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INTERNATIONAL INITIATIVES IN GEOSCIENCE INFORMATION: A GLOBAL PERSPECTIVE

Edited by
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PREFACE

The Geoscience Information Society (GIS) is an independent, nonprofit professional society that was established in November 1965. The Society was created to improve the exchange of information in the geosciences by cooperation of an international membership that is now composed of approximately 300 documentalists, editors, geoscientists, information scientists, and librarians. GIS is a member society of the American Geological Institute and an Associated Society of the Geological Society of America (GSA). The Annual Meeting of GIS is held concurrently with that of GSA, and papers in geoscience information are read as a part of the GSA program.

Papers in these Proceedings were presented during the 1991 GSA annual meeting held in San Diego, California, October 20–24, 1991. This volume is divided into two parts:

1. Invited papers presented in the GIS Symposium "International Initiatives in Geoscience Information: A Global Perspective"

2. Contributed papers presented at the GIS Technical Session "Current Issues in Geoscience Information."

Papers are arranged in the order in which they were scheduled for presentation at the meeting and have been lightly edited for consistency.

I thank each of the authors for the time and effort they put into preparing and reviewing their manuscripts. My sincere thanks go to Amanda Masterson, Publications Manager, for her creative and practical ideas (evident in the professional appearance of this volume), and for editing, formatting, and distributing these Proceedings.

Finally, I deeply thank Doug Ratcliff, Susie Doenges, Jamie H. Coggin, Margaret L. Evans, and Diane M. Spinney, at the Bureau of Economic Geology, The University of Texas at Austin, and Drs. R. N. Donovan and R. E. Hanson at the Department of Geology, Texas Christian University, Fort Worth, for their support in generating camera-ready copy.

Dena Fracolli
Editor and GIS President
January 1992

PART I

SYMPOSIUM:

INTERNATIONAL INITIATIVES IN GEOSCIENCE INFORMATION: A GLOBAL PERSPECTIVE

INTRODUCTION

The 1991 Geoscience Information Society Symposium topic "International Initiatives in Geoscience Information" was selected to reflect the 1991 Geological Society of America's Annual Meeting theme "Global Perspectives." My thanks go to David Reade, GIS Canadian Chapter President, who suggested the wording of the symposium title.

The geoscience community is turning its focus toward a global perspective, recognizing and correlating worldwide occurrences of processes and phenomena. There is a growing international cooperation in research and problem solving in the areas of environmental studies, geology, geophysics, and other geoscience-related disciplines. It seemed therefore appropriate and timely for GIS, in support of its goal to facilitate the exchange of geoscience information, to sponsor this symposium as a forum to discuss two main concepts: what opportunities are available to support the global information needs of our geoscientists in their worldwide research efforts? And, what opportunities exist for sharing geoscience information and its management techniques with those in lesser developed countries, to support their participation in this global effort?

Papers presented in this symposium illustrate a variety of initiatives that are already in place for sharing geoscience information, technologies, and management techniques. These include international meetings (Reade), redistributing geological literature (Kidd), and the World Data Centers program (Ruttenberg). Papers also demonstrate ways of supporting the needs of geoscience researchers, by providing collections of international maps (Johansen), journals (Derksen and Noga), and society and survey publications (Klimley, Regan) for their use. Finally, this collection of papers (especially that by Green) demonstrates some of the challenges that are still facing the geoscience information community and the world at large in successfully supporting global research and cooperation efforts.

Dena Fracolli
GIS President
January 1992

GLOBAL EXCHANGE OF IDEAS AND TECHNOLOGIES IN THE FIELD OF GEOSCIENCE INFORMATION: THE ROLE OF INTERNATIONAL MEETINGS

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Abstract—In the past, international meetings have been considered one of the primary mechanisms for the exchange of information and ideas. The emergence of affordable new technologies in such diverse fields as computing, high-density data storage, and telecommunications has essentially made the world a much smaller place. These developments force us to consider whether international meetings continue to be an effective forum for the exchange of ideas and technologies in the "new" global community.

This paper examines the value of international meetings by determining both the "obvious" and the "hidden" outputs from (1) the Fourth International Conference on Geoscience Information (GeoInfo IV) and (2) COGEODOC, the International Union of Geological Science's Commission on Geologic Documentation.

Special attention is given to the exchange of information, ideas, and technologies between developed and developing nations. Problems unique to an international setting are discussed, along with potential solutions. This study also provides recommendations on how the effectiveness of international meetings can be enhanced.

[Editor's Note: No paper was submitted.]

AMOCO'S MAP COLLECTION: SUPPORTING GLOBAL RESEARCH AND EXPLORATION

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Abstract–Amoco's map collection caters to the needs of Amoco Production Company (APC) users. The various types of maps, as well as the specific geographic areas these maps cover, are selected via a multifaceted process that considers who will be using the maps and for what purpose. When certain maps are needed but are not part of the collection, sources for these maps must be located. This procedure may involve contacting domestic or foreign commercial map suppliers, governmental agencies, or university libraries. After maps are obtained, they are organized by using an unusual cataloging procedure and then stored in special map cases. Access to maps is achieved by using a customized online catalog, which provides an efficient method of retrieval. Library objectives are met when maps are used to support the worldwide research and exploration efforts of the company.

INTRODUCTION

In January 1980, with a staff of one, Amoco International Oil Company began building a library in Houston. To give the new library a start, a core collection of books was sent from the Standard Oil Company of Indiana library in Chicago, along with seven cases of maps from APC's Exploration Department.

Today, APC Library Information Center covers $10{,}000^2$ft on the 15th floor of the main building in Houston and contains approximately 46,000 books and 36,000 map sheets. Although the parent company is now called Amoco Corporation and in recent years the company's international division has been merged with both the Houston and New Orleans domestic regions, the library's collection of books and maps has retained a decidedly global focus.

The library is dedicated to supplying the informational needs of APC's staff of geoscientists, engineers, environmentalists, attorneys, and negotiators. The growth experienced over the past 11 years has been a result of attempts to provide the specific kinds of materials required to achieve success for the company. Today the need for information has become even more crucial for Amoco as it adjusts to dramatic changes in all segments of the industry.

This presentation will focus on the selection, acquisition, and organization of Amoco's map collection, followed by a discussion of its access and use. This overview will demonstrate how the map collection carries out its mission of providing support for worldwide research and exploration in the complex search for oil and gas.

SELECTION

Trying to anticipate and predict what types of maps covering which areas of the world will be needed by library patrons is a daily part of building the collection. These efforts are complicated by the rapid changes in geographic interest, which reflect the changing international scene.

The types of maps that are requested fall into several predictable categories. Geologic maps, which are broadly defined to include general geology, geophysics, tectonics, seismology, magnetics, gravity, or any other maps that are geologic in scope, form the foundation of the collection. Topographic coverage, particularly large-scale quadrangles, comprises the second largest group of maps. Other categories containing smaller numbers of maps include hydrographic and bathymetric charts, political maps, worldwide city and country travel maps, sets of aeronautical charts, plus a sizable number of general and specialized atlases.

Keeping abreast of worldwide areas of interest to oil and gas exploration via the daily news and telexes from consultant sources is a must when trying to predict what geographic map coverage will be needed. Areas of particular significance to Amoco are monitored through official company publications and electronic news bulletins. Countries named in reference requests serve as a preview to those that will eventually reappear in map requests. Probably the most direct and easiest way to ascertain what geographic coverage will be crucial in the future is just to ask. Geologists are always willing to offer suggestions for areas that need strengthening.

Selecting maps extends further than the immediate needs of the day. In the area of collection development, the ultimate goal is to have all significant countries represented by the most up-to-date geologic and topographic coverage. In pursuit of this end, numerous published sources are consulted. Those publications, specifically targeting map libraries include: *base line*, the newsletter of the Map and Geography Round Table of the American Library Association; the *Bulletin* of the Geography and Map Division of the Special Libraries Association; and the *Information Bulletin* of the Western Association of Map Libraries. Each of these publications contains sections noting newly published or yet-to-be-published maps. Familiar to explorationists are *Geotimes* and *Episodes*, which list similar map alerts geared toward the geoscience community. *New Publications of the U.S. Geological Survey* includes newly published maps for the United States as well as other countries. *Geokartenbrief*, published by GeoCenter, is another excellent source for obtaining titles of newly published maps.

ACQUISITION

Acquiring maps for the APC map collection requires perseverance and the help of many people. Foreign maps are notoriously difficult to come by, and yet they comprise roughly 90% of the collection. APC maps are acquired as donations, as purchases either at the request of specific patrons or as part of the library's collection development effort, or as loans.

Donated maps account for about a quarter of those received in the library. Patrons are encouraged to purchase maps while traveling or working in foreign countries and then to pass them on to the library. Many times this method of acquisition is the easiest and least costly in the long run and has provided the collection with a wealth of titles that might not be available to the library through normal ordering channels.

Receiving donated maps is an ideal situation, but the reality is that over half of the maps acquired are purchased by the library. Some suppliers used to provide various types of foreign maps include: GeoCenter, Telberg Geological Map Service, Geoscience Resources, Pennwell, American Association of Petroleum Geologists, Defense Mapping Agency, Timely Discount Topos, National Geographic, Baker Lyman, and One Map Place.

One source, GeoCenter, located in Stuttgart, Germany, bears mentioning again because of its extremely well organized and accurate *Geo-Katalog*. The catalog first divides the world into geographic areas and then by types of maps within each area. It lists not only individually published maps of all types but also titles of books and journals that contain significant cited maps. Titles of maps that are out of print are also included. At times this information has directed map-searching efforts immediately to interlibrary loan. Map indexes included in the catalog have been an invaluable aid when trying to pinpoint individual sheets that are part of quadrangle sets or other multi-sheet sets. One major drawback of the *GeoKatalog* is that it is written in German and prices are quoted in marks. GeoCenter's practice of giving map titles in the language in which the map has been published is helpful; however, this is not much consolation when one discovers that all of the actual map descriptions are in German. Brief introductions and explanations for the catalog itself are an exception. These are given in English and French as well as German. Turnaround time for ordering maps from *GeoKatalog* has been shortened by faxing orders and shipping by air courier.

Other sources for locating foreign maps to purchase are found in the library's International

File. This file was established as the result of a letterwriting campaign to 161 worldwide geologic sources to gather map catalogs and general publication catalogs. Names and addresses were obtained from the *Worldwide Directory of National Earth Science Agencies and Related International Organizations* (USGS Circular 934). Response to these requests was excellent and resulted in files being created for 113 countries. The information gathered answers questions concerning out-of-print maps, map series, and publications related to maps that have been produced by foreign geologic agencies. The Library Information Center, like the parent company, must be sensitive to diplomatic and political needs. Utmost care is exercised when ordering maps or any other materials from foreign governmental agencies. Dealing through company channels when Amoco has an office in a particular locale is preferable. The catalogs in the International File are consulted when requesting aid in obtaining maps through on-site company offices. An additional source for locating foreign maps is *World Mapping Today*, a British publication that specializes in currently available maps.

When needed maps are found to be out of print, they are requested through interlibrary loan from university map collections. Without exception, every university map librarian contacted over the years has willingly provided maps for APC patrons. The existence of this informal network of librarians amplifies the library's map coverage and extends the effectiveness of the collection.

ORGANIZATION

The library's approach to organizing the map collection has been to keep things simple and easy to understand. As is true of all libraries, the physical arrangement of materials is intimately tied to the system used to catalog these materials. Although standard library procedures are followed in most cases, there are three major exceptions that make the organization of the APC map collection somewhat unusual. Two of these exceptions involve cataloging procedures regarding assignment of map call numbers and subject headings or descriptors, and the third concerns the physical storage of maps.

The call number scheme used for the map collection is a modified version of the Library of Congress system and is considered the official map classification schedule for APC. It is based on the needs of patrons who prefer that maps first be grouped by type and then geographically within each type. The system consists of a simple alphanumeric coding, which divides maps into broad subject groups designated A for bathymetric, B for geologic, C for topographic, and D for political, pipeline, and base. This is followed with a geographic classification number from the LC Class G Schedule, a scale designation, and the author Cutter number plus any additional information needed to denote sheet numbers and/or copy numbers.

Not all maps are formally cataloged using the APC homegrown system. The goal is to provide ease of access in three heavily used areas of the collection. For Defense Mapping Agency and British Admiralty hydrographic charts, the numbers that correspond to the maps available in the collection are simply highlighted in each respective regional catalog. Complete sets of aeronautical charts, the *Operational Navigation Charts* (ONC's) and *Tactical Pilotage Charts* (TPC's), are folded and shelved in alphanumeric order. Areas of interest are located by using the one-sheet map index for the charts. The collection of worldwide city and country travel maps is simply filed by name with an accompanying index and list of cross references.

The authority used when assigning subject headings or descriptors to maps is the University of Tulsa's *Exploration and Production Thesaurus* when denoting type of map, and their *Geographic Thesaurus* when describing geographic coverage. Occasionally there is need for a descriptor that does not appear in either of these thesauri. In such cases, other sources, including the *GeoRef Thesaurus and Guide to Indexing* and the American Geological Institute's *Glossary of Geology*, are consulted when choosing terms. If there is a significant descriptive or clarifying word or phrase in the title or elsewhere on the map, it will be used in addition to the formally controlled thesaurus terms. Periodically a thesaurus of all the terms that have been used by Amoco is printed, and this then becomes the final authority for assigning subject headings.

After being cataloged, maps are edged with a special plastic stripping, the call number is attached to this stripping, and then each map sheet is hung in a map case. The map cases, made by Plan Hold, were originally developed for blueprints, but they have provided excellent vertical storage for many irreplaceable maps. Since all maps can be checked out, patrons as well as staff enjoy the ease with which maps can be located in the cases and the ability to view each map before it is removed. Cases are simply pulled apart to allow map removal and can be closed and locked for security purposes.

ACCESS

In place of a traditional "card" catalog, the Library Information Center utilized the INQUIRE database management system to form the framework for building an online catalog. This online system was customized to meet the specific needs of APC library patrons. A menu was created that allows searching the catalog without having to learn a specialized language. To locate maps in the catalog, only two pieces of information need to be entered: the geographic area and the type of map. This self-serve catalog not only satisfies the needs of patrons who want to conduct their own searches but also frees up staff time.

Nevertheless, full use of the library catalog has been hindered because the database was originally installed on a computer system not available except in the library itself. By the end of 1991, an updated system will be installed that will give access to the library catalog to everyone on the Houston computer system. Without leaving their offices, patrons will be able to search the catalog, request materials, and print bibliographies. It is anticipated that the ready availability of the library catalog will generate increased activity in all areas of library service.

USE

The goal of maintaining a map collection is achieved when maps are matched with the people who need them. This goal is fulfilled after interviewing the map user to ascertain what information is needed from what type of map and then being familiar enough with the collection or outside sources to locate the correct map.

Patrons use maps for an array of projects ranging from planning geologic field work to planning a pipeline route or from laying out seismic programs to locating geographic features or landmarks. Maps provide data for digitizing geologic and geographic features and are used in concert with satellite images.

The library has supplied maps for needs as diverse as flying a company plane on an emergency mission from Pakistan to Gabon and locating faults in the Houston area. An attempt was made to find a map of China printed on linen, and topographic maps have been ordered and received from Mexico. Fifty copies of a letter-size map of the world were located for trip notebooks. Maps containing specific runway information for airstrips in Thailand were tracked down, but finding a map showing the oil seeps of the world has remained a challenge. Within minutes the library provided a fellow industry colleague, Conoco, with TPC charts locating the site of their tragic aircraft accident in Malaysia.

CONCLUSION

Growing from 7 map cases to 33, Amoco's map collection supports the needs of patrons who use maps in the global search for oil and gas. Selection of maps is based on an awareness of vital geographic areas. After maps are acquired through donation, purchase, or interlibrary loan, they are organized by using a modified cataloging procedure and an unusual method of storage. An online catalog facilitates map retrieval and provides tailored access for users. As new technologies emerge, Amoco looks forward to adopting these technologies to further enhance the map collection and its usefulness to patrons.

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Permission from the management of Amoco Production Company to publish this paper is gratefully acknowledged. The author wishes to thank those who gave encouragement during the writing of this paper and those who critically reviewed the manuscript.

COORDINATING COLLECTION OF FOREIGN GEOLOGICAL SURVEY AND SOCIETY PUBLICATIONS IN GEOLOGY LIBRARIES: THE RLGEO EXPERIMENT

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Abstract—Coordination among U.S. geology libraries of collection responsibilities for the geologic literature has seemed an obvious solution to rising publication costs and the impossibility of having the whole universe of publications available in one's home institution. Although foreign geologic survey and society publications are frequently not as expensive as commercially produced publications, obtaining this material—especially complete sets of titles—frequently requires correspondence, exchange agreements, and persistence. Economies in staff time presumably could be realized if collection efforts were not duplicated in all libraries. Yet despite agreement on the potential benefits of coordination, little progress has been made at the national level.

One reason for the relatively low level of coordinated collecting is the difficulty of establishing meaningful collecting commitments. Additionally, quality control, necessary for confidence in cooperative arrangements, is time-consuming on an intra-institutional basis. The RLGeo Project, initiated as a result of the 1986 Conoco Study, is an experiment in coordinated collection of geologic publications from five Latin American countries among six United States geology libraries. It is an attempt to work within the existing Research Libraries Group consortia utilizing an expanded Conspectus to set up a cooperative collecting agreement and measure its effectiveness. Preliminary results of this 5-year project will be presented in this paper.

The focus of this symposium is twofold. One aspect of the symposium is the opportunity for meeting the global information needs of our primary patrons, North American geologists. The other aspect of the symposium concerns the efforts we can make toward helping information managers and researchers in other areas of the world gain access to international data. This paper is a summary of the Research Libraries Group's RLGeo Latin American Project. It is an example of an effort to improve access to the geologic information of one geographic area through cooperative action among libraries. This pilot project has two more years to run and will be followed by a formal report and statistics.

