25-volume work and its 3 supplements are a combined author, title and subject list of the books and serials in the U.S.G.S. Library in Reston, Va.

Union List of Geologic Field Trip Guidebooks of North America. Falls Church, American Geological Institute and Geoscience Information Society, 1978.
Ref QE 71 G298 1978

This is a union list of holdings throughout the United States. Arranged alphabetically under the names of societies responsible for the field trips, with an index by geographic area.

Wilmarth, M. Grace. Lexicon of Geologic Names of the United States (including Alaska). Washington, U.S. Geological Survey, 1938. (Its Bulletin 896.) 2 v.
Ref QE 75 U58b no. 896

Keroher, Grace C. Lexicon of Geologic Names of the United States for 1930-1960. Washington, U.S. Geological Survey, 1970. (Its Bulletin 1200.) 3 v.
Ref QE 75 U58b no. 1200

______. Lexicon of Geologic Names of the United States for 1961-1967. Washington, U.S. Geological Survey, 1966. (Its Bulletin 1350.)
Ref QE 75 U58p no. 1350

These three titles are a compilation of formations and stratigraphic nomenclature. Descriptions of type formations are included and first use of the terminology is documented.

Andriot, Laurie. Guide to U.S. Government Maps: Geologic and Hydrologic Maps. McLean, Va., Documents Index, 1978.
Ref QE 77 A573 1978

This is a list, by U.S.G.S. series and map number, of all Geologic and Hydrologic maps published by the U.S.G.S. through December 1977. It has indexes by areas, subject and coordinates. Topographic maps are not included.

V. BIBLIOGRAPHIES -- THESES AND DISSERTATIONS

Chronic, John and Halka Chronic. Bibliography of theses written for advanced degrees in geology and related sciences at universities and colleges in the United States and Canada through 1957. Boulder, Pruett Press, 1958.
Ref *Z 6034 N8C4 1958-63

______________. Bibliography of theses in geology, 1958-1963. Washington, American Geological Institute, 1964.
Ref *Z 6034 N8C4 1958-63

Ward, Dederick C. Bibliography of theses in geology, 1964. Geoscience Abstracts, v. 7, no. 12, supplement, 1965.
Ref Z 6034 N8C4 1964

Ward, Dederick C. and T. C. O'Callaghan. Bibliography of theses in geology, 1965-1966. Washington, American Geological Institute, 1969.
Ref Z 6034 N8C4 1965-66

Ward, Dederick C. Bibliography of theses in geology, 1967-1970. Boulder, Geological Society of America, 1973. (Its Special Paper 143.)
Ref Z 6034 N8C4 1967-70

Dissertation Abstracts International Section IIb: Earth Sciences. Microfiche edition. Ann Arbor, University Microfilms International. v. 37- 1977- .
Microfiche AS 30 D6 Sec. 2b

The full edition of Dissertation Abstracts International is at the Engineering and Mathematical Sciences Library.
This is also searchable on-line as Comprehensive Dissertation Index.

VI. BIBLIOGRAPHIES AND OTHER SPECIAL TOOLS -- CALIFORNIA

Consolidated Index of Publications of the Division of Mines and predecessor State Mining Bureau, 1880-1943, inclusive. San Francisco, California Division of Mines, 1945. (Its Bulletin 131.)
Ref Z 6034 U5C2 1943
Out of date, but the only really comprehensive index of its own publications the Division of Mines ever did.

Shedd, Solon. Bibliography of the Geology and Mineral Resources of California, to December 31, 1930. San Francisco, California Division of Mines Geologic Branch, 1932. (Its Bulletin 104.)
Ref Z 6034 U5C2s

Geologic Atlas of California. Sacramento, California Division of Mines and Geology, 1958.
Ref Atlas Case **G 4362 C123g
This loose-leaf atlas is the basic reference tool on California geology. It is comprised of separate maps at a scale of 1:250,000 which together cover all the state. Each map sheet has its own explanatory text. It includes bibliographic references.

Strand, R. G., J. B. Koenig, and C. W. Jennings. Index to Geologic Maps of California to December 31. 1956. San Francisco, California Division of Mines, 1958. (Its Special Report 52.)
Ref QE 89 137 1850-1956

Koenig, James B. Index to Geologic Maps of California, 1957-1960. San Francisco, California Division of Mines and Geology, 1962. (Its Special Report 52A.)
Ref QE 89 137 1957-60

Koenig, James B. and Edmund W. Kiessling. Index to Geologic Maps of California, 1961-1964. San Francisco, California Division of Mines and Geology, 1968. (Its Special Report 52B.)
Ref QE 89 137 1961-64

Kiessling, Edmund W. Index to geologic maps of California, 1965-1968. Sacramento, California Division of Mines and Geology, 1972(?). (Its Special Report 102.)
Ref QE 89 137 1965-68

Kiessling, Edmund W. and David H. Peterson. Index to Geologic Maps of California, 1969-1975. Sacramento, California Division of Mines and Geology, 1977. (Its Special Report 130.)
Ref QE 89 137 1969-75
These five titles supplement the Geologic Atlas of California. Arranged by sheet name (from the Atlas), each sheet used as an index map for the work done in the area. These works serve as updates to the bibliographic information in the explanatory texts of the Geologic Atlas. They include unpublished items (i.e., theses and open-file reports and maps) as well as series and monographic works.