Before I focus on the RLGeo Project, let me note that a quick review of the library literature on cooperative collection development reveals that the failure of cooperative action is a frequent topic. Joe W. Kraus, Director of Libraries, Illinois State University at Normal, made a relevant comment in 1975 that seems to be as true today as then. He said:

> Although most of the cooperative enterprises of libraries are announced and described in some detail in library periodicals, there are few evaluative reports that give a clear account of the success of a venture and the factors leading to success or failure. Unsuccessful ones, in fact, simply seem to fade away (Kraus, 1975).

The fact remains that despite good intentions and a great deal of effort, cooperative collecting arrangements have little effect on the daily collecting in most libraries. A good example of an extremely large cooperative development project by the Research Libraries Group is the Conspectus. The Conspectus was developed as a tool for aiding cooperative collecting activities. Its objective is to document traditional strengths and current collecting practices for the libraries using it. Since self-assigned collecting levels were almost immediately questioned by participants, "verification studies" followed the Conspectus. Verification studies attempted to quantify what levels of collecting were characteristic of various Conspectus levels. Use of the Conspectus spread far beyond the Research Libraries Group (RLG), and it is used by many members of the Association of Research Libraries and regional groups such as those in the Pacific Northwest and Alaska.

Yet it is not clear that the Conspectus has actually enabled us to develop our collections as a group rather than individually. In a recent paper, Anthony Ferguson suggests that "most librarians forgot the Conspectus was a means to an end. They made it an end unto itself" (Ferguson, in press).

Concerned for some time about the apparent lack of success of broad-based cooperative efforts, RLG decided to devise a study to analyze how selection decisions were made and what factors might influence the choice between access and ownership of an item. Funding was received from the Conoco Foundation to conduct a study focusing on geology and German literature.

The results were reported at GIS and other meetings during the mid-1980's (Klimley, 1986a, 1986b). The results were a surprise to many higher level administrators. Far from being parochial in their attitudes, geology selectors were found to be willing to depend on access to geologic materials rather than on ownership of a large percentage of the materials that were included in the sample. In fact, the geology librarians proved more amenable to cooperative collecting than did the German selectors, the corresponding humanities group included in the study. More surprising to the participants was the fact that access was chosen despite the sample's slant toward mainstream, core publications, rather than more esoteric research publications. In other respects, the results were less surprising—foreign language materials were among the most frequent choices for cooperative ownership. The selectors tied the acceptability of access to quick turnaround time. Flushed by the documented willingness to employ cooperative efforts in geology, RLG undertook a pilot project, to become known as the RLGeo Latin American Project.

It is important to point out that this project has been undertaken to try to work out effective cooperative collection development among libraries, rather than to provide better access to international information. Access to international information was considered problematic enough to those of us who designed the project so that improving access to the literature of several South American countries was chosen as the focus of the pilot. Cooperative action among our library group for the benefit of the geologists of our own institutions was the objective. But the project, I feel, illustrates the complexity of using cooperative activities to help provide access to information in the U.S. in general. Since we often propose that less developed areas of the world should use cooperative activities to improve their information needs, perhaps the complexity of our project and the problems we had will temper the optimism with which we recommend cooperative activities as a solution to others' problems.

After working on the RLGeo Project for several years, I think I have a better understanding of what it takes to manage our collections on a national basis. One reason we have not been more successful is that cooperative collection development is not simple. It is not easy to pick an area of cooperation that does not risk the selector's responsibility to his or her own patrons, particularly as the timeframes available through commonly used interlibrary loan do not meet the requirements of our patrons. It is not easy to set up tools to keep track of our cooperative efforts. And it is hard to see results.

The Conoco data suggested that geology selectors would be willing to rely on other libraries for a substantial amount of material. And as a result, the group of librarians who had participated in the project were charged with finding a pilot project to take advantage of these findings. As noted earlier, selectors linked willingness to rely on others with a speed of interlibrary availability much quicker than that commonly available, then or now, through interlibrary loan. The option of coupling a cooperative project with improved interlibrary loan was not discussed.

The reliance on current interlibrary loan turnaround time did not dissuade those of us involved in the pilot project. Many, if not all, of us felt that the geologic literature fell into two parts, a fairly small well-defined core and a gigantic world beyond the core. We felt that the greater research literature would be a good candidate for cooperative activities. I felt that institutions had interests quite different from one another, a factor we could build upon. Libraries could continue to collect in areas they *must* for faculty/teaching/research interests and rely on other libraries for other materials. The area we used to visualize our cooperative activities was Latin America. The geology of this area lent itself to thought about how we would accept collecting responsibilities. Some institutions had strong interests in plate tectonics and as a result were especially concerned about access to materials from the east coast of South America. Other schools were more interested in the paleontology and geology characteristic of places like the Amazon Basin and east coast.

In the end, we decided to base the project on the area we had discussed theoretically, and we chose Argentina, Bolivia, Brazil, Colombia, and Chile. It was a decision that caused questions and reservations right from the beginning. For example, the project was country-based, and geology does not follow national borders. The reasoning behind our decision was that the literature, not the geology, tended to conform to national boundaries. We also felt that our problems tended to be related to the national character of the literature.

There was also a strong feeling that the foreign survey and society publications were increasingly difficult for all of us to obtain. While many of us worked in geology libraries that had attempted to collect the geology literature from the whole world, this seemed to be an unrealistic goal amid today's reality of reduced staff. The greatest potential for savings was seen, not in money, but in staff and librarian time.

A big problem with the focus of the pilot was that several libraries interested in participating simply did not collect foreign survey materials, either in general or in this particular area. There were also concerns about so severely limiting the focus of the study to these five countries. How would we be able to tell anything from such a limited study? As will become clear, the desire to carefully document and track the project dictated the tight focus of the study. We did not think we could collect the data we wanted if we used a larger area.

Problems still loomed ahead. There was the prospect of keeping records on who was covering which areas. Since we were an RLG group and given that the Conspectus was developed within RLG, one might have thought the Conspectus was the logical place to record our commitments. Yet we were quite certain we wanted a geographic basis for collecting responsibilities. The Conspectus is not geographically based but rather is based on Library of Congress subject fields (Fig. 1). We

Figure 1. Physical geography and earth sciences Conspectus subject listing.

GEOLOGY (GEOCAT6)

- GEO89–General
- GEO90–Periodicals
- GEO91–History
- GEO91.10–Aerial photography
- GEO91.20–Mathematical geology
- GEO91.30–Geological maps
- GEO91.40–Agricultural geology
- GEO91.50–Submarine geology
- GEO91.60–Electronic data processing
- GEO92–Regional geology–General
- GEO93–Regional geology–United States
- GEO94–Regional geology–Canada
- GEO95–Regional geology–Mexico, Central America, West Indies
- GEO96–Regional geology–South America
- GEO97–Regional geology–Europe
- GEO98–Regional geology–Asia
- GEO99–Regional geology–Africa
- GEO100–Regional geology–Australasia
- GEO101–Regional geology–Arctic regions
- GEO102–Regional geology–Antarctic regions
- GEO103–Mineralogy
- GEO104–Petrology–General
- GEO105–Igneous petrology

RLG Conspectus–October 1984

Figure 2. RLGeo commitment form.

CHILE	GENERAL WORKS	TRADE PUBLICATIONS	NAT'L GEO. SURVEY		STATE DOCUMENTS	ALL TYPES
	← Stanford	—	Columbia —	Stanford	—	→
Economic Geology			│	│		
Engineering Geology			│	│		
Environmental Geology			│	│		
Geochemistry			│	│		
Geochronology			│	│		
Geomorphology			│	│		
Geophysical Surveys			│	│		
Glacial Geology			│	│		
Hydrogeology			│	│		
Meteorology	←				NYP	→
Mineralogy			│	│		
Mines and Mining	←	NYP				→
Oceanography			│	│		
Paleoarcheology			│	│		
Paleobotany			│	│		
Paleoclimatology			│	│		
Paleogeography			│	│		
Paleomagnetism			│	│		
Paleontology-Vertebrate			│	│		
Paleontology			│	│		
Invertebrate Paleontology			│	│		
Micropaleontology			│	│		
Petrology-Igneous Petrology			│	│		
Metamorphic Petrology			│	│		
Sedimentary Petrology			↓	↓		
NATIONAL GEOLOGICAL SOCIETY →						

wanted a form that was first broken down by country, then by subjects. Figure 2 is the commitment form for Chile. As you can see, it is almost multidimensional. Not only can an institution define its responsibilities by geologic field but also if it prefers it can define collecting responsibilities by publisher.

When I committed to the area of Chile, I knew immediately that what we were attempting to collect was the national survey and society publications, and it was easy for me to represent this on the chart. Other selectors facing reductions in collecting knew that paleontology was the area they would try to continue to collect, and they represented themselves as committed in that area.

We discussed the problem of technical processing at length. We felt strongly that bibliographic control was essential for providing access as a viable alternative to ownership. As such, we were concerned about the low status given cataloging for this type of material in our libraries. How would we ensure that the Latin American materials were processed as promptly as possible? In the end, we agreed to try to give these materials higher priority within our libraries through various means—flagging materials, marking them RLGeo, and so on. We also discussed ways of making sure interlibrary loan requests were promptly sent on to our branches and attempted to get our interlibrary

Figure 3. RLGeo statistics reporting form.

WHEN ANSWERING THE REMAINING QUESTIONS, USE ONE FORM PER COLLECTING RESPONSIBILITY

INSTITUTION AND UNIT ______________________
INSTITUTIONAL COORDINATOR ______________________
DATE ______________________
COLLECTING RESPONSIBILITY ______________________

II. Changes in the Collection

Specify the number of titles (not volumes), in your institution's area of collecting responsibility, which you have (1) ordered, (2) received (uncataloged), and (3) received (cataloged) ready for patron use since your last report:

	(1)	(2)	(3)
Serials			
Monographs			
Other Formats (Please Specify)			

If there are specific series or set titles which required unusual efforts or staff time since your last report, please list the title(s) and briefly describe the problem(s) and your solution(s).

loan people to send through unverified, "blind" requests. We all expressed concerns that we would be able to get our institutions to participate at this level—which brings up the question of institutional support. Many of us emphasized the need for institutional support of the project. We simply could not "go it alone." The document that was prepared for RLG and given to our institutions included a commitment to process the RLGeo materials promptly.

We also discussed ways of enhancing our ability to obtain these sometimes elusive materials. Over the first years of the project, we exchanged catalogs and information on vendors, talked to distributors who travel in Latin America, and made contacts with the Latin American bibliographers. I personally used the Research Libraries Group database, RLIN, to look at other libraries' holdings. It helps me to know if someone has received more recent issues of a journal than I have—it also tells me the journal is still being published. I often find helpful information, like the fact that a title has split or, even better, someone has established that it has ceased. Unfortunately, many libraries including my own have stopped putting this level of detail into RLIN. I suppose it is still available to us if we utilize our hacker skills and navigate through the online public access catalogs available in our networks. But that lacks the same efficiency as looking through the grouped RLIN holdings all in one place.

Finally, we were concerned with—as noted in that earlier quote—evaluating our success. As a result, we developed an extensive system of statistic-keeping to track the project. Using the form shown in Figure 3, we tried to record our baseline holdings. Then on a yearly basis, we recorded the increases to our collections. We monitored our interlibrary loan requests for materials in this area to see if there was an increase. We tried to keep track of how many times we requested special handling. Finally, there was always a place to record how, if at all, we had changed our collecting in areas of the study outside our collecting responsibility.

It is an ambitious project, and all of us have felt frustrated in our efforts to make it work. By their very nature, the materials from this area are difficult to obtain. We did not solve that problem. I have found it disheartening to fill out my annual report and see so little change. I look in my KARDEX and see that the four issues of the Geological Survey of Chile represent four more current issues than I had last year, but not being monographs or new serials they don't even make it onto the form. One participant made an extensive effort to contact the surveys in the countries she was responsible for to make exchange arrangements. Few of the letters received a response. Some countries' materials come, some do not. I have found that interlibrary loan follows perverse patterns. Capricious requests come to me for materials from Latin American countries, but not for the ones in the study.

Still, we persist. Now in the third year of the study, we continue to gather statistics, meet at GSA, and continue the project. Although we have not finished our 5-year stint, I am beginning to understand why it is so hard to make cooperative collection development work both on the scale we are trying within RLG and using cooperation as a tool in general.

First of all, an institutional support structure is essential. The reason we were able to attempt this project at all is because all the participating libraries are RLG members. Even so, some librarians belonging to RLG did not feel that their collection management administrators supported the project. They did not feel that their institutions wanted to *commit* to areas of responsibility. RLG, at least, was a giant umbrella under which we could cover all sorts of cooperative activities.

Secondly, we have to have a structure in which to record our varying cooperative commitments. Otherwise, other libraries simply don't know who is responsible for what. The structure also has to be specific enough so we can divide up responsibilities in areas where more than one institution has a strong collection. I think that the decision to focus on Latin America was a wise one. Foreign survey and society publications are source materials for our scientists and yet among the trickiest things to acquire. For our strong collections in the earth sciences, the Conspectus just doesn't make it. We're all level 4's in petrology and geochemistry. That information doesn't help us. Our RLGeo system was complex, but we had a record of each others' commitments, on paper.

Finally, a project of this sort takes an enormous personal commitment from the librarians involved. It takes time to record commitments at a level that is meaningful. It is difficult to make a special effort on behalf of the group when many of us have faced serial budget and staffing problems. It is very hard to keep all the statistics that permit us each to see what the other is doing and have confidence that the project is working. The annual GIS meetings helped our efforts by allowing us to get together face to face and discuss our problems both in the formal meeting we schedule each year and informally during the conference. Electronic mail facilitates contact. In the last year or so, we have also utilized telephone conference calls to help us keep in touch.

The RLGeo Project is an example of a working attempt to coordinate collecting of global information in a very specific way. I know there have been other cooperative collecting efforts—I participate in some of them myself. The American Museum of Natural History stresses paleontology and evolution in their geology collection; I know it and don't buy as much. The Long Term Serials Project in the Research Libraries Group has developed a core list of geology journals, and every effort will be made to keep these available within RLG. But these projects have not attempted to deal with the foreign geologic survey and society publications and they are the things which I use the least often and which concern me. The RLGeo Latin American Project is an attempt to make sure we have access to the elusive, extensive survey and society literature. Are cooperative efforts such as this going to be the solution to our global information problem? I don't think we have an answer yet. But the problem itself is much clearer.

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THE WORLD OF GEOSCIENCE SERIALS: COMPARATIVE USE PATTERNS

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Abstract—A major portion of the geoscience literature is published in serials. These journals and series are produced by associations, government agencies, commercial publishers, and research institutes in almost every country. This study presents results from intensive use studies at two large academic geoscience libraries in California. Their serial collections cover most of the subject and geographic areas of the geoscience literature. In-house use, circulation, use in theses, and faculty choices of publication were all measured. The data show differential use patterns of various subject areas, such as geophysics and paleontology. Other comparisons include analyses of serial use by country, by language, and by type of publisher. These results provide an overview of the international diffusion of geoscience information.

INTRODUCTION

Serials are a very important part of the geoscience literature, and their purchase consumes a majority of library book budgets. Geoscience journals and other serials are produced by associations, government agencies, commercial publishers, and research institutes in almost every country.

How much of this information is used? What are the use patterns? This paper presents results from intensive use studies at two large academic geoscience libraries. Our serials collections together reflect much of the subject and geographic breadth of the geoscience literature.

The UCLA Geology/Geophysics Library serves a department and a research institute with emphases in geochemistry, geophysics, space physics, planetary science, and the evolution and origin of life. The Stanford Branner Earth Sciences Library serves a school with strong interests in geophysics, geochemistry, ore deposits, petroleum, and hydrogeology. Use data from studies at both libraries are presented.

METHODOLOGY

Both studies measured use of material (including unbound issues) and the number of circulations per title. Use was recorded from volumes left on tables or near photocopiers. Users were asked not to reshelve materials, but we are aware that use was undercounted because some users reshelved volumes themselves.

All titles in the combined studies were coded for country of publisher, present language of publication, type of publisher, and subject. If articles in different languages were published in a journal, the predominant language was coded. The organization responsible for the editorial content was used for the type of publisher. For example, association journals published by commercial publishers were coded as association publications. The subjects were chosen from the *Bibliography and Index of Geology's* subject categories, some of which were consolidated. Only one subject was assigned to each title.

There were two major differences between the studies. The UCLA study lasted 12 months, which included a period of unusually intensive paleontological research; the Stanford study lasted 18 months. The Stanford study looked at regularly published journals only; the UCLA study included monographic serials such as memoirs, professional papers, and reports as well as journals.

Since the journals in which faculty publish represent an important gauge of a journal's worth in a collection, we also looked at faculty publications at UCLA and Stanford.

An additional study examined the references cited in Stanford dissertations that were completed during 1989 and 1990. Ten thousand citations were examined, of which only the journal citations are presented here.

OVERALL USE

All journals in the Stanford Branner Earth Sciences Library are included in this study. The data presented in this paper include only titles which (as far as can be determined) are still in existence, including those for which the subscription has recently been cancelled. Of a total of 617 titles held, 479 (78%) journal titles were used. Two hundred eighty-three of the ceased titles were also used but are not included in this study.

At UCLA 743 serial titles were used. The UCLA use figures are considerably smaller than the Stanford figures partly because the Stanford study lasted longer and partly because the circulation period for UCLA journals and serials is much longer (one academic quarter versus 3 days).

The 20 most-used serials at UCLA are listed in Table 1A (UCLA). Twelve of these titles (indicated by asterisks) are also included on the Stanford list. There are no petroleum engineering titles in the UCLA list, but *Icarus*, a space science journal, is included. Close comparison of the Stanford and UCLA rankings reaffirms that the importance of a specific serial varies considerably between collections, in accordance with user interests. For example, *Icarus* is clearly a core title in the UCLA collection, but Branner does not even subscribe to it. The reverse is true of *SPE Formation Evaluation*. The *USGS Professional Paper* is the most often used monographic serial in the UCLA collection.

Table 1A. UCLA serials that received the most use, 1988.

Journal title	Publisher type	Total use
Journal of Geophysical Research*	Assoc. - US	660
Nature*	Commer. - For.	573
Science*	Assoc. - US	431
Geological Society of America. Bulletin*	Assoc. - US	380
American Association of Petroleum Geologists. Bulletin*	Assoc. - US	308
USGS Professional Paper	Govt. - US	294
Geochimica et Cosmochimica Acta*	Assoc. - For.	216
American Journal of Science*	Univ. - US	209
Earth and Planetary Science Letters*	Commer. - For.	205
Scientific American	Commer. - US	186
Contributions to Mineralogy and Petrology*	Commer. - For.	160
Canadian Journal of Earth Science	Govt. - For.	159
Geology*	Assoc. - US	154
Geophysical Journal International*	Assoc. - For.	146
Geophysical Research Letters	Assoc. - US	140
Physics of the Earth & Planetary Interiors	Commer. - For.	140
Journal of Geology	Univ. - US	139
Tectonophysics*	Commer. - For.	138
Icarus	Assoc. - US	133
Economic Geology	Assoc. - US	131

Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Univ. = university, US = United States. * = also on Stanford's list.

The 25 most heavily used titles at Stanford are listed in Table 1B. There is a considerable drop between the top two titles and the next ones. Note the relatively high use for *Metals Week*, most of which was in-house rather than by circulation. Petroleum journals account for most of the high-use commercial titles. Eight of the top 10 journals are the same in both collections.

Table 1B. Stanford journals that received the most use, 1988–1989.

Journal title	Publisher type	Total use
Journal of Geophysical Research*	Assoc. - US	1,661
Nature*	Commer. - For.	1,170
Oil and Gas Journal	Commer. - US	951
Earth and Planetary Science Letters*	Commer. - For.	914
Geochimica et Cosmochimica Acta*	Assoc.- For.	886
Contributions to Mineralogy and Petrology*	Commer. - For.	748
Science*	Assoc. - US	721
World Oil	Commer. - US	672
Tectonophysics*	Commer. - For.	640
Geological Society of America. Bulletin*	Assoc. - US	553
American Journal of Science*	Univ. - US	548
Geophysical Journal (international)*	Assoc. - For.	505
American Mineralogist	Assoc. - US	503
Geology*	Assoc. - US	499
Seismological Society of America. Bulletin	Assoc. - US	490
SPE Formation Evaluation	Assoc. - US	450
Geophysics	Assoc. - US	397
Chemical Geology and Isotope Geoscience	Commer. - For.	396
American Association of Petroleum Geologists. Bulletin*	Assoc. - US	379
Water Resources Research	Assoc. - US	325
Economic Geology	Assoc. - US	315
Metals Week	Commer. - US	287
Geophysical Research Letters	Assoc. - US	283
Geological Society of America. Abstracts with Programs	Assoc. - US	277
Soil Science Society of America. Journal	Assoc. - US	260

Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Univ. = university, US = United States. * = also on UCLA's list.

It is interesting to compare theses citations with the use data (Table 2). *Journal of Geophysical Research* and *Nature* are the most frequently used journals in both libraries. *JGR* is also the most heavily cited in the Stanford theses. However, several of the heavily used titles (*Nature, World Oil, Science, American Mineralogist,* and *Chemical Geology*) are not included in the top 20 most heavily cited titles, indicating that these titles may more likely be used for current awareness than for research. On the other hand, *Geological Society of America. Abstracts with Programs* and *EOS*, which are often thought of as current awareness tools, are actually cited quite heavily. *JPT (Journal of Petroleum Technology)* and *AIME Transactions* are other titles cited more often than their use would seem to predict, as were several paleontology titles. Twenty titles that showed no use were nonetheless cited in theses. These were esoteric titles not likely to be acquired as personal subscriptions, thus giving credence to the belief that many people did reshelve materials after use. Note also the preponderance of society publications in the list of most often cited journals; only 20% are commercial publications.

Table 2. Journals that were cited most often in Stanford theses completed in 1988–1989.

Journal title	Publisher type	Theses citations
Journal of Geophysical Research	Assoc. - US	628
Geological Society of America. Bulletin	Assoc. - US	366
Water Resources Research	Assoc. - US	239
American Association of Petroleum Geologists. Bulletin	Assoc. - US	225
Geochimica et Cosmochimica Acta	Assoc. - For.	209
Geology	Assoc. - US	183
Geological Society of America. Abstracts with Programs	Assoc. - US	179
SPE Formation Evaluation	Assoc. - US	175
Geophysics	Assoc. - US	172
JPT. Journal of Petroleum Technology	Assoc. - US	161
Contributions to Mineralogy and Petrology	Commer. - For.	157
American Journal of Science	Univ. - US	151
American Institute of Mining, Metallurgical, & Petrol.	Assoc. - US	147
Tectonophysics	Commer. - For.	134
Geophysical Journal (international)	Assoc. - For.	129
Earth and Planetary Science Letters	Commer. - For.	128
EOS (Transactions, American Geophysical Union)	Assoc. - US	121
Seismological Society of America. Bulletin	Assoc. - US	109
Economic Geology	Assoc. - US	108
Oil and Gas Journal	Commer. - US	86

Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Univ. = university, US = United States.

FACULTY PUBLISHING PATTERNS

UCLA faculty publications were identified by scanning serials received in the library over a 4-year period (Table 3A).

Stanford faculty publication was identified by a scan of the journals received at Branner over a period of 5 years, ending in 1990. Altogether 581 Stanford faculty publications appeared in 81 different journals. Five were in Chinese, two in Spanish, and one each in German and Japanese. Besides the United States (70%), articles were published in 12 other countries; the United Kingdom, the Netherlands, and Germany accounted for 27%; other countries included China, Canada, Denmark, Italy, Japan, Mexico, and Switzerland. The *EOS* items are articles, rather than abstracts.

Not surprisingly, there is a strong emphasis at both schools on geophysical and geochemical journals. Both faculties chose association journals for a huge proportion of their publications, 75% for UCLA and 76% for Stanford.

Table 3A. Journals (20) in which UCLA faculty most frequently published, 1986–1990.

Journal title	Publication type	No. of pubs.
Journal of Geophysical Research	Assoc.	46
Geophysical Research Letters	Assoc.	24
American Mineralogist	Assoc.	9
Geochimica et Cosmochimica Acta	Assoc.	8
Meteoritics	Assoc.	7
Nature	Commer.	6
Geophysical & Astrophysical Fluid Dynamics	Commer.	6
Geophysical Journal International	Assoc.	5
Icarus	Assoc.	5
Astrophysical Journal	Univ.	5
Geophysical Monograph	Assoc.	5
Geology	Assoc.	4
Geological Society of America Bulletin	Assoc.	4
Tectonophysics	Commer.	4
Physics and Chemistry of Minerals	Commer.	3
Science	Assoc.	3
Earth and Planetary Science Letters	Commer.	3
Marine Chemistry	Commer.	3
Physics of Fluids	Assoc.	3
Chemical Geology	Commer.	2
Physics of Earth and Planetary Interiors	Commer.	2
Organic Geochemistry	Assoc.	2
Planetary and Space Science	Commer.	2
Tectonics	Assoc.	2
Journal of Paleontology	Assoc.	1
Applied Geochemistry	Assoc.	1

Note: Assoc. = association, Commer. = commercial, Univ. = university.

Table 3B. Journals (25) in which Stanford faculty most frequently published, 1985–1990.

Journal title	Publication type	No. of pubs.
Journal of Geophysical Research	Assoc.	78
Geology	Assoc.	41
Geological Society of America. Bulletin	Assoc.	40
Geochimica et Cosmochimica Acta	Assoc.	30
SPE Reservoir Engineering	Assoc.	27
American Mineralogist	Assoc.	25
Nature	Commer.	22
Geophysical Research Letters	Assoc.	17
Geophysics	Assoc.	16
JPT (Journal of Petroleum Technology)	Assoc.	16
Water Resources Research	Assoc.	16
Mathematical Geology	Commer.	15
Tectonics	Assoc.	15
Organic Geochemistry	Assoc.	14
SPE Formation Evaluation	Assoc.	14
Economic Geology	Assoc.	13
Science	Assoc.	13
Tectonophysics	Commer.	10
Contributions to Mineralogy and Petrology	Commer.	8
Earth and Planetary Science Letters	Commer.	8
Journal of Petrology	Commer.	8
Precambrian Research	Assoc.	7
American Association of Petroleum Geologists. Bulletin	Assoc.	6
EOS (Transactions, American Geophysical Union)	Assoc.	6
Physics and Chemistry of Minerals	Commer.	6

Note: Assoc. = association, Commer. = commercial.

USE BY COUNTRY OF PUBLISHER

Most of the serials used at UCLA were published in the United States. Titles from the United Kingdom, the Netherlands, and Germany were also heavily used (Fig. 1A). This result is not unexpected, because there is a major commercial serial publisher in each of these European countries.

There was a significant use of serials from the USSR and Japan. UCLA has a strong collection of Russian serials, and paleontologists have been the greatest users of these titles.

An even greater percentage of titles used at Stanford were published in the United States (Fig. 1B). United Kingdom titles had slightly more use than at UCLA, whereas Germany and the other countries had proportionately smaller use. Considering the strong research on Australia at Stanford, the low use of Australian titles was somewhat surprising. We had also expected the use of journals published in Japan to be much higher, given the strong interest in both earthquakes and Pacific Rim geology.

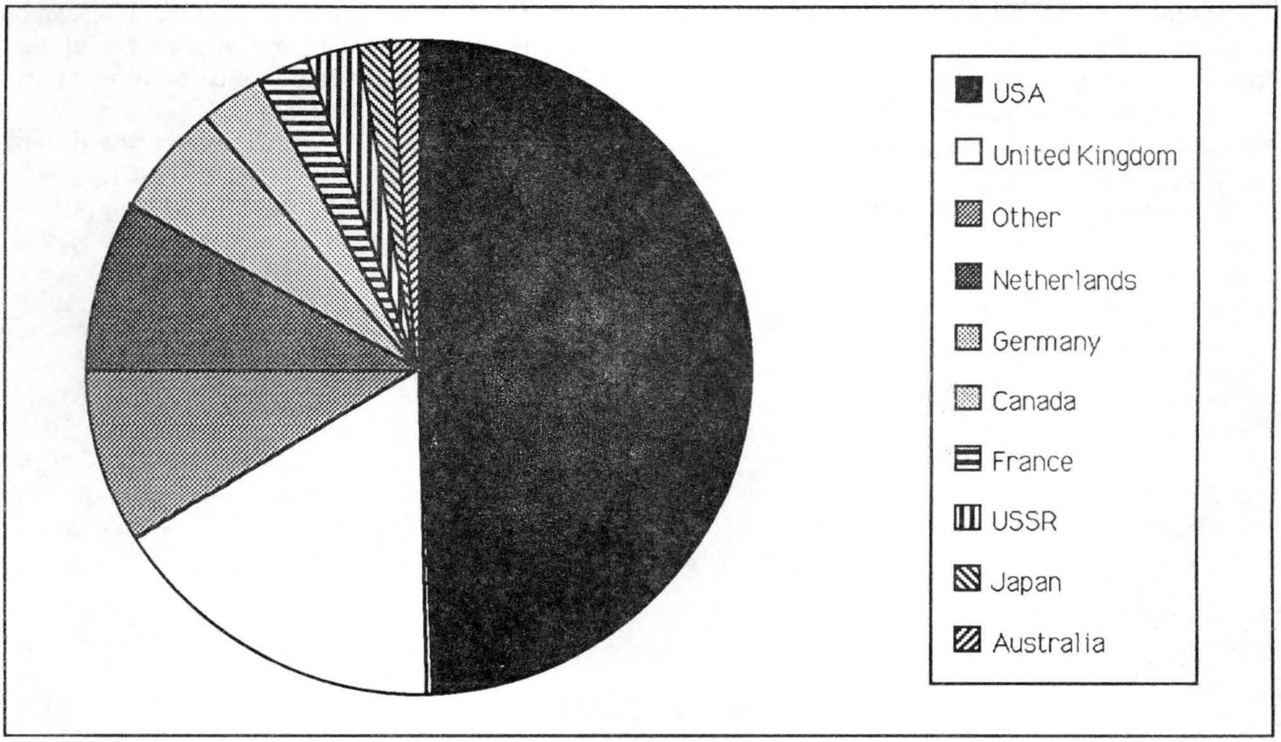


Figure 1A. UCLA serial use by country of publisher.

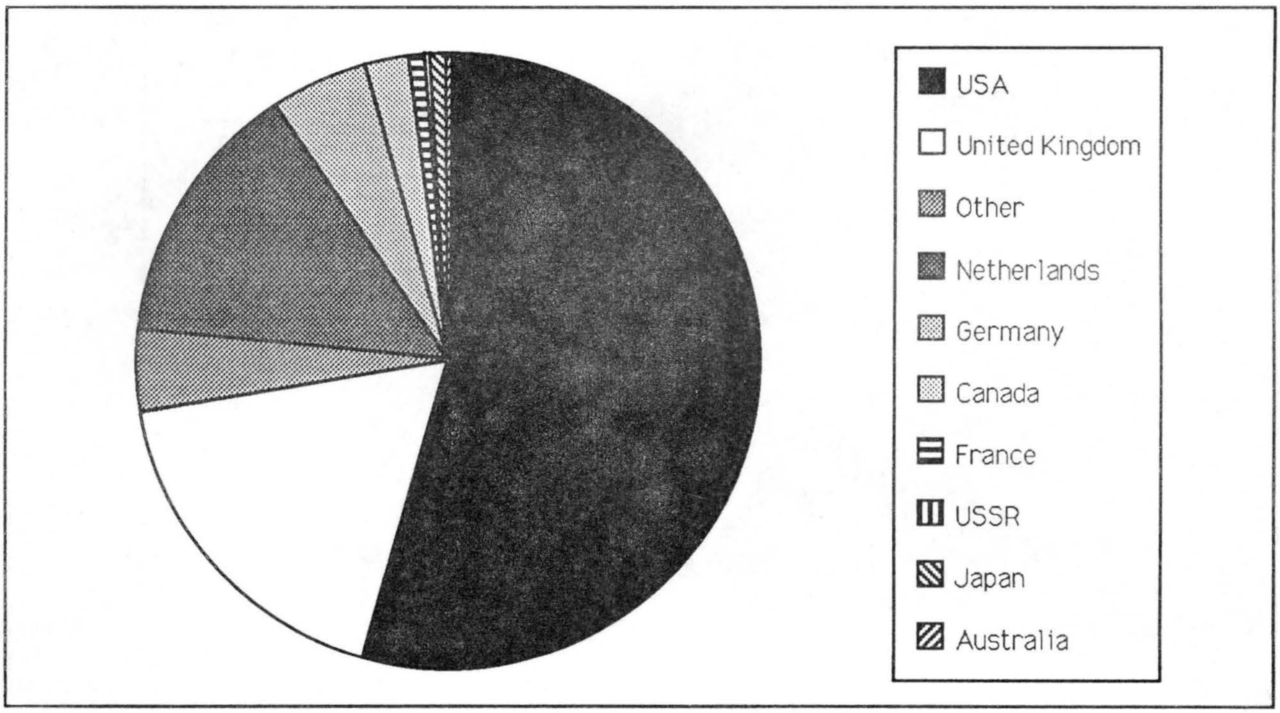


Figure 1B. Stanford journal use by country of publisher.

Figures 2A and 2B show total use of serials in the second rank of countries, which form the "other" category in Figures 1A and 1B. It is in looking at these second-ranked titles that the difference in the use of the two collections is really apparent. At UCLA there is a relatively even, gradually decreasing spread among the countries not represented by large commercial publishers. There is also a surprisingly high use of titles from two Eastern European countries (Poland and Czechoslovakia), which might be explained by the strong interest of the paleontologists using the collection during the study.

On the other hand, use at Stanford among the journals from countries shown in figures 2A and 2B was very uneven. Use of Indian, Polish, and Czech titles was almost nil, whereas use of Chinese, Danish, and Swiss titles was comparatively large, reflecting in part current research interests in Western China, Greenland, and the Alps, as well as the importance of mineralogy and crystallography at Stanford.

It is hard to say what influence the different foci of the studies (all serials at UCLA, only journals at Stanford) had upon these results. Our impression is that the differences in countries of publication (and, thus, languages used) between the two schools would increase if monographic series had been included in both studies.

As field research interests tend to shift over time, it is very difficult to predict future use of certain titles, based upon that of the past. Since the two newest areas of interest at Stanford are Mongolia and Western Siberia, it is expected that the use of Russian titles will increase in the next few years.