Index to Graduate Theses on California to December 31, 1961.
San Francisco, California Division of Mines and Geology, 1963.
(Its Special Report 74.)
Ref QE 89 I38 1961

Index to Graduate Theses and Dissertations on California Geology, 1962 through 1971. Sacramento, California Division of Mines and Geology, 1974. (Its Special Report 115.)
Ref QE 89 I38 1962-71

Peterson, David and George J. Saucedo. "Index to Graduate Theses and Dissertations on California Geology, 1973 and 1974," California Geology 31:2, February 1978, pp. 33-40.
Ref QE 89 I38 1973-74

______. "Index to Graduate Theses and Dissertations on California Geology, 1975 and 1976," California Geology 31:4, April 1978, pp. 90-94.
Ref QE 89 I38 1975-76

Saucedo, George J. "Index to Graduate Theses and Dissertations on California Geology, 1977 and 1978," California Geology 33:7, July 1980, pp. 158-164.
Ref QE 89 I38 1977-78

List of Available Publications. Sacramento, California Division of Mines.
Ref latest edition only
This is not a complete list of publications: it's a list of what's in print. It includes both book and map publications, plus ordering information.

APPENDIX B

SAMPLE INSTRUCTION FROM PROCEDURE MANUAL

Answering Questions

Do you have this book?

1. In the name/title section of the public catalog:
   A. check under the author's name
   B. check by title
   C. check by series
   D. check by the name of the conference
2. If you can't find it in one of these 4 places, check under title in the in-process file.
   A. If you find its slip in the file:
      1) If it has a "GX" number, and has not been stamped "at cataloging," look for it
         a) on the New Book ("GX") Shelf
         b) on the Holds shelf
         c) in the circulation file under its "GX" number
         d) if you can't find it in any of these places, see A.4) below.
      2) If it has an "at cataloging" stamp on it, ask the patron to fill out a "Hold" card for the book. Leave the completed "Hold" card, clipped together with the in-process slip, on the GA desk for the the Public Services Assistant. It will be rush cataloged and the patron will be notified when it is ready.
      3) If it has no stamps on it, check the shelves behind the Technical Services Assistant's desk. Books are shelved there by the author's last name. If you find it there:
         a) let the patron look at it in the library, but tell him or her that it needs to be rush cataloged before it can be checked out. Follow the instructions in A.2) above.
      4) If you still can't find the item after you've found its slips in the in-process file, have the patron fill out a "Search" card, and tell the patron we'll look for it and be in touch.
   B. If you don't find its slip in the in-process file
      1) check (by title) in the on-order file
      2) check the UCLA Catalog Supplement (on microfiche) to see if any

Do you have this book? (continued)

other library on campus has it. (This is good only for books published since about 1975.)

C. If you still don't find that the library system has the item, tell the patron that you are unable to locate it, but that one of the full-time staff might be able to. Ask for his or her name and phone number (Use a pink "Information Followup" slip) and make sure the patron writes down as much as is known about the book. The Public Services Assistant will check on it, and will be in touch as soon as possible. If it is determined that the item is not at UCLA, an attempt can be made to borrow it on interlibrary loan.

APPENDIX C

BITS OF INFORMATION

Society Names

AAPG	American Association of Petroleum Geologists
AASP	American Association of Stratigraphic Palynologists
AEG	Association of Engineering Geologists
AGI	American Geological Institute
AGU	American Geophysical Union
AIME	American Institute of Mining, Metallurgical and Mechanical Engineers
AIPG	American Institute of Petroleum Geologists
AN SSSR	Akademiia nuak, SSSR.
BMR	(Australia.) Bureau of Mineral Resources, Geology and Geophysics
BRGM	(France.) Bureau de recherches geologiques et minieres
CDMG	California. Division of Mines and Geology.
CNRS	(France.) Centre national de recherches scientifiques
CSPG	Canadian Society of Petroleum Geologists
EERC	Earthquake Engineering Research Center
EERI	Earthquake Engineering Research Institute
GAC	Geological Association of Canada
GIS	Geoscience Information Society
GSA	Geological Society of America
IAHS	International Association of Hydrological Sciences
IAS	International Association of Sedimentologists
IMM	Institution of Mining and Metallurgy
IPA	International Petroleum Association
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
MAC	Mineralogical Association of Canada
MSA	Mineralogical Society of America
NAGT	National Association of Geology Teachers
NASA	(United States.) National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization (but it files as though it were the word "nato.")
NOAA	(United States.) National Oceanic and Atmospheric Administration
NSS	National Speleological Society

Society Names (continued)

RAS	Royal Astronomical Society
SEG	Society of Exploration Geophysicists
SEPM	Society of Economic Paleontologists and Mineralogists
SSA	Seismological Society of America
USGS	United States. Geological Survey.

Other

AGI Directory	American Geological Institute. Directory of Geoscience Departments.
Bulletin Signaletique	Look it up under: France. Centre national de recherches scientifiques. Bulletin Signaletique.
California Journal of Mines and Geology.	This is an earlier title for: California. Division of Mines and Geology. Report of the State Mineralogist.
California. State Mining Bureau	Look things up by its later names: California. Division of Mines, and California. Division of Mines and Geology.
EPSL	Earth and Planetary Science Letters
GCA	Geochimica et Cosmochimica Acta
Geol. Assoc., London. Proc.	Geologists' Association, London. Proceedings.
Geophysical Journal	Look it up under Royal Astronomical Society. Geophysical Journal.
Guidebook list	Union List of Fieldtrip guidebooks of North America.
Journal of Atmospheric Sciences	Journal of the Atmospheric Sciences
JGR	Journal of Geophysical Research
Palaeo	Palaeogeography, Palaeoclimatology, Palaeoecology
PEPI	Physics of the Earth and Planetary Interiors
SEPM 16	Society of Economic Paleontologists and Mineralogists. Special Publication 16.

GEOSCIENCE INFORMATION FOR DEVELOPING COUNTRIES:
A FORGOTTEN PRIORITY

Julian W. Green
Harvard University Geological Sciences Library
24 Oxford St.
Cambridge, MA 02138

Abstract: Science and technology are requisites for development. This is recognized by both developing countries and the national and international organizations that work with those countries in assisting development. However, the transition is rarely made to acknowledging library needs for those developing countries, libraries that would make possible or facilitate that development.

When they do mention libraries, the assistance organizations prefer approaching library development from the top, through a national library system. Argument is made in this paper that such an approach loses force and certainly precious time before the actions filter down to the department or ministry level. Rather, the approach to assistance in library development should be to an administrative level that can, in fact, use the information services developed, evaluate their worth, and then proceed to help develop more permanent information policies specific to the unit's needs.

The potential programs for assistance can range from exchanges and other consulting and teaching, to the less glamorous development of lists of what is available and useful to the developing country so as to better be able to determine what is needed. These programs should all be tied to specific departments, ministries, research centers, or universities. As geoscience information specialists we have the specific skills that can be adapted to such programs, and it is our responsibility to actively assist in their development.

Introduction

Let me begin the talk with a few questions, questions which should run through our minds as we consider geoscience information for developing countries. The first is for the geoscience information specialists in the audience. What have we, as geoscience information specialists, done for or even said about geoscience information in developing countries? What have we done to begin to improve that resource? If we look at the Proceedings of our past meetings there is but one talk with any international concerns. My purpose here is to suggest that we do more.

The second question has two parts, the first being: how many of our own institutions, the ones for which we work, have people working in developing countries? Most, if not, all. Now the second part. How many of these workers left the developing country with the same quality of geoscience information as when they arrived? Certainly, a considerable amount of work is done there. Looking at Tables 1 and 2 we see indications of the work, the numbers and percentages of articles and dissertations done on topics concerning developing countries. And we ask again, what about the libraries?

Reasons for Action

Now you might come back to me and say, why us? In spite of an obvious need for good or improved science and, more specifically, geoscience information (International Colloquium on Science, Technology, and Society, 1980) in the developing countries, why us? Are there not diplomatic professionals who can and should work on these things? Do not our organizations speak to other more important things? Response to this could be presented by looking at the purposes of some of these organizations. Table 3 shows us the appropriate sections of the by-laws and constitutions of these organizations. And it is funny how none of them preclude work in or for developing countries by specifically limmiting their activities to an American field; but from their inactivity, you would have thought so.

It is nice to have the constitutional support of our organizations, support for something that could also be considered a moral responsibility. As stated in the findings of the Brandt Commission: "All the lessons of reform within national societies confirm the gains for all in a process of change that makes the world a less unequal and more just and habitable place. The

TABLE 1. DISSERTATIONS ON DEVELOPING COUNTRIES.

Taken from "Geology" subject in Dissertations Abstracts International.

years	total "geology"	about LDCs	% about LDCs
1975	199	23	11.6
1976	217	15	6.9
1977	220	31	14.1
1978	220	20	9.1
1979	177	16	9.0
five year total	1033	105	10.2%

TABLE 2. GEOLOGY ARTICLES ON DEVELOPING COUNTRIES

journal	years	total articles	on LDCs	% on LDCs
AAPG Bull.	1975-1979	460	70	15.2
Economic Geology	1975-1979	444	77	17.3
GSA Bull.	1975-1979	734	94	12.8

TABLE 3.

ORGANIZATIONAL "PERMISSION" FOR WORK IN DEVELOPING COUNTRIES.

Organization	Permission
G.I.S.	The purpose of this Society shall be to initiate, aid, and improve the exchange of information in the earth sciences through mutual cooperation among libraries, earth scientists, documentalists, editors, and information specialists.
G.S.A.	The purpose of the Society is the promotion of the science of geology by the issuance of scholarly publications, the holding of meetings, the provision of assistance to research, and other appropriate means. The Society also cooperates with other bodies having similar objectives and assists more recently formed societies interested in the specialized branches of geology.
A.G.I.D.	The objectives of the Association are: to encourage communication between all individuals, societies, agencies, and corporations interested in the application of the geosciences to international development; to encourage and promote activities in the geoscience fields which are related to the needs of developing countries; to promote and encourage among earth scientists an awareness of their responsible role in the management of natural resources; to emphasize to countries cooperating in international geoscientific aid, the fundamental role of the geosciences in social and economic development.
A.L.A.	The object of the American Library Association shall be to promote library service and librarianship.

great moral imperatives that underpinned such reforms are as valid internationally as they were and are nationally." And if moral imperative does not move us, how about self-interest? The Brandt Commission continues: "but experience confirms that there are other imperatives also, rooted in the hard-headed self-interest of all countries and people, that reinforce the claim of human solidarity." (Independent Commission on International Development Issues, 1980:77)

We have a responsibility to act because of our skills, our knowledge, our profession, and because we are part of the same species as those accidentally inhabiting the developing countries. The question then becomes, how should we direct our energies?