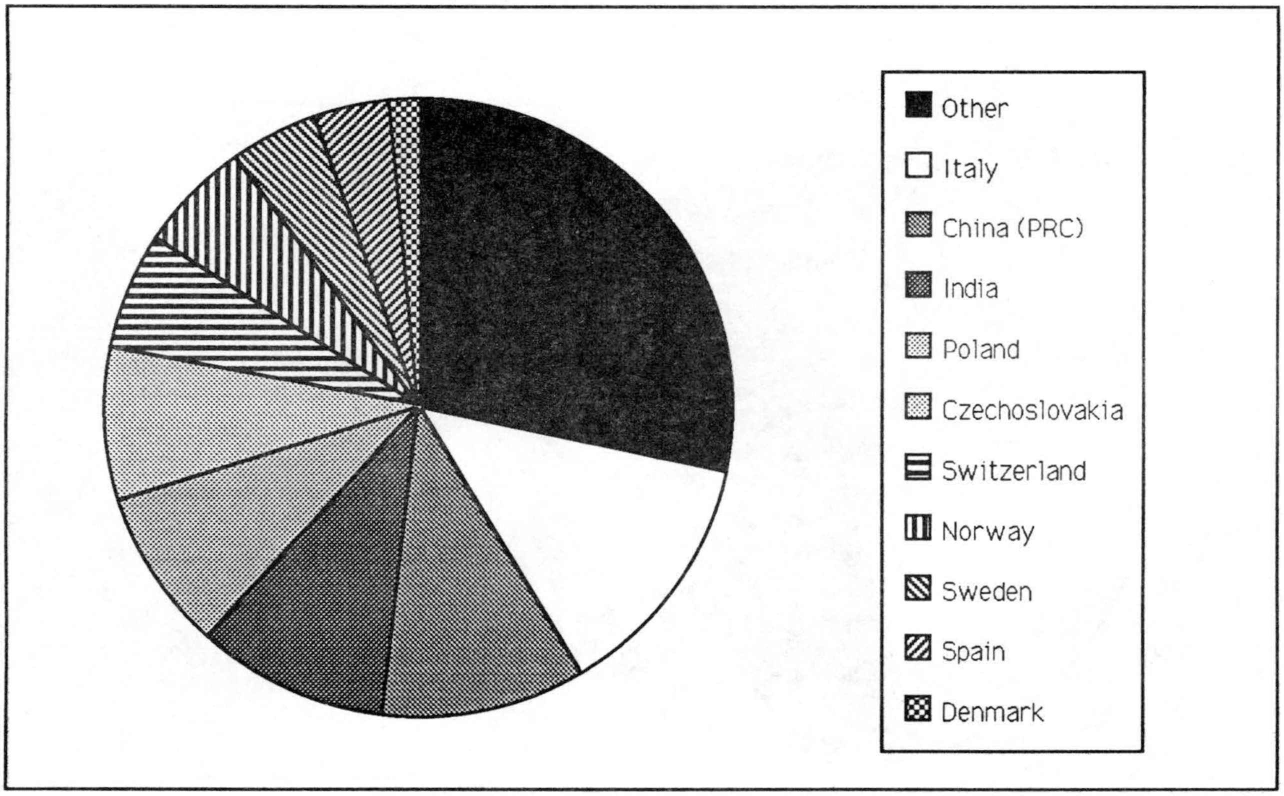


Figure 2A. UCLA serial use by country of publisher: second rank.

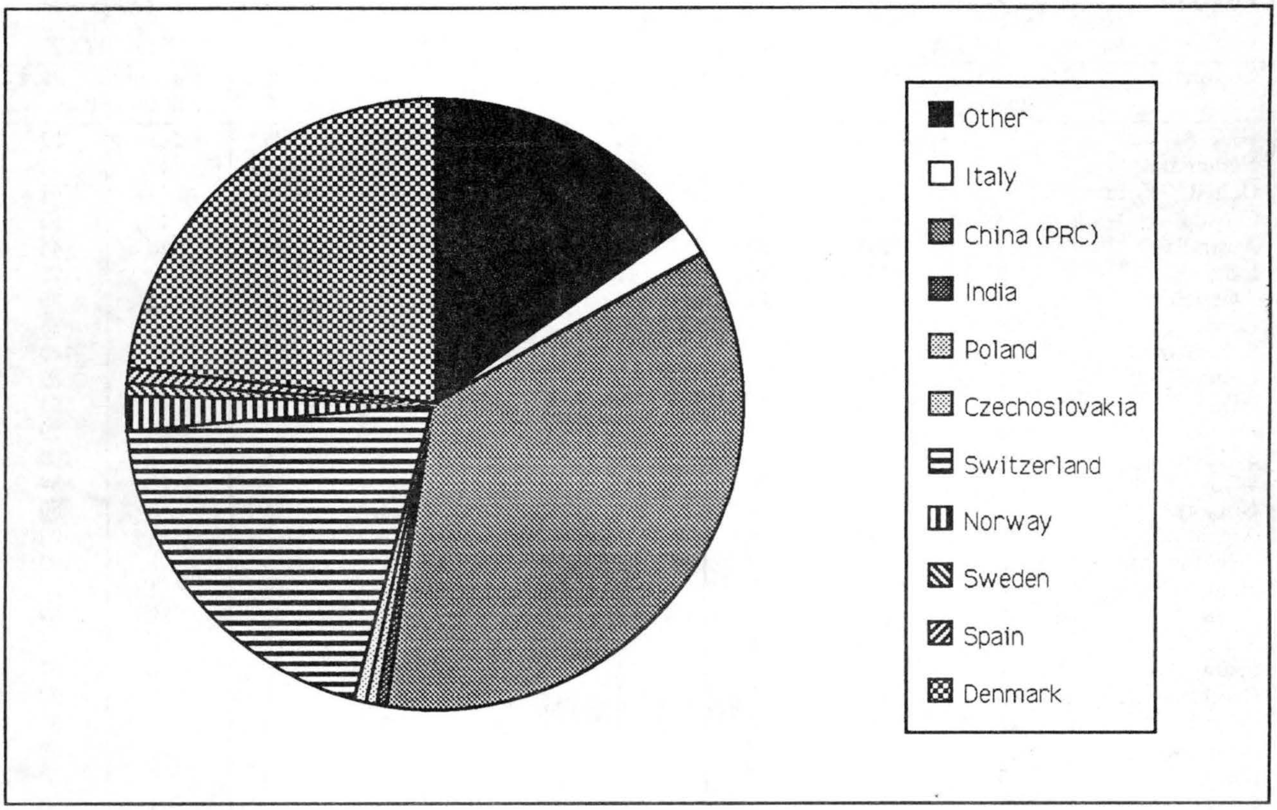


Figure 2B. Stanford journal use by country of publisher: second rank.

Complete use data by country are listed in Table 4. Countries are listed in descending order by use per title at UCLA. We think that use per title gives an indication of the value of the average serial from each country.

In the UCLA study, the ranks of serials from Australia, India, Switzerland, and South Africa are noticeably higher on this list than their positions in the various charts presented above. In contrast, the rankings for Japan and the USSR are relatively lower. Most of the serials from the higher ranked countries are in English, while most from Japan and the USSR titles are not. Moreover, serials from those two countries at UCLA cover a wide variety of subjects, and many see very little use.

In contrast to use at UCLA, there was relatively low use of Eastern European titles in general at Stanford. Hungary and Bulgaria were the highest with 50% of titles used (but only two uses per title). Titles from Poland (31%), Czechoslovakia (27%), and Romania (38%) were lower in use, and Yugoslavian titles were not used at all; neither were journals from Greece, Turkey, or Iran, all of which had been used in the 2 years prior to the study.

Table 4. Use by country of publisher, sorted by use per title at UCLA.

	UCLA			STANFORD				STANFORD	
Country	No. titles used	Total use	Use per title	No. titles used	Total use	Use per title	Theses	Total no. titles	Titles used (%)
USA	226	7,659	34	150	14,140	94	3,945	183	82
Netherlands	42	1,286	31	43	3,630	84	467	47	91
United Kingdom	87	2,575	30	60	4,621	77	715	69	87
Canada	19	445	23	15	522	35	90	18	83
Australia	10	201	20	7	33	5	10	16	44
India	9	140	16	6	8	1	1	8	75
Switzerland	6	87	15	3	223	74	17	4	75
Germany	58	855	15	31	1,288	42	268	40	78
South Africa	3	41	14	3	21	7	2	3	100
China (PRC)	11	147	13	22	409	19	24	32	69
Italy	14	184	13	7	18	3	3	13	54
France	38	404	11	27	235	9	25	34	79
Sweden	6	63	11	2	8	4	6	2	100
USSR	40	381	10	13	80	6	9	22	59
Norway	9	80	9	4	21	5	5	5	80
Argentina	5	43	9	4	15	4	1	4	100
Belgium	5	44	9	3	3	1	3	3	100
Hong Kong	1	9	9	0	0	0	0	1	0
Japan	33	256	8	27	227	8	36	39	69
Romania	4	30	8	3	12	4	0	8	38
Spain	7	57	8	4	9	2	5	6	67
Czechoslovakia	16	113	7	3	6	2	1	11	27
Poland	17	119	7	4	4	1	3	13	31
Malaysia	1	7	7	1	1	1	0	2	50
Portugal	3	22	7	1	1	1	0	5	20
Greece	1	7	7	0	0	0	0	1	0
New Zealand	5	29	6	2	6	3	5	2	100
Iceland	2	12	6	2	2	1	3	3	67
Egypt	2	9	5	1	0	0	6	1	100
Finland	3	15	5	0	0	0	0	1	0
Austria	8	34	4	4	41	10	0	7	57
China (Taiwan)	3	11	4	1	5	5	0	6	17
Hungary	6	23	4	2	4	2	0	4	50
Mexico	6	25	4	5	18	4	2	5	100
Ireland	2	8	4	0	0	0	0	1	0
Turkey	1	4	4	0	0	0	0	2	0
Denmark	8	20	3	7	261	37	26	7	100
Chile	2	5	3	1	11	11	0	2	50
Bulgaria	2	5	3	2	2	1	1	4	50
Uruguay	1	3	3	1	1	1	0	2	50
Yugoslavia	3	8	3	0	0	0	0	4	0
Venezuela	1	2	2	1	1	1	0	5	20
Colombia	2	3	2	0	0	0	0	2	0
Fiji	1	1	1	0	0	0	0	0	NA
Thailand	2	3	2	0	0	0	0	0	NA
Puerto Rico	0	0	0	1	8	8	0	1	100
Brazil	0	0	0	2	10	5	0	4	50
Israel	0	0	0	2	6	3	0	2	100
Korea	0	0	0	1	3	3	0	4	25
Namibia	0	0	0	1	1	1	0	2	50
Indonesia	0	0	0	0	0	0	0	1	0
Iran	0	0	0	0	0	0	0	1	0
Luxembourg	0	0	0	0	0	0	0	1	0
Nepal	0	0	0	0	0	0	0	1	0
Saudi Arabia	0	0	0	0	0	0	0	1	0
Singapore	0	0	0	0	0	0	0	1	0
Tanzania	0	0	0	0	0	0	0	1	0
Summary	731	15,475	412	479	25,915	585	5,679	667	

Interestingly enough, when the data in Table 4 are sorted by number of thesis citations per title (Table 5), Canadian and German titles (mostly paleontology) appear higher in the list than they do when listed according to use. Egypt, Sweden, and Iceland are other countries that publish titles that are more heavily cited, whereas the Netherlands titles are cited infrequently. Note also the strong correspondence between where the faculty publish and what the students cite.

Table 5. Journal citations in Stanford theses (1988-1989) by country of publisher.

Country of publication	Total no. of titles	No. titles used	No. cites in theses	No. cites per title	No. faculty pubs.
USA	183	150	3,945	26	407
Canada	18	15	268	18	13
Germany	40	31	467	15	54
United Kingdom	69	60	715	12	88
Egypt	1	1	6	6	0
Switzerland	4	3	17	6	1
Denmark	7	7	26	4	1
Sweden	2	2	6	3	0
New Zealand	2	2	5	3	0
Iceland	3	2	3	2	0
Netherlands	47	43	43	1	0
Australia	16	7	10	1	0
Japan	39	27	36	1	1
Norway	5	4	5	1	0
Spain	6	4	5	1	0
China (PRC)	32	22	24	1	5
Belgium	3	3	3	1	0
France	34	27	25	1	0
Poland	13	4	3	1	0
USSR	22	13	9	1	0
South Africa	3	3	2	1	0
Bulgaria	4	2	1	1	2

Altogether there are journals from 53 countries in the Stanford collection. Of these, titles from only 40 were used during the study. The last two columns in Table 4 list the total number of titles per country and the percentage of those titles actually used. These data should be used with care, since 25 journal titles (including the only ones from Hong Kong and Nepal, and 1 of the Korean titles) have been added to the collection since the study.

Twenty-seven percent of all the titles are published in the United States. Eight other countries supply 45%, and the remaining 27% is produced by 47 other countries (Fig. 3). In both collections the U.S. titles supply about half the use.

Both the Stanford and UCLA studies indicate that geoscience literature from a wide variety of countries is used. Certainly, geoscience collections cannot be restricted to titles from the big country publishers alone.

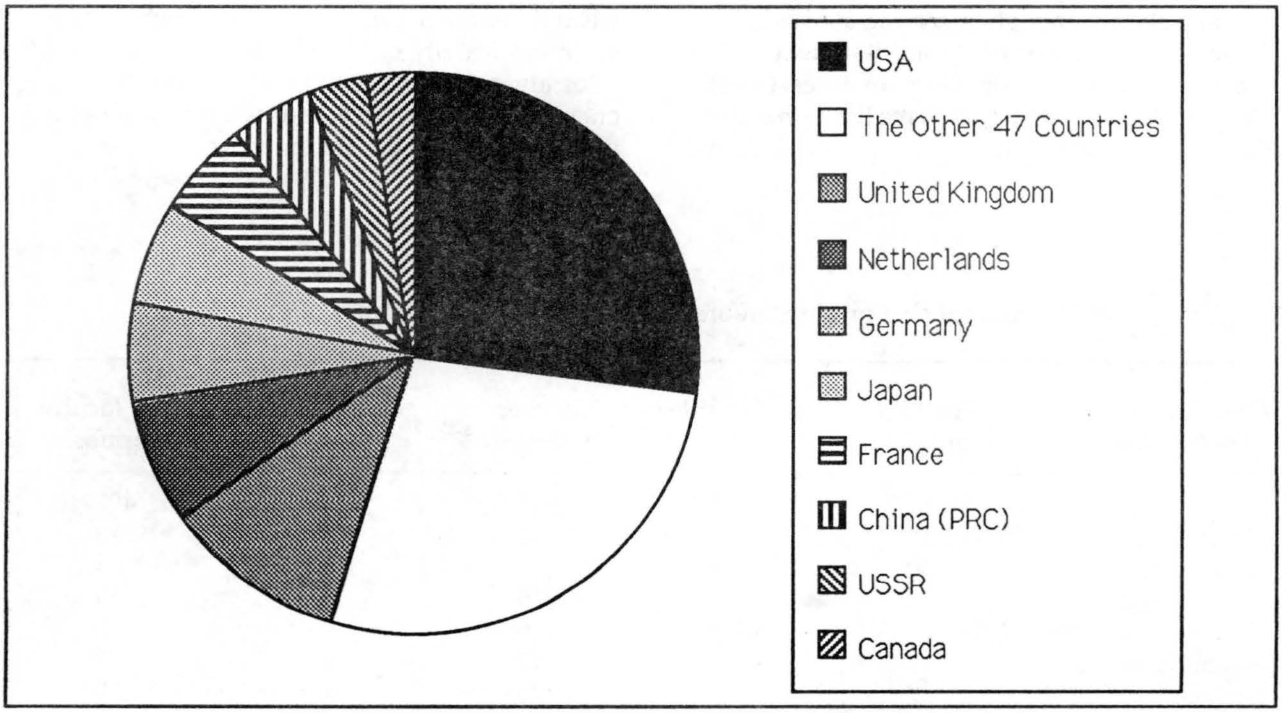


Figure 3. Countries with most number of journal titles at Stanford.

USE BY LANGUAGE

Serials in English are by far the main choice of users of both collections (Figs. 4A and 4B). This is even more pronounced at Stanford than at UCLA.

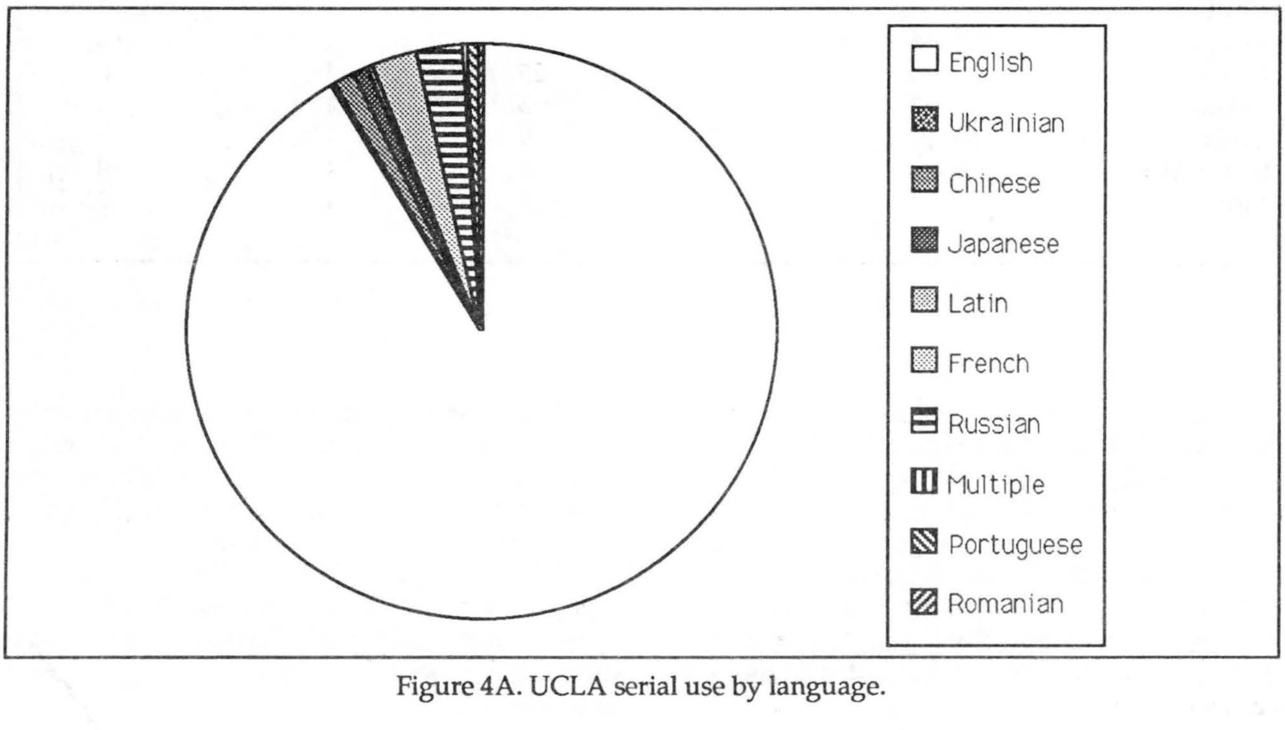


Figure 4A. UCLA serial use by language.

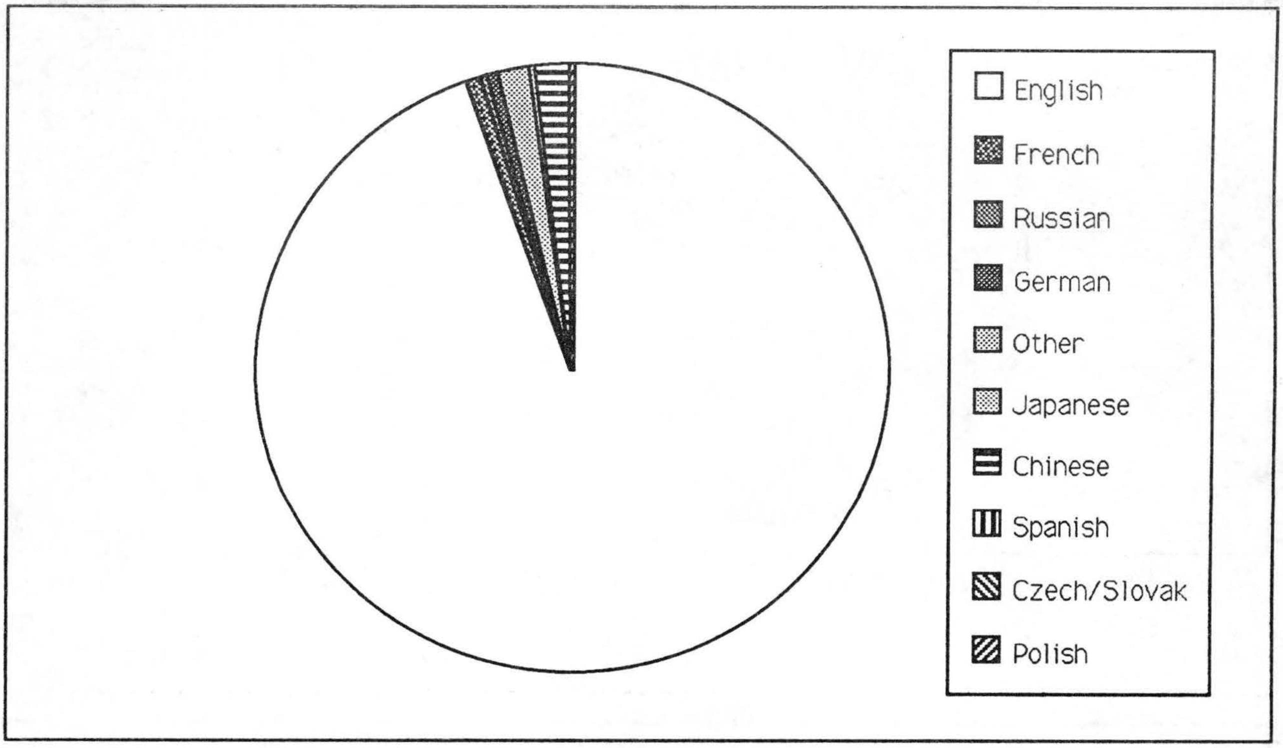


Figure 4B. Stanford journal use by language.

When English is excluded, the distribution of use by other languages becomes clearer (see Figures 5A and 5B). At UCLA, serials in French and German were heavily used, as expected. In contrast with the Stanford study, UCLA researchers used considerably more Russian than Chinese titles. Most of the Chinese titles are not very old, and interest in Chinese literature has grown since the use study. Czech/Slovak and Polish serials were also used heavily. Most of this latter use is attributable to paleontologists.

In the Stanford study, titles in German were used much less frequently than expected, and Czech/Slovak and Polish literature hardly at all. This is in contrast to the UCLA data and to use of these titles about 5 years before the study. Considering the perception that a significant number of reference questions are concerned with finding Russian titles, it is surprising how little they seem to have been used, unlike at UCLA. Chinese was the most used non-English language during the period of study at Stanford.

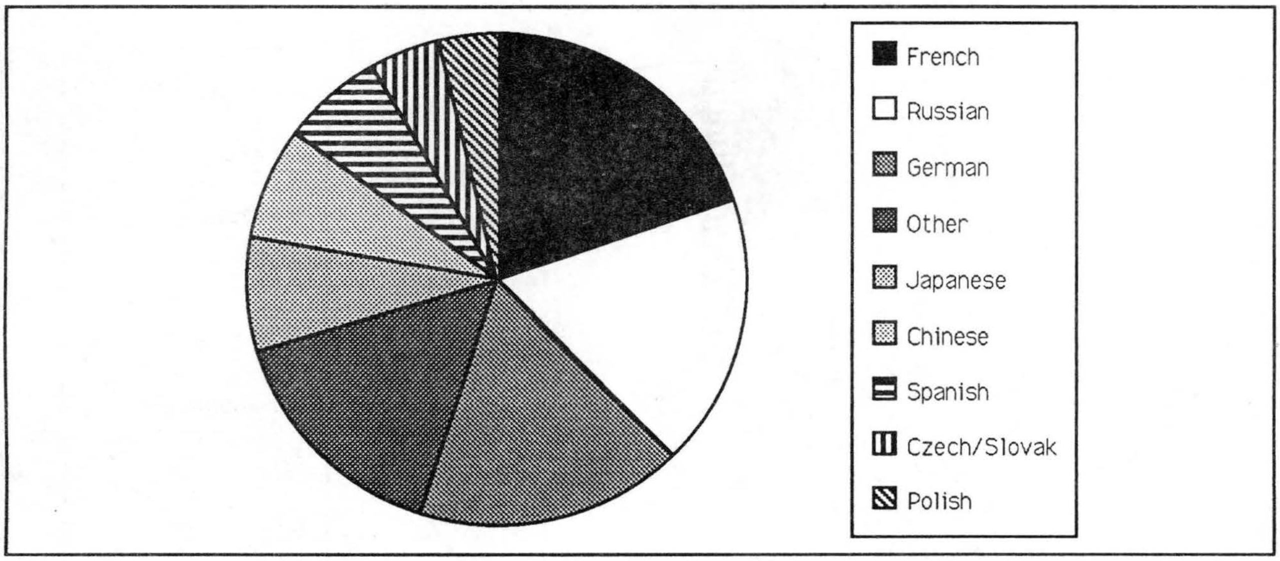


Figure 5A. UCLA serial use by language other than English.

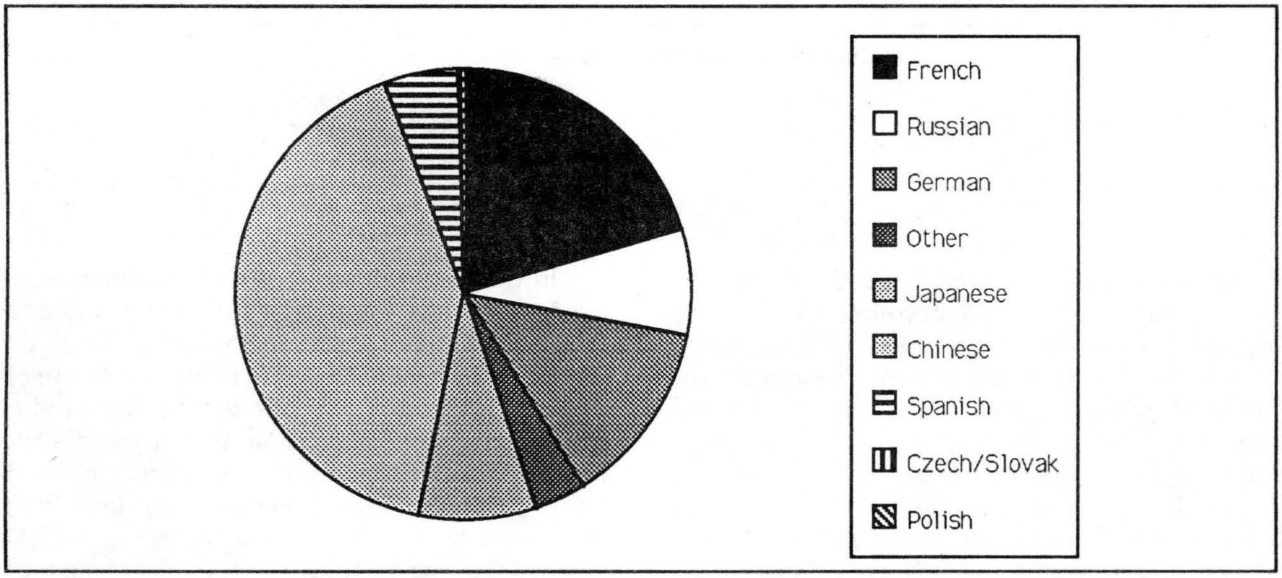


Figure 5B. Stanford journal use by language other than English.

Table 6 shows complete use data by language for both studies. An examination shows that several languages included in UCLA's "other" category in Figure 5A have fairly significant use: Portuguese, Italian, and Romanian, to name the most important. There is only one Ukrainian title at UCLA, which had a surprising amount of use. There was a total of 400 uses of Chinese language issues at Stanford; since there are so many Chinese titles (27), use per title is fairly small. Interestingly, thesis citations tend to be to the more traditional languages of the literature (French, Russian, German, Italian), plus some Chinese and Japanese titles. This use of Japanese titles is surprising given their low rankings in the use study.

Is it possible to select for cancellation some/many of the non-English language titles, without doing a study of their use? Considering the relatively high use of Eastern European languages at UCLA and the somewhat erratic use of such titles at Stanford, it seems unlikely. However, after a careful correlation between subject and language interests at a particular institution, it might be possible, as long as the faculty population remains fairly constant.

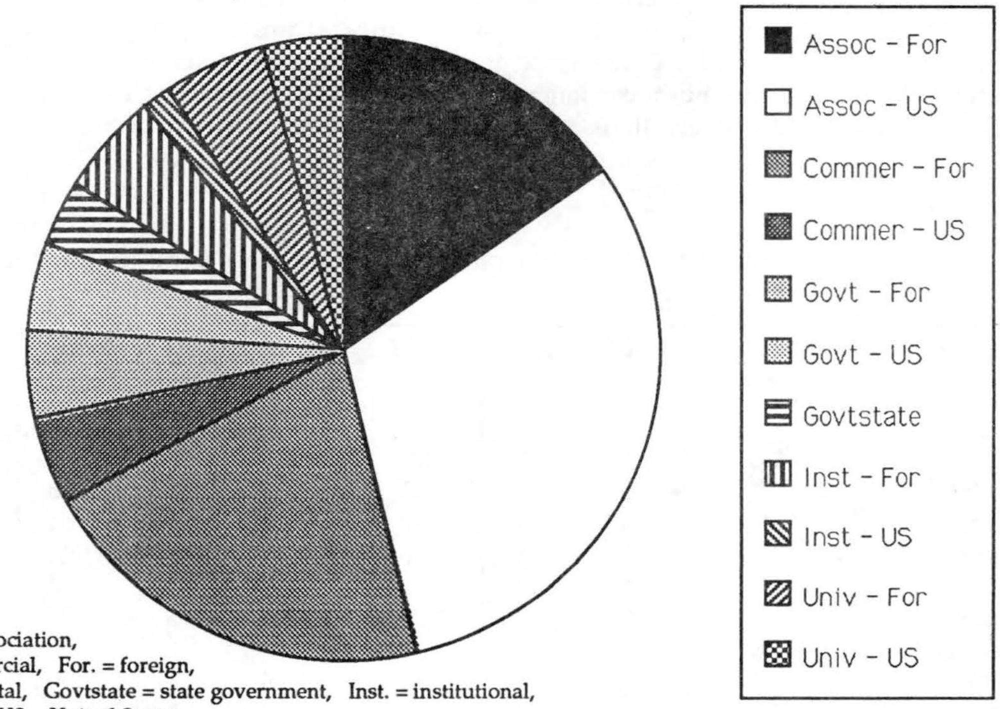
Table 6. Use data by language ranked according to use per title at UCLA.

	UCLA			STANFORD				STANFORD	
Language	No. of titles	No. of uses	Use per title	No. of titles	No. of uses	Use per title	Thesis cites	Total no. of titles	% titles used
English	505	13,591	27	375	24,938	67	5,566	498	75
Ukrainian	1	24	24	0	0	0	0	0	0
Chinese	11	147	13	18	401	22	4	27	67
Japanese	14	150	11	10	84	8	22	13	77
Latin	2	21	11	0	0	0	0	0	0
French	39	396	10	21	200	10	25	27	78
Russian	39	357	9	12	77	6	9	20	60
Multiple	5	45	9	2	6	3	0	7	29
Portugese	9	74	8	2	3	2	0	7	29
Romanian	3	24	8	1	4	4	0	3	33
German	45	347	8	14	126	9	45	21	67
Italian	9	67	7	3	5	2	1	5	60
Polish	11	77	7	1	2	2	0	6	17
Norwegian	1	7	7	1	9	9	0	2	50
Czech/Slovak	13	84	6	1	3	3	0	4	25
Spanish	23	133	6	14	50	4	7	22	64
Hungarian	2	10	5	0	0	0	0	0	0
Dutch	3	10	3	1	1	1	0	1	100
Bulgarian	2	6	3	1	2	2	0	2	50
Serbo-Croatian	3	8	3	0	0	0	0	2	0
Danish	4	5	1	0	0	0	0	0	0
Korean	0	0	0	1	3	3	0	2	50
Icelandic	0	0	0	1	1	1	0	1	100
Turkish	0	0	0	0	0	0	0	1	0
Sum	531	13,912		479	25,915		5,679	671	

USE BY TYPE OF PUBLISHER

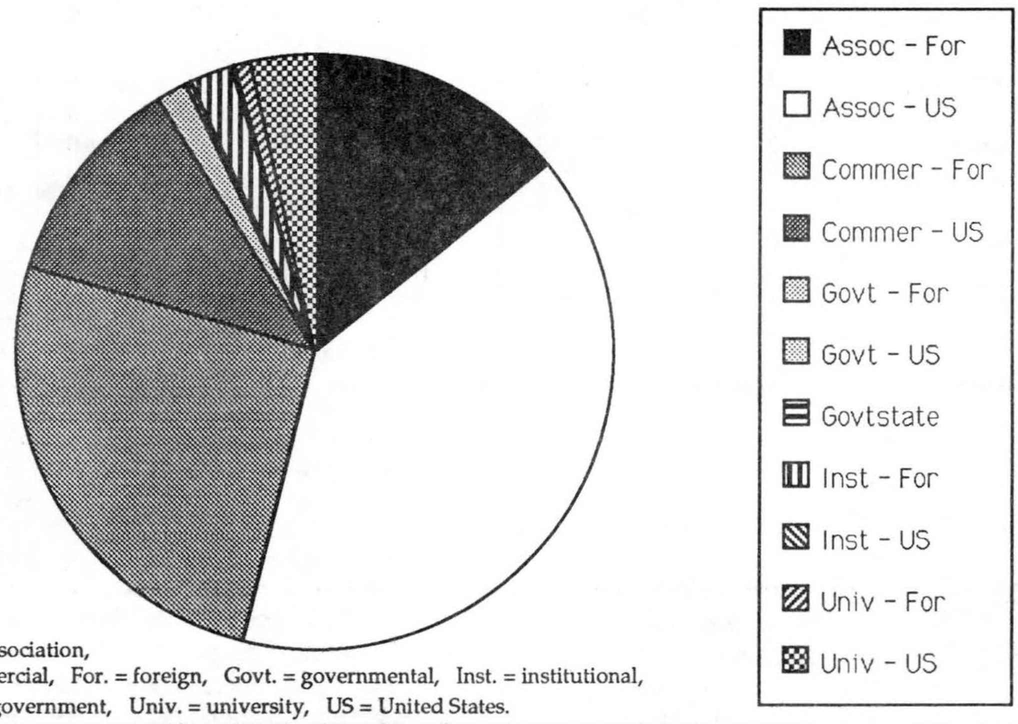
Association publications account for 46% of UCLA use (Fig. 6A); only 25% came from commercial publishers. Government and university press titles account for a larger percentage of use than at Stanford (Fig. 6B). Inclusion of geological survey publications and the use of paleontological literature published by European universities might explain this difference.

Of all titles used at Stanford, 54% are published by societies; however, 35% do come from commercial publishers (Fig. 6B). Journals published by government bodies and foreign universities account for only a very small amount of use.



Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Govtstate = state government, Inst. = institutional, Univ. = university, US = United States.

Figure 6A. UCLA serial use by publisher type.

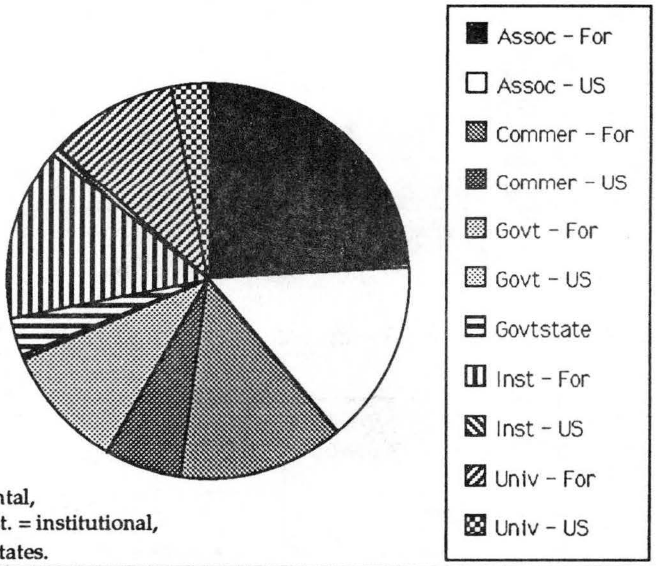


Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Inst. = institutional, Govtstate = state government, Univ. = university, US = United States.

Figure 6B. Stanford journal use by publisher type.

Although they account for the bulk of the use, journals published by associations make up only 39% of the total number of journals in the Stanford collection (Fig. 7), whereas commercially published titles comprise 22%. Titles from foreign universities and institutes make up a far greater part of the whole than their use would seem to indicate. This might indicate possible candidates for cancellation, particularly if they are costly.