Response of Organizations

Let us look again at the organizations to which we belong, and at those with which we might be able to work. Table 4 lists some with their respective current approaches to developing countries, along with some possible ways to correct that approach. Some forget about developing countries, and therefore, forget the need for our expertise. The Geoscience Information Society is a perfect example that could and should do more. Other organizations, like G.S.A., use developing countries in the course of their activities. They might sponsor work in a developing country, and then leave, forgetting long term needs, needs which might be responded to by library or information systems. Another organization, the Association of Geoscientists for International Development, does an excellent job of responding to the needs of the developing countries in many ways, but has failed to make the leap to information systems such as libraries, and their worth. We cannot blame the organizations in these cases. It is rather, for us, the geoscience information specialists, to recognize the mistake in a forgotten priority and correct it. One other organization, the American Library Association, has been active in the past, but now. unfortunately, does little more than encourage visits by high-level administrators either to the United States from the developing countries or to the developing country to the United States. Each country's representative tends to

TABLE 4. POTENTIALLY USEFUL ORGANIZATIONS AND AGENCIES.

Organizations	Problem	Solution
G.I.S.	Forgets developing countries.	Geoscience information specialists awaken
G.S.A.	Uses developing countries, but forgets development.	"
A.G.I.D.	Excellent, but neglects libraries.	"
A.L.A.	Only formal high-level interchange with few developing countries.	" , but must be persistent
Larger international organizations (quasi-governmental) such as U.N.	Work at too high a level to produce real results.	Continue, for maybe someday we can build up to meet them

visit only national headquarters or national meetings. And even when that is done, it involves only a token of developing countries. This organization will be more difficult to properly motivate; but it (or one of its Round Tables) could be, at least, a coordinator of information and activities, so we do not duplicate efforts, and so that the next person to ask "what can I do?" is not lost.

Then there are the large international agencies. The United Nations is the most active in the field in question. An example of their approach to the problem was the United Nations Conference on Science and Technology for Development held last year. (One could at this point interject another question. How many of us knew of the existence of the conference, much less followed with any interest either with joy or dismay, the build-up, event, and result?) The conference did directly relate to our topic: "The global and international information networks should be so developed as to meet particularly the needs of developing countries" (Report of the UNCSTD, 1979:68). Yet, the actual results were limited, being at best merely political according to several analysts (Behrman, 1979)(Standke, 1979)(Wionczek, 1980). The limited results can readily be attributable to working at such a high level, a level where every decision must be carefully considered because of its implications both to image and to national politics. In the case of information systems their final conclusion was to set up national and international centers, something that, according to Moravcsik (1975:72), "can easily be misdirected into purely formalistic activities."

Proposed here is that we approach the problem on a less grandiose level, at a level that can have specific results, at a level where we, the geoscience information specialists, can work, at a level such as a national ministry of natural resources, or a national geological or mining society. It should not be suggested that the high level activity of organizations of a type like those of the UN should be given up. They are important. They can start at the top, but it is difficult to see value in that activity if there is nothing lower to meet them.

Now we are ready to consider ways to improve the geoscience information systems in developing countries, setting up what the

UN might call a node, that can reach up to the larger national and international systems when and if they are formed. We can work toward specifics, aimed at improving the geoscience information systems, since we have thus been relieved of the responsibility of the national and international information networks.

Recommendations

As we look at Table 5 we can see that some of the possibilities have been divided into three groups. First, the romantic travel to the developing country where one has several options as to activities: 1) one could be a consultant to libraries, to organizations like geological or mining societies, or to the appropriate governmental departments; 2) one could teach the local information specialist (be he librarian or scientist), having the advantage that by being in the developing country the real limitations are ever-present, therefore forcing one to make more realistic recommendations; and 3) one could catalog, simply listing where the relevant materials are housed, forming a geoscience union catalog for a specific geographic region for a specific subject. The second group on the Table talks to administrative work -- from being an activist in the appropriate organizations (from our employers to the UN), to helping encourage publishers (like G.S.A. or Elsevier) that it is in their interest to give selected items to the developing countries. Then there is the group on our Table creatively listed as "other," those things that could be done independently of any organization. This group includes teaching the information specialist and the scientist here. It also includes doing bibliographies of what is available in what languages (pointing out what there is left to do), doing translations of important works, and helping bring to light and correcting weaknesses in data bases that often show bias against items appropriate to the developing countries as suggested by Berger (1980).

To facilitate these activities we would also want to have our organizations help. Table 6 shows what they might do. Certainly, it would not be too much to ask A.L.A. to be a clearinghouse of information on where work is being done, almost a S.S.I.E. of library work in developing countries. This would,

TABLE 5. GENERAL RECOMMENDATIONS FOR ACTION.

In Developing Country

Consult

Teach

Catalog

At Home

Administrative

- active in other organizations
- work on gift and exchange programs
- work with publishers, encouraging gifts

Other

- teach scientists and librarians
- bibliographies of what is done in what languages
- translate
- correct biases in data bases

TABLE 6. ROLES FOR APPROPRIATE ORGANIZATIONS

Organizations	Roles
A.L.A.	Clearinghouse for all library work.
G.I.S., A.G.I.D.	Actual work on geoscience information for developing countries.
G.S.A. (and other geoscience organizations)	Clearinghouse for all geoscience work.

in turn, help in deciding what is left to do, what areas need work. G.S.A. and other geoscience organizations could also coordinate information on who is doing geology in the developing countries, so that the interested geoscience information specialist could then find with whom to work. G.I.S. or A.G.I.D could then pull together information from the previous two groups, coordinating work for specific places. Work toward improving geoscience information for developing countries would then be relatively easy to begin, not an ordeal.

For the scientists doing work or planning to do work in developing countries there is also a specific recommendation. How about a self-imposed (for who likes government-imposed?) requirement that each proposal for a grant for work in a developing country include an inventory of the relevant library resources, along with a statement on how the proposed work will improve (or why not) those resources --- an environmental impact statement for library and information systems in the developing countries? This may, in turn, necessitate a geoscience information specialist as a coinvestigator. With such a plan, we could then more easily make suggestions on what should be considered for action.

Conclusion

So what must we do? We must get motivated so that we will take up what has been a neglected responsibility. Then we must get aggressive in our concerns for our new found priority, geoscience information in developing countries. We then should push ourselves and our colleagues. And finally we should get our organizations to help. It is for us, the librarians, the information specialists, to act, for we are the ones who have an interest in and hopefully a love of libraries and what they can do. We have the skills and knowledge that can be applied to an international problem --- development. By having the skills and knowledge we incur the responsibility.

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THE FAIRCHILD COLLECTION OF HISTORICAL AERIAL PHOTOGRAPHS

Dallas D. Rhodes

Department of Geology
Whittier College
Whittier, CA 90608

Abstract: The Fairchild Collection of Aerial Photography at Whittier College is a unique library of historical aerial photographs. The collection is composed of more than 400,000 prints and negatives from photography taken during 1258 separate flight missions, most of which were flown over California. The other flights cover portions of 28 states and 4 countries. However, it is the age of the photographs, rather than the breadth of their coverage, which gives the collection its value. The pictures were taken during the period 1921-1964. Some of the oldest photographs were the first aerial pictures made of parts of the United States. These photographs are a unique resource for the study of the natural processes and historical changes in the areas pictured. The care and use of the Fairchild Collection is administered by the Department of Geology at Whittier College. All of the photographs are available for use by the public.

INTRODUCTION

The Fairchild Aerial Photography Collection at Whittier College is the tenth largest library of aerial photographs in North America (Stevens, 1978). However, the value of the collection is more in the dates of the photography than in the size of the collection. These Fairchild Aerial Survey photographs were taken during the period 1921-1964. More than half of the photographic missions were flown prior to 1945; and many were among the first to be flown over parts of the United States. Whittier College holds the photographs from 1258 separate flights, of which 1159 cover California. This unique collection of historical aerial photographs is maintained by the Department of Geology at Whittier College and is available for public use. If a series of fortunate circumstances had not occurred in 1965, all of the Fairchild Aerial Surveys' early photography would have been destroyed. To more fully appreciate the Fairchild Collection and its contents, some history is desirable.

A SHORT HISTORY OF FAIRCHILD AERIAL SURVEYS

The Fairchild Collection at Whittier College is part of the library of aerial photographs produced by Fairchild Aerial Surveys. This company was the corner-stone of a business empire built by Sherman Mills Fairchild (1896-1971). The story of Fairchild's financial successes is hardly a "rags-to-riches" tale. Fairchild was the son of George W. Fairchild, one of the founders of International Business Machines and its first president. Upon his father's death in 1924, Fairchild inherited IBM stock worth more than $2-million, after taxes. However, Fairchild's wealth, which was ultimately much more vast, was mostly a result of his own industry. He was a restless inventor, with the personal wealth to enable him to turn his ideas into major businesses.

Fairchild never earned a college degree, although he attended both Harvard and Columbia. At Columbia, he studied engineering and became interested in the problems of aerial photography, whose techniques were new then. The first photograph taken from a plane had been made in 1909 by Wilbur Wright (Colwell, 1960). During World War I, the War Department became interested in the use of aerial photography for the observation of enemy positions. In 1918, while Fairchild was still at Columbia, government officials offered him a contract for $7,000 to build an aerial camera to their specifications. By the time it was completed, the project had cost more than $40,000; the senior Fairchild made up the difference. The major innovation in Fairchild's camera was the placement of the shutter within the lens. This arrangement, which is still used today, allows an entire image to be recorded quickly enough to eliminate distortion caused by the high speed at which airplanes travel.