Authors of theses tend to cite association titles (63%) (Fig. 8). Commercial titles are cited about 20% of the time. Publications issued by U.S. universities also seem to be more important than their numbers suggest.



Note: Assoc. = association,
Commer. = commercial,
For. = foreign, Govt. = governmental,
Govtstate = state government, Inst. = institutional,
Univ. = university, US = United States.

Figure 7. Number of journal titles in Stanford collection by type of publisher.

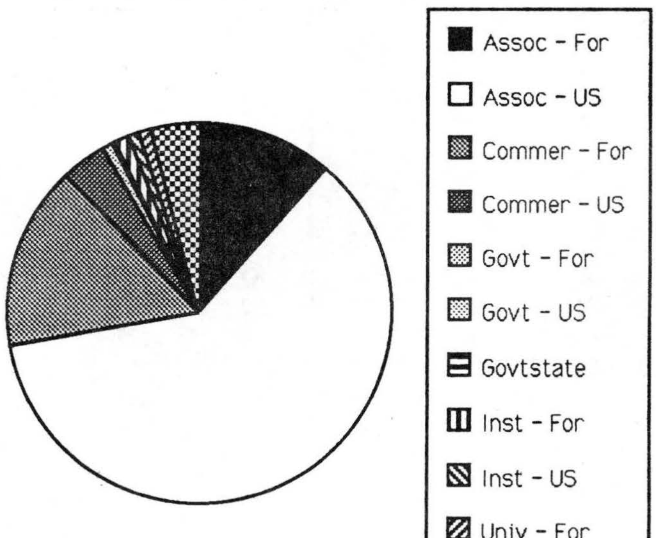


Figure 8. Stanford thesis citations by type of publisher. Abbreviations are the same as those in figure 7.

Table 7. Publication use by type of publisher.

	UCLA			STANFORD				STANFORD	
Pub. type and country	No. of titles	Uses	Use per title	No. of titles	Uses	Use per title	Thesis cites	No. of titles	% of titles used
Assoc. - Us	83	4,800	58	88	10,231	116	3,439	99	89
Govt. - US	13	657	51	1	1	1	0	2	50
Commer. - US	20	724	36	38	2,950	78	211	40	95
Commer. - For.	99	3,216	32	81	6,689	83	900	91	89
Univ. - US	30	619	21	15	898	60	227	20	75
Assoc. - For.	145	2,421	17	116	3,715	32	657	162	72
Inst. US	17	200	12	5	51	10	59	6	83
Govt. - For.	76	737	10	35	415	12	57	68	51
Univ. - For.	84	832	10	35	230	7	61	69	51
Govt. state	57	526	9	8	82	10	13	20	40
Inst. For.	119	850	7	56	582	10	55	94	60
other	0	0	0	1	71	71	0	1	100

Note: Assoc. = association, Commer. = commercial, For. = foreign, Govt. = governmental, Inst. = institutional, Univ. = university.

Table 8. Publication use by subject, ranked according to use per title at UCLA.

	UCLA			STANFORD				STANFORD	
Subject	No. of titles	Uses	Use per title	No. of titles	Use	Use per title	Thesis cites	No. of titles used	% of titles used
General	14	1,284	92	7	1,906	272	133	11	64
Geophysics, general	47	2,076	44	34	5,440	160	1,509	46	74
Soils	5	201	40	7	480	69	90	8	88
Econ. geol.-Petroleum	14	524	37	14	553	40	247	19	74
Petrology	10	330	33	17	1,945	114	271	19	89
Geochemistry	16	521	33	15	1,677	112	243	19	79
Extraterrestrial	16	515	32	2	17	9	0	3	67
Mineral./crystal.	22	604	27	29	2,505	86	310	38	76
Hydrology	7	176	25	5	716	143	274	5	100
Strat., hist., & paleoecol.	14	347	25	18	279	16	45	27	67
General geology	224	4,697	21	106	3,282	31	1,222	189	56
Math. geology	4	81	20	7	506	72	66	7	100
Economic geology	29	536	18	40	1,344	34	152	61	66
Atmosphere	3	53	18	3	82	27	0	3	100
Marine geol. & ocean.	39	616	16	23	448	19	42	25	92
Paleontology	86	1,320	15	32	143	4	267	46	70
Structural geology	5	66	13	4	277	69	33	5	80
Geophysics, applied	11	140	13	26	736	28	76	29	90
Seismology	16	168	11	11	811	74	123	13	85
Eng. & env. geology	14	133	10	12	217	18	2	17	71
Geochronology	3	27	9	3	31	10	19	3	100
Areal geology	108	893	8	16	196	12	7	19	84
Petroleum engineering	1	8	8	29	2,067	71	543	35	83
Geomorphology	35	268	8	15	112	7	5	20	75
Geodesy	7	28	4	4	145	36	0	6	67
Sum	750	15,612		475	25,770	54	5,679		

USE BY SUBJECT

Note from Table 8 that paleontology titles at Stanford are cited almost twice as often as they are used. On the other hand, general titles are used quite heavily but are not cited often. Also very surprising is that despite the discussion about the upswing in interest in the environment, engineering and environmental geology titles show relatively little use in either collection and certainly are not heavily cited.

A look at the subjects (Figs. 9A and 9B) used in both collections reveals that geophysics and general geology are the two most important subjects. Use of general titles (such as *Nature* and *Science*) shows up much more often than their numbers would warrant. Titles in the economic geology category show relatively small use, which is interesting considering that a study of users 4–5 years ago showed that economic geologists were the heaviest users of the Stanford collection. As expected, paleontology titles show higher use at UCLA than at Stanford (Fig. 9B).

The real differences in the use patterns between the two collections are apparent in the

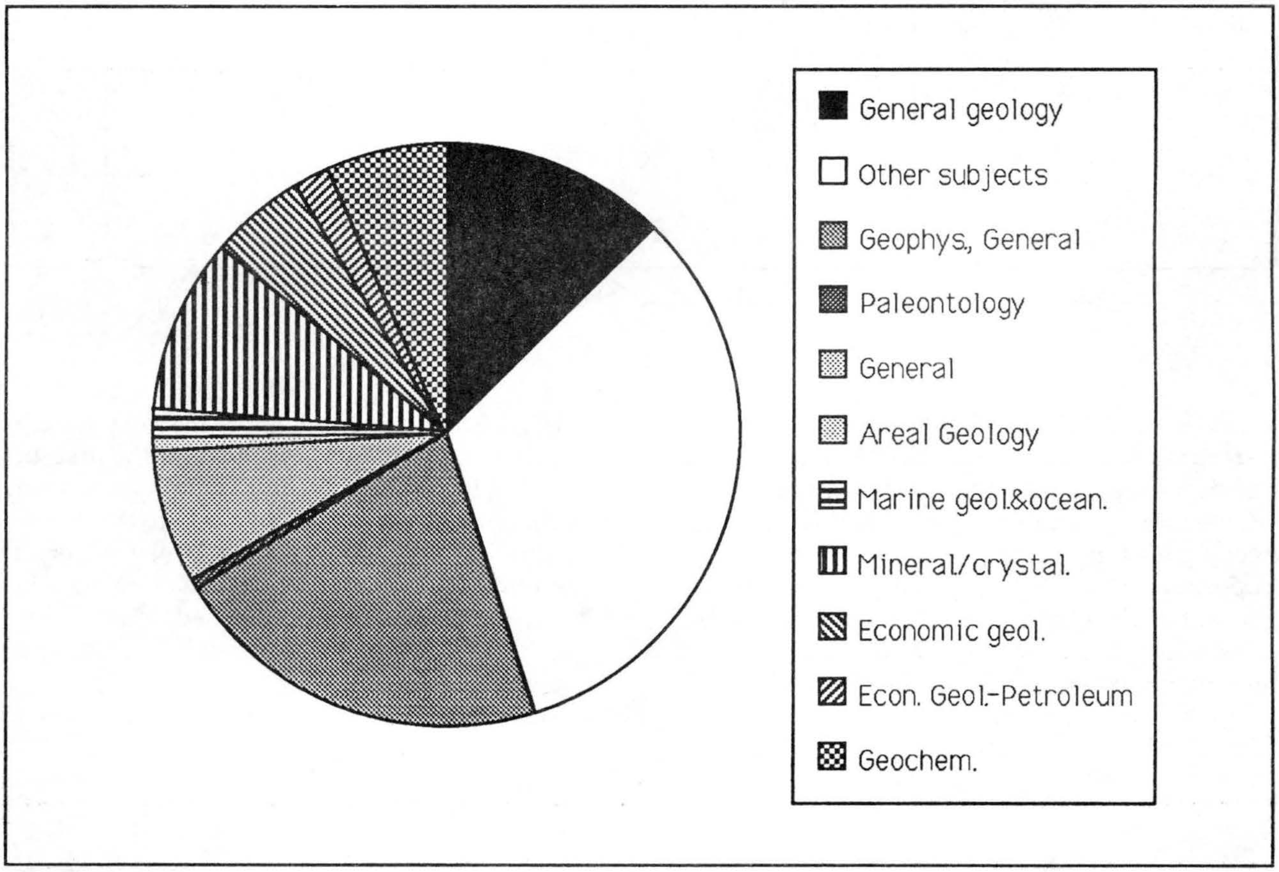


Figure 9A. Stanford journal use by subject.

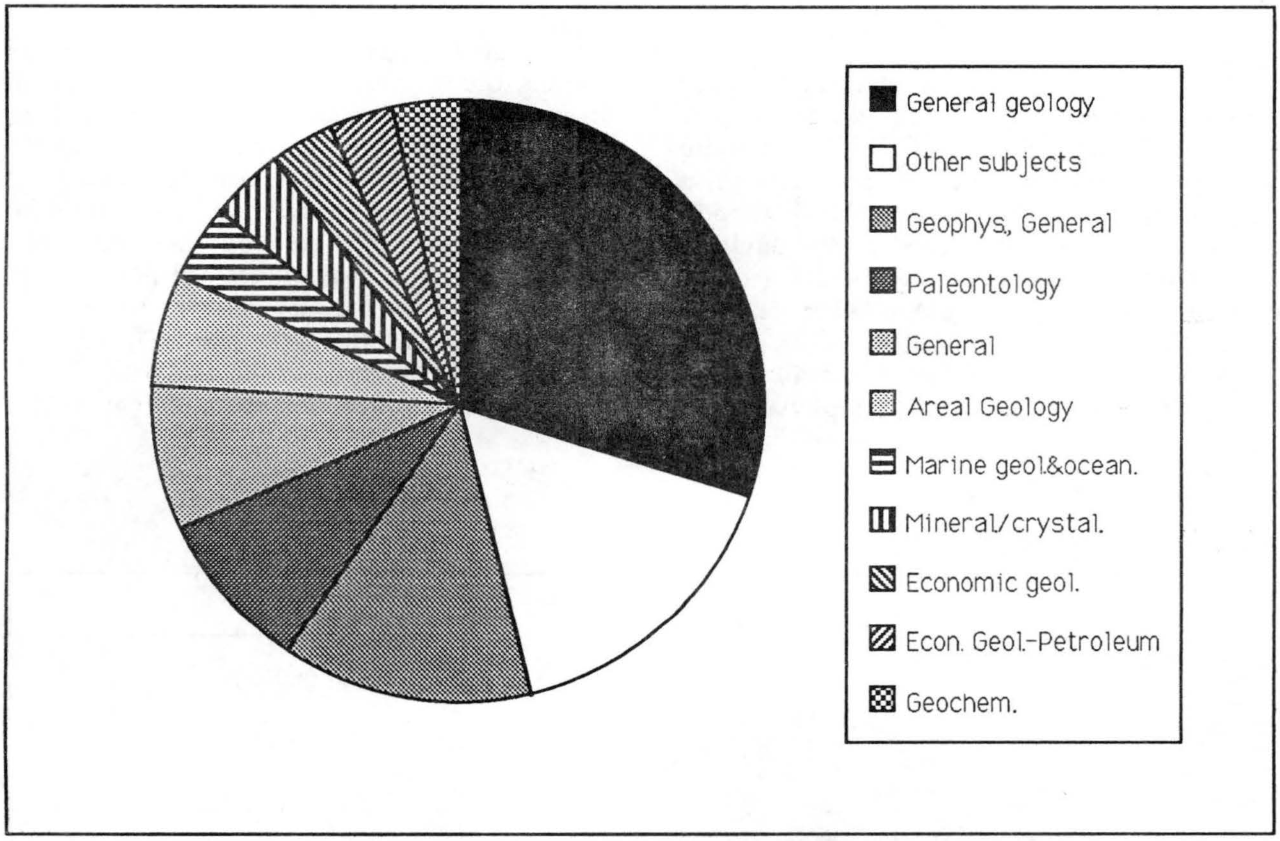


Figure 9B. UCLA serial use by subject.

second-ranked subjects (Figs. 10A and 10B). Extraterrestrial titles and stratigraphy, history, and paleoecology appear to be very important at UCLA, whereas at Stanford petroleum engineering and petrology were both extremely important. Seismology, hydrology, and applied geophysics are also very important. On the other hand, there are only two extraterrestrial titles in the collection and very little use of them.

English is the predominant language in each subject group. In fact, 98–99% of the use of general geophysics, applied geophysics, and extraterrestrial serials is in English. Medium- and low-use serials in other subject categories were often in non-English languages. Serials in French, German, and Japanese had some of the highest use totals in the paleontology and areal geology groups.

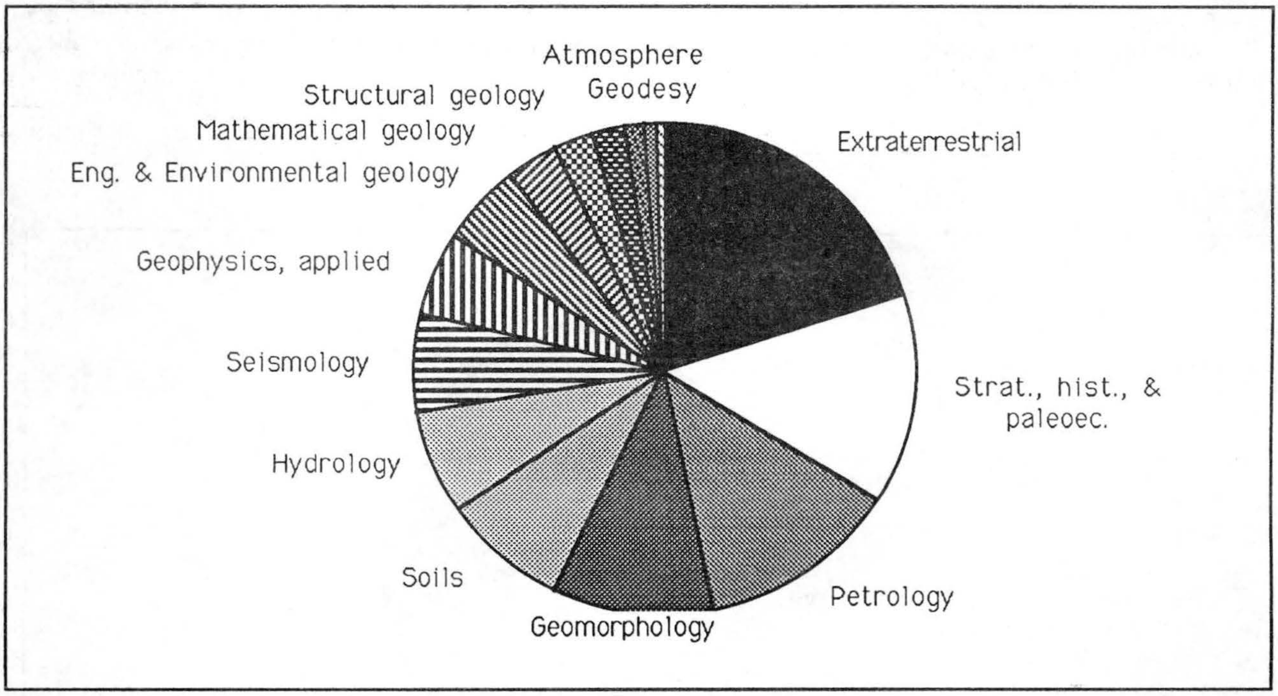


Figure 10A. UCLA serial use for second-ranked subjects.

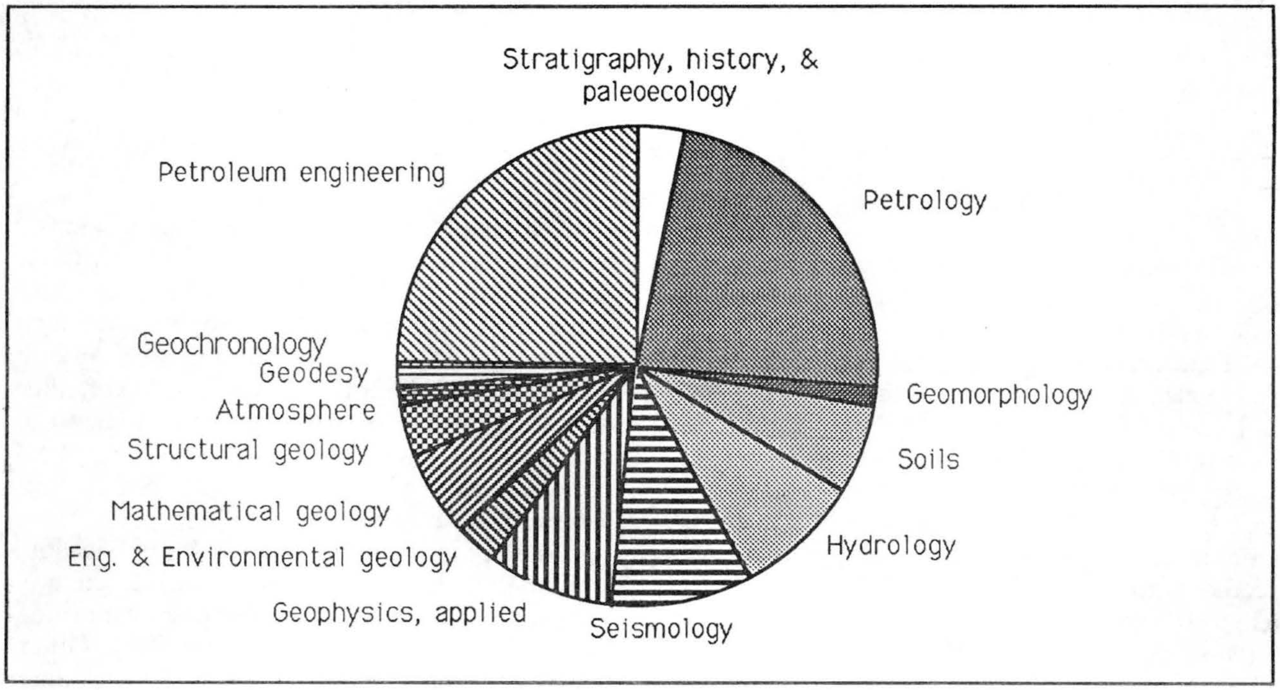


Figure 10B. Stanford journal use for second-ranked subjects.