Fairchild was convinced that his camera had great practical value; with the encouragement of his father, he set up his own aerial photography company in 1920. His early successes received publicity, but little profit. For example, a New York Times headline reported on February 26, 1922, "Airplane camera maps city clearly in 69 minutes." The article did not mention that Fairchild's operation was losing money. Eventually, Fairchild began using his camera for map making, and, in 1924, he established his second company, Fairchild Aerial Surveys, to carry out this work. This company also lost money for a few years, but, in time, it became highly profitable.

Aerial photography was the spring-board from which Fairchild launched all of his other businesses. His desire to have a more stable plane for photographic work led him into the aviation industry in 1926. Although his early ventures failed, he succeeded with Fairchild Aviation and later with the Fairchild-Hiller Corporation. Fairchild Camera and Equipment Company was another result of his interest in photography and technological innovation.

Sherman Fairchild died on March 28, 1971, at the age of 74. He left an estate valued at $200-million and no heirs.

THE FAIRCHILD COLLECTION AT WHITTIER COLLEGE

Introduction

By the early 1960's, Fairchild Aerial Surveys had accumulated a large library of aerial photographs in its Los Angeles headquarters. Among the frequent users of the library was Dr. F. Beach Leighton, who was then chairman of the geology department at Whittier College, and faculty members from UCLA and San Fernando Valley State College (now California State University at Northridge).

In 1965, Fairchild Aerial Surveys was sold to Aero Services Corporation. Aero Services planned to move the Fairchild library to their offices in Hollywood, but they found that there was insufficient space to store the entire library collection. To solve the problem, Aero Services decided simply to discard as much of the early photography as necessary. The prints and negatives of the archival photography were being separated for disposal when a former Fairchild employee, who had been retained by Aero Services, suggested that the material be donated to the colleges that had made the greatest use of it. Dr. Leighton and the faculty members from UCLA and San Fernando State were informed that if they wanted the photography "they had better come and get it", because some of it had already been placed on the loading dock for disposal.

Some attempt at orderly division was made. San Fernando State mostly received images of the eastern United States. Whittier College and UCLA were given flights covering the western United States and especially California. However, time for distribution was short, and many boxes of prints and rolls of negatives were given out at random. The materials were generally in complete disarray when the colleges received them. The part of the Fairchild library retained by Aero Services has changed ownership twice since 1965, and those photographs remain in the hands of private commercial business.

As soon as Whittier acquired the photographic library, cataloging and indexing began. The magnitude of the task became apparent when the initial survey of materials was completed. That inventory showed that the collection comprises approximately 300,000 prints or individual photographs, 110,000 individual negatives, 800 photoindexes and photomosaic maps, and nearly 1000 negatives for the indexes and mosaics. Part of the original gift to Whittier College was lost in December, 1969, when Founders Hall, where the collection had been stored, was completely destroyed by fire. The loss included the negatives from 120 flights and virtually all of the photomosaic negatives. Fortunately, these were the only materials that remained in that building. Most of the collection had been moved, along with the geology department, to a new science center, which had been completed the previous year.

Indexing the Collection

Because of the haphazard manner of distribution of the Fairchild library, location maps of the exact flight lines did not necessarily accompany the photographs. In many instances, even the general location of a flight was not known.

After the move to the new science building, the process of indexing the collection began in earnest, but progress was slow due to a lack of funds. In the summer of 1972, Whittier College undertook "Project Compilation" to produce a complete inventory and index of the collection. The project was funded by a combination of private and government grants, and it was completed at a cost of more than $10,000.

Project Compilation had several important results. An inventory of all of the materials in the collection was made. Whittier College holds some of the prints and/or negatives of the photography from 1258 separate flight missions, 1159 of which were flown over California. The remaining 99 flights cover small portions of 28 states and 5 countries. The boundaries of the coverage from each flight over California were plotted on 1:250,000-scale topographic maps, and these 62 index maps are the keys to the use of the collection. They allow an immediate determination of the coverage that is available for any area in California. Once the catalog numbers of the flights covering an area are known, the photomosaics for the flight can be inspected to determine which individual photographs show the exact area of interest. In many cases, photographs of a specific area can be retrieved from storage in 20 minutes or less.

Use of the Collection

Since Whittier College received the Fairchild Collection, the photographs have been available for public inspection. The indexing done during the compilation project made it possible to locate photographs quickly, and this greatly enhanced the usefulness of the collection. In 1973, Whittier made the photographs available for loan to qualified users. Since then, the geology department has processed more than 1600 requests for photography. Among the users of the collection are federal agencies, researchers at academic institutions, legal firms, state and local government agencies, and especially engineering consultants and professional geologists.

The value of the Fairchild Collection for these users is not so much in the breadth of its coverage as it is in the age of the photographs. The Fairchild Collection contains the first, or at least the oldest, existing photography of many areas. Additionally, some regions, especially the urbanized areas of California, are portrayed on a number of different sets of photographs of various ages. Such repetitive photography traces the development of the area and changes in the natural systems.

The Fairchild library is much too large and varied to describe in detail. To illustrate the types of uses to which the collection may be put, the photography of the Los Angeles urban area will be used as an example.

Portions of Los Angeles and surrounding counties are depicted on the photographs from 319 separate flights, 129 of which were made prior to 1937. Not all of the area was photographed on each mission, but rather most of the flights cover a relatively small part of the region. However, nearly every part of the area was photographed more than once. Many parts of the City of Los Angeles and its immediate suburbs were photographed repeatedly between the 1920's and 1960's.

One particularly important early flight, C-300, which was made in 1928, covers all of Los Angeles County at a scale of 1:18,000. The hundreds of pictures that compose C-300 are, in essence, a "snap-shot" of the entire county; every building, road, valley, and tree can be seen. These pictures and those of similar age provide detailed information on the growth and development of the city. The earliest photographs are the only record of the natural landscape prior to urbanization.

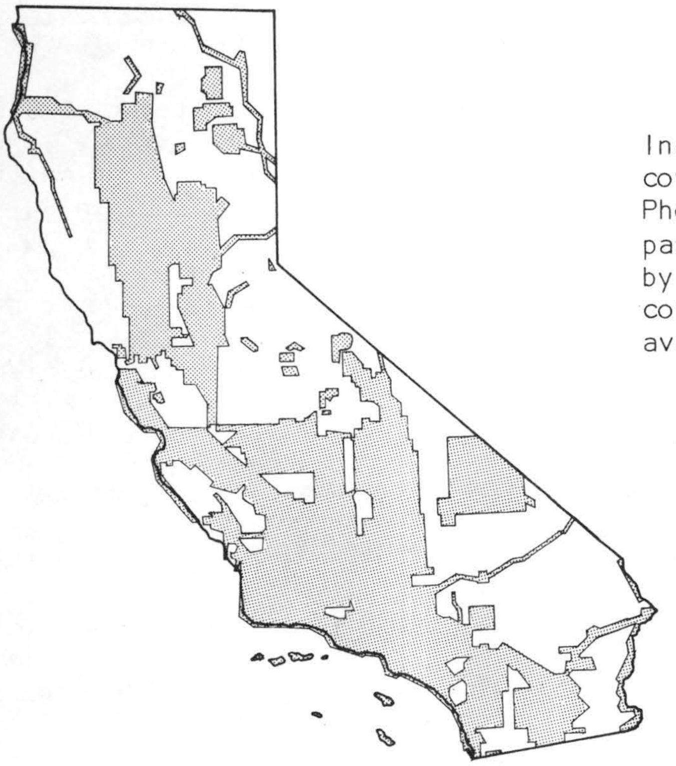
Because of the detailed information contained in these early photographs, they have a great value for the study of natural and man-made changes. For example, biologists have used the photographs to assess the extent of various habitats that have been destroyed by construction. From such studies, the populations of animal species can be estimated and the extent and type of natural vegetation can be deduced. Geologists and geological engineers have also made frequent use of the pictures. Subtle traces of faults, once clearly visible from the air, are now hidden by housing developments, freeways, and parking lots. Similarly, the limits of landslides and floodplain boundaries which are now obscured by construction are shown. Detailed knowledge of such potentially hazardous natural features is essential for environmental-impact studies and planning. Scientists have also used the early pictures as a source of base-line data for the study of natural processes. When repetitive photography of a specific area is available, the rate of operation of some processes and man's influence on them can be assessed. For instance, the coastline near Los Angeles is recorded on 12 sets of photographs. Many significant changes in the beaches are notable, and some can be related to events such as the construction of dams, which interrupted the sediment supply of rivers, and coastal engineering structures like piers, jetties, and breakwaters. Fairchild photography has also been used as legal evidence, particularly in property disputes where survey lines were based on natural features that have since been destroyed. These have been the most frequent uses of the Fairchild Collection, but others will certainly be made as the collection becomes more widely known.

Access to the Collection

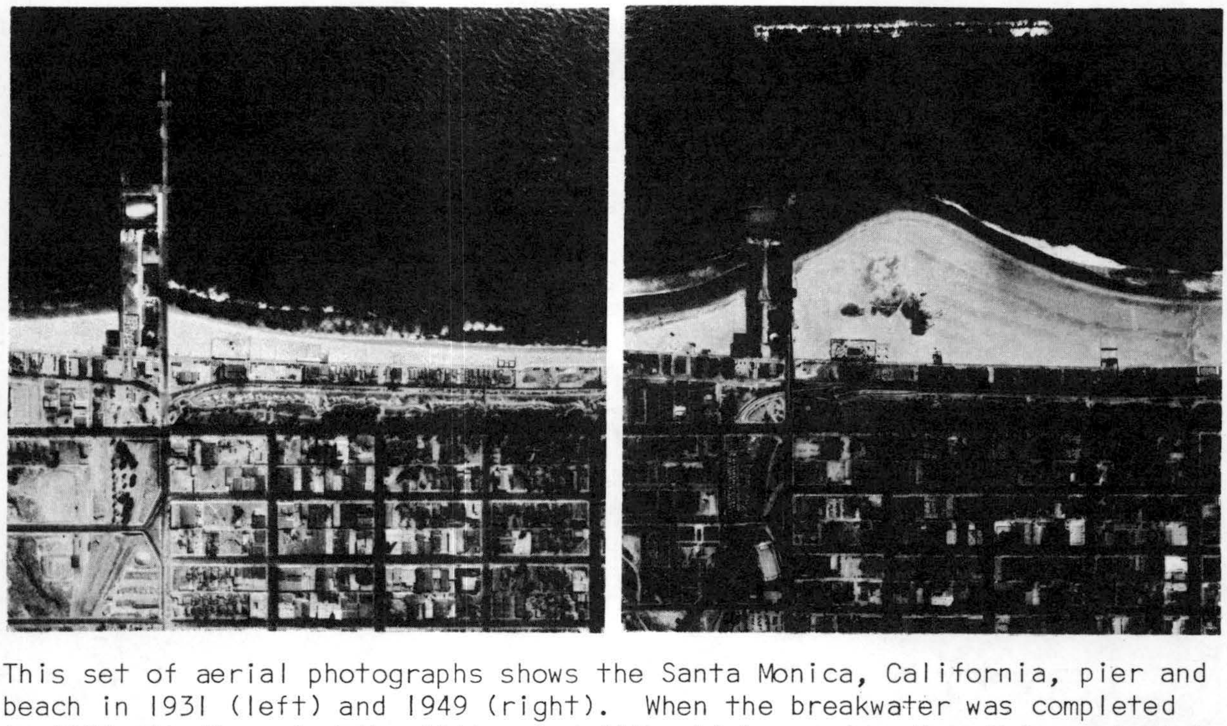
Access to the Fairchild Collection is managed by the Department of Geology at Whittier College. The photographs may either be used at the college or loaned to qualified users.