An examination of Stanford's total journal collection reveals, as expected, more general geology titles than anything else. Economic geology is, however, a close second. Paleontology titles still make up a sizable part of the collection, even though many have been cancelled.

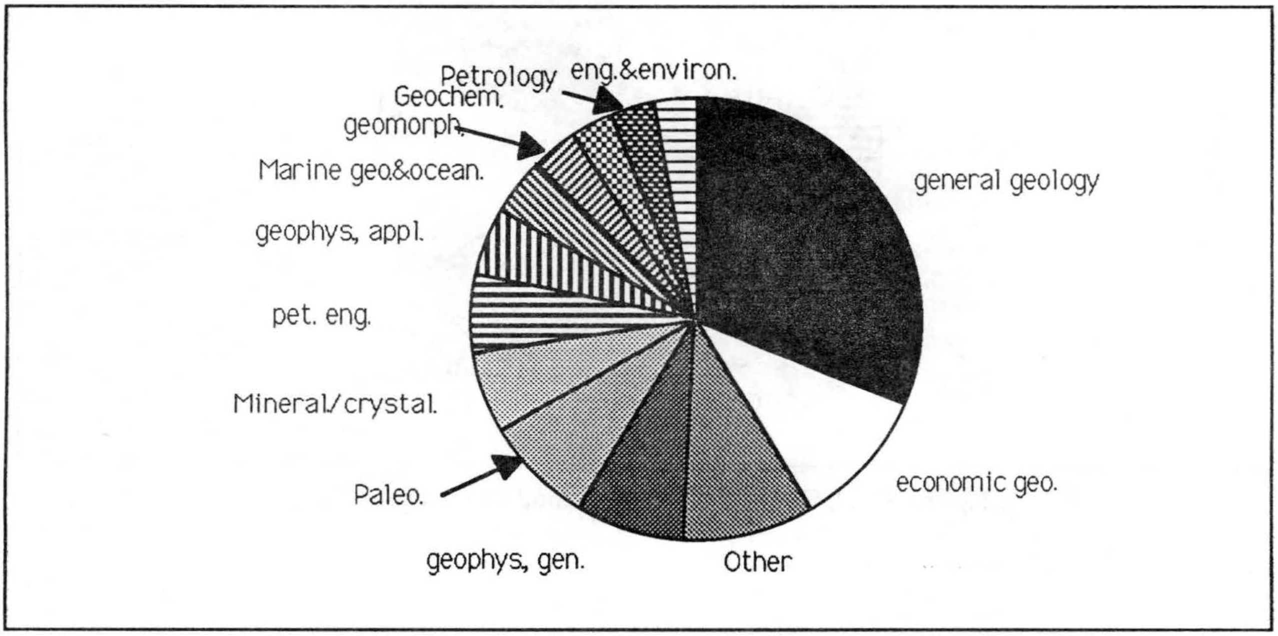


Figure 11. Current Stanford journal titles, by subject.

CONCLUSIONS

The world of geoscience publication is global. Libraries need to collect and make accessible materials from many countries.

Field areas change with researchers' interests, and collections must anticipate those changes. Chinese materials were used heavily during the Stanford study, but the use has diminished since; at the same time, use of Chinese material at UCLA has increased. As field research interests tend to shift over time, it is very difficult to predict future use of specific titles, based upon use in the past. Because the two newest areas of interest at Stanford are Mongolia and Western Siberia, it is expected that the use of Russian titles will increase in the next few years.

Is it possible to select for cancellation some or many of the non-English language titles without doing a study of their use? Considering the relatively high use of Eastern European language materials at UCLA and their somewhat erratic use at Stanford, it seems unlikely. However, after careful correlation between subject and language interests at a particular institution, it might be possible, as long as the faculty population remains fairly constant.

None of our studies (use, faculty publication, and citation studies) gives the complete picture. They produce complementary information, as illustrated by Stanford's subject data. Other libraries are encouraged to do use studies. In times of short resources, a focused study of serials in subject areas where cuts must be made would be very useful. The subject lists of serial titles are available on request from the authors.

The Stanford study revealed a difference between use and citations for geophysics and paleontology. Geophysics, except seismology, has a tight core of heavily used journals in English. The paleontological literature is characterized by many geographic sources and several languages.

Studies such as this can demonstrate to technical services colleagues and to administrators the importance to the geoscience users of titles in so-called esoteric languages and materials published in countries that are not known as publication centers.

Finally, the UCLA study showed more use of Eastern European serials than expected. Often this literature has been downgraded by libraries and researchers. Because of political changes since 1989, libraries may have a harder time collecting this material for several years, but these studies show that the effort may be crucial.

ACKNOWLEDGMENTS

The authors thank Jim O'Donnell for his critical comments on the text. We also thank Thomas Dorsey for his immense assistance with the production of the tables and figures from the UCLA data. One of the authors also thanks her husband and daughter for their forbearance during the study.

APPENDIX 1. Suggested related reading.

Craig, J. E. G., Jr., 1969, Characteristics of use of geology literature: College and Research Libraries, May, p. 230–236.

Crissinger, J. D., 1981, The use of journal citations in theses as a collection development methodology, *in* Pruett, Nancy, ed., Keeping current with geoscience information: Geoscience Information Society Proceedings, v. 11, p. 113–124.

Sheaves, M. L., 1983, A serials review program based on journal use in a departmental geology library, *in* Scott, M. W., ed., The future of the journal: Geoscience Information Society Proceedings, v. 12, p. 59–71.

Woodford, A. O., 1969, Serial literature used by American geologists, 1967: Journal of Geological Education, v. 17, p. 87–90.

APPENDIX 2. UCLA and Stanford titles used in this survey.

UCLA Title	**Publisher type**	No. of uses
A N SSSR. Izvestiia. Fizika Atmosfery i Okeana	Inst. For	4
A N SSSR. Izvestiia. Fizika Zemli	Inst. For.	8
A N SSSR. Izvestiia. Physics of the Solid Earth	Assoc. U.S.	5
A N SSSR. Paleontologicheskii Institut. Trudy	Inst. For.	11
A N Turkmenskoi ssr. Nauchnyi sovet po prob pustyn	Inst. For.	3
A N URSR. Dopovidi. Ser b geologichni, khimichni	Inst. For.	24
AAPG Bulletin	Assoc. U.S.	308
AAPG Memoir	Assoc. U.S.	51
AASP. Proceedings of the Annual Meeting	Assoc. U.S.	5
Abhandlungen der Geologischen Bundesanstalt	Govt. For.	4
Acta Geologica et Geographica Univ Comenianae	Univ. For.	3
Acta Geologica Hispanica	Univ. For.	10
Acta Geologica Hungarica	Inst. For.	7
Acta Geologica Lilloan	Govt. For.	6
Acta Geologica Polonica	Inst. For.	16
Acta Geologica Taiwanica	Univ. For.	4
Acta Geophysica Polonica	Inst. For.	3
Acta Geophysica Sinica. Ti Chiu Wu Li Hsueh Pao	Assoc. For.	8
Acta Micropalaeontologica	Comm. For.	5
Acta Palaeonotologica Polonica	Inst. For.	24
Acta Palaeontologica Sinica (Ku Sheng Wu Hsueh Pao)	Inst. For.	31
Acta Univ Szegediensis. Acta Mineralogica-Petrogra	Univ. For.	3
Acta Universitatis Carolinae. Geologica	Univ. For.	8
Advances in Geophysics	Comm. For.	13
Advances in Petroleum Geochemistry	Comm. For.	7
Advances in X-Ray Analysis	Comm. U.S.	8
Akad Nauk Gruzinskoi Ssr. Trudy	Inst. For.	5
Akad Nauk Sssr. Geologicheskii Institut. Trudy	Inst. For.	9
Akad Nauk Sssr. Institut Geologii I Geofiz. Trudy	Inst. For.	29
Akad Nauk Sssr. Izvestiia. Seriia Geologicheskaia	Inst. For.	37
Akad Nauk Sssr. Komi Filial. Inst Geologii. Trudy	Inst. For.	1
Akita Daigaku Kozan Gakubu Kenkyu Hohoku	Univ. For.	6
Alabama. Geological Survey. Information Series	Govt. State	1
Alaska Geological Society. Journal	Assoc. U.S.	2
Alaska. Div. of Geol & Geophys Surveys. Prof Report	Govt. State	4
Albertiana	Inst. For.	1
Alcheringa	Assoc. For.	30
Alpensvereinsjahrbuch	Assoc. For.	1
American Journal of Science	Univ. U.S.	209
American Mineralogist	Assoc. U.S.	102
American Mining Congress. AMC Journal	Assoc. U.S.	20
American Scientist	Assoc. U.S.	23
Annales Academiae Scientiarum Fennicae. Geol-Geogr	Inst. For.	6
Annales de Paleontologie	Comm. For.	35
Annales Geologiques des Pays Helleniques	Univ. For.	7
Annales Geophysicae	Assoc. For.	13
Annales Sci de l'Univ de Besancon. 4eme Ser: Geolo	Univ. For.	2
Annals of Glaciology	Assoc. For.	5
Annual Review of Astronomy and Astrophysics	Comm. U.S.	11
Annual Review of Earth and Planetary Sciences	Comm. U.S.	33
Annual Review of Fluid Mechanics	Comm. U.S.	15
Antarctic Journal of the United States	Govt. U.S.	5
Antarctic Science (British Antarctic Surv Bulletin)	Comm. For.	10

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Antarktika. Antarctic.	Inst. For.	2
Apea Journal	Assoc. For.	22
Applied Geochemistry	Assoc. For.	5
Archaeometry	Univ. For.	29
Arctic	Inst. For.	4
Arctic and Alpine Research	Univ. U.S.	21
Arizona Geological Society. Digest	Assoc. U.S.	14
Arizona Geological Survey. Bulletin	Govt. State	18
Arizona Geology	Govt. State	20
Asociacion Geologica Argentina. Revista	Assoc. For.	32
Astronomical Almanac	Govt. U.S.	8
Astrophysical Journal	Assoc. U.S.	99
Astrophysical Journal Supplement	Assoc. U.S.	10
Astrophysics and Space Science	Comm. For.	8
Atoll Research Bulletin	Inst. U.S.	11
Aufschluss	Assoc. For.	9
Australia Bur of Mineral Res Geo & Geoph. Bulletin	Govt. For.	15
Australia Bur of Mineral Res Geo & Geoph. Report	Govt. For.	12
Australian Journal of Earth Sciences	Assoc. U.S.	68
Australian Journal of Marine and Freshwater Res	Inst. For.	18
Austria. Geologische Bundesanstalt. Jahrbuch	Govt. For.	1
Austria. Geologische Bundesanstalt. Verhandlungen	Govt. For.	4
Bayerische Staatsamm fur Palaeo und Hist Geo. Mitt	Inst. For.	4
Baylor Geological Studies	Univ. U.S.	6
Beitrage zur Meereskunde	Inst. For.	3
Belgium. Service Geologique. Memoire	Govt. For.	2
Berliner Geographische Abhandlungen	Inst. For.	1
Bioscience	Assoc. U.S.	50
Bmr Journal of Australian Geology	Govt. For.	15
Boletim de Geociencias da Petrobras	Inst. For.	4
Boletim Ig-Usp. Serie Cientifica	Univ. For.	8
Boletim Paranaense de Geociencias	Univ. For.	4
Boletin de Geologia, Rev de Univ Indust de Santand	Univ. For.	1
Bollettino di Geofisica Teoreca Ed Applicata	Inst. For.	1
Boreas	Univ. For.	9
Brgm (France). Principaux Scientifiques et Techni	Govt. For.	1
Brigham Young University Geology Studies	Univ. U.S.	14
British Geological Survey. Bgs Report	Govt. For.	4
British Geological Survey. Annual Report	Govt. For.	4
Bulgarian Geophysical Journal	Inst. For.	1
Bulletin Geodesique	Assoc. For.	8
Bulletin of Assoc of Engineering Geologists	Assoc. U.S.	25
Bulletin of Brit Museum (Nat Hist) Geology Series	Inst. For.	32
Bulletin of Canadian Petroleum Geology	Assoc. For.	27
Bulletin of the Geological Society of Finland	Assoc. For.	3
Bulletin of the Inst of Earth Sciences, Acad Sinic	Inst. For.	4
Bulletin of the Internat Assoc of Eng Geologists	Assoc. For.	4
Bulletin of the Nanjing Inst of Geo & Min Resource	Inst. For.	5
Bulletin of the Polish Academy of Sciences. Earth	Inst. For.	4
Bulletin of Volcanology	Assoc. For.	21
Bulletin Persatuan Geologi Malaysia.	Assoc. For.	7
Bulletins of American Paleontology	Inst. U.S.	29
Cahiers de Micropaleontologie	Inst. For.	12

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Cahiers Geologiques	Univ. For.	4
Cahiers Orstom. Serie Pedologie	Govt. For.	2
California Div. of Mines and Geol. Special Report	Govt. State	97
California Div. of Mines and Geo. Rep of State Geol	Govt. State	24
California Div. of Mines and Geol. Bulletin	Govt. State	99
California Div. of Oil & Gas. Ann Rep of State Oil	Govt. State	6
California Geology	Govt. State	79
Canada. Geological Survey. Bulletin	Govt. For.	21
Canada. Geological Survey. Economic Geology Report	Govt. For.	4
Canada. Geological Survey. Memoir	Govt. For.	5
Canada. Geological Survey. Paper	Govt. For.	41
Canadian Inst of Mining & Metallurgy. Cim Bulletin	Assoc. For.	11
Canadian Journal of Earth Sciences	Govt. For.	159
Canadian Mineralogist	Assoc. For.	14
Canadian Mining Journal	Comm. For.	15
Canadian Soc of Petrol Geologists. CSPG Reservoir	Assoc. For.	3
Carnegie Institution of Washington. Yearbook	Inst. U.S.	3
Casopis Pro Mineralogii a Geologii	Inst. For.	16
Cave Science	Assoc. For.	10
Caves & Caving	Comm. For.	1
Ccop Newsletter	Inst. For.	1
Ccop Technical Bulletin	Inst. For.	2
Celestial Mechanics	Comm. For.	6
Cent de Rech de Sed Marin de Perpignan. Recueil de	Univ. For.	4
Chemical Geology	Comm. For.	90
Chemical Oceanography	Comm. U.S.	4
Chemie der Erde	Comm. For.	3
Chikyu Kagaku (Earth Science)	Assoc. For.	20
China Science & Tech Abstracts. Chem, Earth Sci En	Comm. For.	9
Chinese Journal of Geochemistry	Assoc. For.	3
Chishitsu Chosajo. Bulletin	Govt. For.	35
Chishitsu Chosajo. Cruise Report	Govt. For.	4
Chronique de La Recherche Miniere	Govt. U.S.	4
Clausthaler Geologische Abhandlungen	Univ. For.	1
Clay Minerals	Assoc. For.	13
Coal	Comm. U.S.	25
Coastal Research	Univ. U.S.	2
Colorado School of Mines. Professional Contribution	Univ. U.S.	1
Colorado School of Mines. Quarterly	Univ. U.S.	19
Commission for the Geol Map of the World. Bulletin	Inst. For.	4
Compass	Assoc. U.S.	6
Computational Seismology	Comm. U.S.	3
Computers & Geosciences	Comm. For.	53
Continental Shelf Research	Comm. For.	52
Contributions to Geology, Univ. of Wyoming	Univ. U.S.	9
Contributions to Mineralogy and Petrology	Comm. For.	160
Contributions to the Geology of the Northwest Terr	Govt. For.	2
Copenhagen. Geoteknisk Institut	Inst. For.	1
Cretaceous Research	Comm. For.	50
Crystal Research and Technology	Comm. For.	41
Cuadernos de Geologia Iberica	Univ. For.	6
Current Topics in Chinese Sci. Sect F. Earth Scien	Comm. For.	1
Cushman Foundation for Foram Research. Special Pub	Assoc. U.S.	16
Danish Polar Center. Newsletter	Inst. For.	2