Use of the collection is initiated by making a written or telephone request for a search of the coverage available for a given area. The location and extent of the area should be specified in as much detail as possible. Latitudes and longitudes from U.S. Geological Survey topographic maps are excellent for this purpose. For locations in California, the

Figure 1: Coverage and Sample Photos



Index map of areas in California covered by the Fairchild Aerial Photography Collection. Many parts of the state are covered by more than one flight. Limited coverage of other areas is available.



This set of aerial photographs shows the Santa Monica, California, pier and beach in 1931 (left) and 1949 (right). When the breakwater was completed in 1934, it disrupted the littoral drift, which moved sediment from right to left (south) along the beach. By 1949, deposition in the quiet water near the pier had extended the beach by nearly 300 m.

coordinates used in the various Thomas Bros. map guides are also very good. The requestor will be notified of the dates and scales of all the available photography that covers the area of interest. A nominal fee is charged for this service.

After the search has been made, the photographs may be used at the college by appointment or, in most cases, may be loaned to qualified users for a period of two weeks. A qualified user is defined as a responsible individual or organization that has a professional interest in the information contained in the photographs. Most of the prints in the collection may be loaned, but those for which there are no negatives may be used only at the college. In addition to the search fee, a charge is made for loan requests to cover the cost of operating the service. Upon request, extensions of the loan period will usually be allowed for an additional two-week period; however, the college may demand the return of the photographs at any time. Furthermore, because of the age and value of the photographs, the college reserves the right to deny any loan request.

FUTURE OF THE COLLECTION

The future of the Fairchild Collection and its continued availability is uncertain. As the collection has become more widely known, requests for use of the pictures have increased every year. Some of the most frequently used prints are in poor condition and need to be replaced.

A more difficult problem places the existence of much of the older photography in jeopardy. Nearly all of the photographs taken prior to 1938 were made on nitrate-base film, a notoriously unstable material. Nitrate film decomposes spontaneously in stages, and the rate of deterioration increases with time (Weinstein and Booth, 1977). The Fairchild Collection contains approximately 29,000 nitrate-base negatives that are, as yet, unaffected by deterioration. Thousands of nitrate negatives that were badly decomposed have been destroyed because they could not be duplicated and because they were harmful to the unaffected negatives. Unless the remaining negatives are duplicated on a safety-base film soon, the images they contain will be irrevocably lost.

Recent attempts have been made to improve the storage conditions of the nitrate negatives to slow the deterioration process. However, duplication is the only solution to the problem, and this would be a very expensive operation for such a large number of negatives. The estimated cost of the conversion project is $60,000-100,000, a sum that is beyond the means of most colleges, including Whittier. Grants from private and governmental sources are being sought to fund the work. If these attempts are successful, the Fairchild Collection will be saved from destruction again and continue to serve as a unique historical record.

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APPENDIX A

AUTHOR INDEX

APPENDIX B

GEOSCIENCE INFORMATION SOCIETY

PURPOSE:

To initiate, aid, and improve the exchange of information in the earth sciences through mutual cooperation among librarians, earth scientists, documentalists, editors, and information specialists.

MEETINGS:

Annual, with that of the Geological Society of America.

MEMBERSHIP:

Open to persons and organizations whose professional activities are related to geoscience or who are interested in the purpose of the Society. Dues are $20 (individual), $30 (institutional) and $100 (sustaining). There are currently more than 250 members.

PROGRAMS:

The management, organization and dissemination of geoscience information.

PUBLICATIONS:

A directory of geoscience libraries, a union list of geologic field trip guidebooks, the _Proceedings_, and the _GIS Newsletter_.

PERMANENT ADDRESS:

Geoscience Information Society
c/o American Geological Institute
5205 Leesburg Pike
Falls Church, VA 22041