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Danmarks Geologiske Undersogelse. Rapport	Govt. For.	1
Danmarks Geologiske Undersogelse. Arbog	Govt. For.	1
Danmarks Geologiske Undersogelse. Ii Raekke	Govt. For.	1
Danmarks Geologiske Undersogelse. Serie B.	Govt. For.	1
Dansk Geologisk Forening. Arsskrift	Assoc. For.	2
Dansk Geologisk Forening. Bull of Geol Soc of Denm	Assoc. For.	11
Deep Sea Research	Comm. U.S.	45
Deutsche Geologische Gesellschaft. Nachrichten	Assoc. For.	4
Diatom Research	Assoc. For.	2
Earth and Planetary Science Letters	Comm. For.	205
Earth Evolution Sciences	Comm. For.	1
Earth Moon and Planets	Comm. For.	15
Earth Science - Journal of China Univ of Geoscienc	Univ. For.	39
Earth Sciences History: Journ of the Earth Sci Soc	Assoc. U.S.	4
Earth Surface Processes and Landforms	Assoc. For.	31
Earth-Science Reviews	Comm. For.	35
Earthquake Prediction Research: Epr	Assoc. For.	6
Earthquake Research in China (Chung-Kuo Ti Chen)	Govt. For.	2
Earthquakes & Volcanoes	Govt. U.S.	17
Eclogae Geologicae Helvetiae	Assoc. For.	42
Ecological Monographs	Assoc. U.S.	22
Ecology	Assoc. U.S.	21
Economic Geology	Assoc. U.S.	131
Edit Ontographica Italica	Assoc. For.	5
Eesti Nsv Teaduste Akadeemia. Toimetitsed. Geologi	Inst. For.	4
Egyptian Journal of Geology	Assoc. For.	4
Elf-Aquitaine Centres de Rech Expl-Prod. Bulletin	Inst. For.	10
Engineering Geology	Comm. For.	14
Environmental Geology and Water Sciences	Comm. For.	11
Environmental Science and Technology	Assoc. U.S.	14
Eos	Assoc. U.S.	97
Episodes	Assoc. For.	28
Erlanger Geologische Abhandlungen	Univ. For.	1
Escap Mineral Resources Development Series	Inst. U.S.	5
Estuarine, Coastal, and Shelf Science	Assoc. For.	50
Estudios Geologicos	Inst. For.	14
Eth (Swizterland). Inst fur Geodasie. Mitteilungen	Inst. For.	1
European Journal of Mineralogy	Assoc. For.	29
Evolution	Assoc. U.S.	27
Evolutionary Theory	Univ. U.S.	3
Exploration Geophysics	Assoc. For.	6
Facies	Univ. For.	14
Fieldiana: Geology	Inst. U.S.	7
Finland. Geological Survey. Bulletin	Govt. For.	6
Florida Bureau of Geology. Bulletin	Govt. State	1
Florida Bureau of Geology. Information Circular	Govt. State	2
Florida Bureau of Geology. Special Publication	Govt. State	1
Foldtani Kozlony	Assoc. For.	9
Fortschritte in Der Geologie Von Rheinland und Wes	Govt. For.	2
Fossilium Catalogus. I: Animalia	Comm. For.	21
Freiberger Forschungshefte. Reihe C: Geowissenscha	Inst. For.	7
Ganko (J of Japanese Assoc of Min Pet & Econ Geolo	Assoc. For.	4
Geo-Marine Letters	Comm. For.	40
Geo-Processing	Comm. For.	3

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Geobios	Univ. For.	41
Geobyte	Assoc. U.S.	15
Geochemical Journal	Assoc. For.	18
Geochemistry International	Assoc. U.S.	51
Geochimica (Ti Ch'iu Hua Hsueh)	Inst. For.	6
Geochimica Et Cosmochimica Acta	Assoc. For.	216
Geochronique	Govt. For.	3
Geociencias (Univ Estadual Paulista)	Univ. For.	12
Geoderma	Comm. For.	8
Geodesia	Assoc. For.	2
Geodeziia i Kartografiia	Govt. For.	1
Geodinamica Acta	Comm. For.	7
Geodynamique	Inst. For.	1
Geofisica Internacional	Univ. For.	5
Geofizikai Kozlemenyek	Inst. For.	1
Geoforum	Comm. For.	8
Geographica, Geologica (Univ Palackeho V Olomouci)	Univ. For.	2
Geokhimiia	Inst. For.	13
Geol., Mining, & Metallurg. Soc. of India. Quart. Jour.	Assoc. For.	3
Geolog	Assoc. For.	4
Geolog Landesamt Baden Wurttemberg. Jahreshefte	Govt. For.	6
Geologia Colombiana	Univ. For.	2
Geologia Sudetica	Inst. For.	1
Geologica Balcanica	Assoc. For.	26
Geologica Bavarica	Govt. For.	2
Geologica et Palaeontologica	Univ. For.	5
Geologica Hungarica. Series Geologica	Inst. For.	1
Geologica Romana	Univ. For.	6
Geological Association of Canada. Special Paper	Assoc. U.S.	14
Geological Correlation	Inst. For.	3
Geological Curator	Assoc. For.	3
Geological Journal	Assoc. For.	16
Geological Magazine	Univ. For.	83
Geological Society of America Bulletin	Assoc. U.S.	380
Geological Society of America Abstracts with Programs	Assoc. U.S.	130
Geological Society of America. Special Paper	Assoc. U.S.	70
Geological Society of America. Memoir	Assoc. U.S.	91
Geological Society of Glasgow. Proceedings	Assoc. For.	1
Geological Society of India. Journal	Assoc. For.	46
Geological Society of Japan. Journal	Assoc. For.	47
Geological Society of London. Journal	Assoc. For.	80
Geological Society of London. Memoir	Assoc. For.	5
Geological Society of London. Newsletter	Assoc. For.	8
Geological Society of London. Special Report	Assoc. For.	18
Geological Society of Norfolk. Bulletin	Assoc. For.	2
Geological Survey (South Africa). Bulletin	Govt. For.	10
Geological Survey of Egypt. Annals	Govt. For.	5
Geological Survey of India. Records	Govt. For.	37
Geological Survey of India. News	Govt. For.	10
Geological Survey of Ireland. Bulletin	Govt. For.	4
Geologicke Prace	Govt. For.	7
Geologicky Pruzkum	Govt. For.	6
Geologicky Zbornik. Geologica Carpathica	Inst. For.	21
Geologie de la France	Govt. For.	11

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Geologie en Mijnbouw	Assoc. For.	28
Geologiia i Geofizika	Inst. For.	22
Geologiia Rudnykh Mestorozhdenii	Inst. For.	6
Geologiia Sibiri i Dal'nego Vostoka	Inst. For.	12
Geologische Abhandlungen Hessen	Govt. For.	1
Geologische Blatter fur Nordost-Bayern	Univ. For.	8
Geologische Rundschau	Assoc. For.	32
Geologisches Jahrbuch. A:Allgemeine und Regionale	Govt. For.	16
Geologisches Jahrbuch. B: Regionale Geologie Ausla	Govt. For.	2
Geologisches Jahrbuch. C:Hydrogeologie, Ingenieurg	Govt. For.	2
Geologisches Jahrbuch. E: Geophysik	Govt. For.	5
Geologisches Jahrbuch. F: Bodenkunde	Govt. For.	3
Geologiska Foreningens Forhandlingar	Assoc. For.	34
Geologists' Association Proceedings	Assoc. For.	59
Geology	Assoc. U.S.	154
Geology Today	Assoc. For.	40
Geoloski Glasnik. Bulletin Geologique	Inst. For.	1
Geoloski Vjesnik. Bulletin Geologique	Inst. For.	5
Geomagnetism and Aeronomy	Assoc. U.S.	21
Geomicrobiology Journal	Comm. For.	8
Geomorphology	Comm. For.	2
Geophysical and Astrophysical Fluid Dynamics	Comm. For.	16
Geophysical Journal International	Assoc. For.	146
Geophysical Magazine	Govt. For.	3
Geophysical Monograph	Assoc. U.S.	24
Geophysical Prospecting	Assoc. For.	13
Geophysical Research Letters	Assoc. U.S.	140
Geophysics	Assoc. U.S.	46
Geophysics,Tthe Leading Edge	Assoc. U.S.	6
Geophysik und Geologie	Univ. For.	1
Geophytology	Assoc. For.	14
Georgia Geologic and Water Resources Div. Bulletin	Govt. State	2
Geos	Univ. For.	2
Geos (Energy, Mines, and Resources Canada)	Govt. For.	6
Geoscience Canada	Assoc. For.	33
Geoscience Information Society. Proceedings	Assoc. U.S.	4
Geoscience Journal (Lucknow, India)	Comm. For.	8
Geoscience Wisconsin	Govt. State	3
Geostandards Newsletter	Assoc. For.	4
Geotectonics	Assoc. U.S.	2
Geothermal Service of Canada. Geothermal Series.	Govt. For.	1
Geothermics	Inst. For.	11
Geotimes	Assoc. U.S.	37
Gerlands Beitrage zur Geophysik	Comm. For.	3
Giornale di Geologia	Univ. For.	6
Global Biogeochemical Cycles	Assoc. U.S.	8
Gondwana Newsletter	Inst. For.	1
Gosudarstvennogo Okeanograficheskii Institut Trudy	Inst. For.	2
Grana	Assoc. For.	7
Grondboor en Hamer	Assoc. For.	7
Gulf Coast Assoc of Geological Societies. Transactions	Assoc. U.S.	16
Hamburg Univ. Geologisch-Paleont Inst. Mitteilunge	Univ. For.	20
Hannover Univ. Geologische Institut. Mitteilungen	Univ. For.	8
Hercynica	Assoc. For.	6

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Hokkaido Daigaku. Rigakubu. J. of Fac of Sci. Geol.	Univ. For.	3
Hsien Tai Ti K'o Yun Tung Yen Chiu	Inst. For.	3
Hydrological Sciences Journal	Assoc. For.	3
Icarus	Assoc. U.S.	133
Ice	Assoc. For.	4
Ichnology Newsletter	Govt. U.S.	14
Illinois State Geological Survey. Guidebook	Govt. State	2
Illinois State Geological Survey. Circular	Govt. State	3
Indian Journal of Earth Sciences	Assoc. For.	4
Indiana Geological Survey. Occasional Paper	Govt. State	1
Indiana Geological Survey. Special Report	Govt. State	2
Industrial Minerals	Comm. For.	47
Initial Reports of the Deep Sea Drilling Project	Univ. U.S.	71
Inst Roy Des Sci Nat de Belg. Bulletin Sci de Terr	Inst. For.	2
Institut de Geologie du Bassin d'Aquitaine. Bullet	Univ. For.	4
Instituta Okeanologii im P.P. Shirshova. Trudy	Inst. For.	3
Instituto Antarctico Chileno. Serie Cientifica	Inst. For.	1
Instituto de Geofisica (Unam, Mexico). Anales	Univ. For.	1
Instytut Geologiczny (Warsaw, Poland) Biuletyn	Inst. For.	4
Instytut Geologiczny (Warsaw, Poland). Prace	Inst. For.	3
International Geology Review	Assoc. U.S.	96
International Journal of Rock Mechanics & Geomechanics	Assoc. For.	5
International Journal of Coal Geology	Comm. For.	5
International Nannoplankton Association Newsletter	Assoc. For.	7
International Seismological Centre. Bulletin	Inst. For.	6
Irish Journal of Earth Sciences	Assoc. For.	4
Isochron/West	Govt. State	8
Israel Journal of Earth Sciences	Govt. For.	33
Itogi Nauki i Tekhniki: Stratigrafiia, Paleontolog	Inst. For.	2
Izvestiia Vysshikh Uchebnykh Zavedenii. Geol i Raz	Inst. For.	23
Joekull	Univ. For.	8
Journal of African Earth Sciences (& Middle East)	Comm. For.	24
Journal of Atmospheric and Terrestrial Physics	Comm. For.	22
Journal of Conchology	Assoc. For.	6
Journal of Earth Sciences (Nagoya, Japan)	Univ. For.	4
Journal of Fluid Mechanics	Univ. For.	73
Journal of Foraminiferal Research	Assoc. U.S.	23
Journal of Geochemical Exploration	Assoc. For.	13
Journal of Geodynamics	Comm. For.	7
Journal of Geological Education	Assoc. U.S.	26
Journal of Geology	Univ. U.S.	139
Journal of Geomagnetism and Geoelectricity	Assoc. For.	17
Journal of Geophysical Research	Assoc. U.S.	660
Journal of Glaciology	Assoc. For.	35
Journal of Great Lakes Research	Assoc. U.S.	9
Journal of Irreproducible Results	Comm. For.	11
Journal of Japanese Assoc of Petroleum Technologists	Assoc. For.	8
Journal of Marine Research	Univ. U.S.	7
Journal of Metamorphic Geology	Comm. For.	17
Journal of Micropaleontology	Assoc. For.	18
Journal of Molluscan Studies	Assoc. For.	3
Journal of Natural Disaster Science	Inst. For.	1
Journal of Paleontology	Assoc. U.S.	68
Journal of Petroleum Geology	Comm. For.	12

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Journal of Petrology	Comm. For.	35
Journal of Physics of the Earth	Assoc. For.	12
Journal of Sedimentary Petrology	Assoc. U.S.	124
Journal of South American Earth Sciences	Comm. For.	2
Journal of South-East Asian Earth Sciences	Comm. For.	5
Journal of Structural Geology	Comm. For.	53
Journal of the Atmospheric Sciences	Assoc. U.S.	18
Journal of the Geological Society of Iraq	Assoc. For.	1
Journal of the Palaeontological Society of India	Assoc. For.	7
Journal of Volcanology and Geothermal Research	Comm. For.	39
Kansas Geological Survey. Bulletin	Govt. State	5
Kwartalnik Geologiczny	Inst. For.	13
Kyushu Daigaku Rigakubu. Mem. of Fac. of Sci., Geolog.	Univ. For.	1
Kyushu Daigaku Rigakubu. Science Repts., Dep. of Geo.	Univ. For.	5
Lamont-Doherty Geological Observatory. Yearbook	Univ. U.S.	6
Lethaia	Univ. For.	27
Limnology and Oceanography	Assoc. U.S.	61
Lithology and Mineral Resources	Comm. For.	9
Lithos	Govt. For.	20
Litologiia i Poleznye Iskopaemye	Inst. For.	8
Maden Tetkik Ve Arama Enstitusu. Bulletin	Govt. For.	4
Magyar Allami Foldtani Intezet. Evkonyve	Inst. For.	2
Mainzer Geowissenschaftliche Mitteilungen	Govt. For.	2
Malacologia	Inst. U.S.	8
Manuscripta Geodaetica	Comm. For.	6
Mapping Sciences and Remote Sensing	Assoc. U.S.	28
Marine and Petroleum Geology	Assoc. For.	10
Marine Chemistry	Comm. For.	25
Marine Geology	Comm. For.	80
Marine Geophysical Researches	Comm. For.	1
Marine Micropaleontology	Comm. For.	26
Marine Pollution Bulletin	Comm. For.	45
Mathematical Geology	Comm. U.S.	9
Mededelingen Rijks Geologische Dienst (Netherlands)	Govt. For.	1
Memoire du Brgm	Govt. For.	20
Memorie di Scienze Geologiche (Univ. di Padova)	Univ. For.	7
Mercian Geologist	Assoc. For.	8
Meteoritics	Assoc. U.S.	7
Meteoritika	Inst. For.	1
Meyniana	Univ. For.	4
Micropaleontology	Inst. U.S.	41
Mineralium Deposita	Assoc. For.	24
Mineralogica et Petrographica Acta	Univ. For.	1
Mineralogical Journal	Assoc. For.	4
Mineralogical Magazine	Assoc. For.	46
Mineralogical Record	Comm. U.S.	40
Mineralogicheskii Zhurnal	Inst. For.	3
Mineralogy and Petrology	Comm. For.	8
Mining Annual Review	Comm. For.	8
Mining Journal	Comm. For.	28
Mining Magazine	Comm. For.	24
Minnesota Geological Survey. Report of Investigation	Govt. State	3
Mississippi Bureau of Geology. Bulletin	Govt. State	1
Mississippi Geology	Govt. State	2

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Missouri Geological Survey. Report of Investigation	Govt. State	1
Mitteilungen der Osterreichische Geol. Gesellschaft	Assoc. For.	1
Modern Geology	Comm. For.	12
Montana Bureau of Mines and Geology. Special Publ.	Govt. State	2
Montana Bureau of Mines and Geology. Memoir	Govt. State	2
Montana Bureau of Mines and Geology. Bulletin	Govt. State	9
Montevideo. Mus de Nat Historia. Commun Paleontolo	Inst. For.	3
Morocco. Service Geologique. Notes et Memoires	Govt. For.	8
Morskoi Gidrofizicheskii Zhurnal	Inst. For.	1
Moscow University Geology Bulletin	Comm. For.	25
Moscow. Gosudarstvennyi Okeanograf Inst. Trudy	Inst. For.	2
Moskov Gosudarst Univ M V Lomonosova	Univ. For.	11
Moskovskoe Obshchestvo Isp Prirody. Biulletin	Assoc. For.	18
Mountain Geologist	Assoc. U.S.	14
Munstersche Forschungen zur Geologie und Palaeonto	Assoc. For.	10
Musee Royal de l'Afrique Cent. Dpt Geol. Rapt Ann	Inst. For.	2
Museo de La Plata. Revista. Nueva Serie. Paleontol	Univ. For.	2
Museum National d'Histoire Naturelle. Memoires	Inst. For.	1
Museum National d'Histoire Naturelle. Bulletin	Inst. For.	8
Natural Resources Forum	Inst. For.	1
Nature	Comm. For.	573
Nautilus	Comm. U.S.	21
Neotectonics	Comm. U.S.	2
Neues Jahrbuch fur Geologie und Palaontologie Mon.	Comm. For.	47
Neues Jahrbuch fur Geologie und Palaontologie Abha	Comm. For.	31
Neues Jahrbuch fur Mineralogie. Monatshefte	Comm. For.	11
Neues Jahrbuch fur Mineralogie. Abhandlungen	Comm. For.	18
Nevada Bureau of Mines and Geology. Bulletin	Govt. State	17
New Mexico Bur of Mines and Mineral Res. Memoir	Govt. State	6
New Mexico Geology	Govt. State	7
New Zealand Geological Survey. Paleontologic Bulletin	Govt. For.	4
New Zealand Journal of Geology and Geophysics	Govt. For.	16
New Zealand Journal of Marine and Freshwater Research	Govt. For.	7
New Zealand Nat Soc For Earthquake Eng. Bulletin	Assoc. For.	1
New Zealand Seismological Report	Govt. For.	1
Newsletters on Stratigraphy	Comm. For.	20
Nihon Kazan Gakkai. Bulletin (Volcanol. Soc. Japan)	Assoc. For.	6
NOAA	Inst. U.S.	1
Nomen Nudum	Assoc. For.	6
Non-Ferrous Metal Data	Inst. U.S.	1
Nordic Hydrology	Assoc. For.	4
Norges Geologiske Undersokelse. Skrifter	Govt. For.	7
Norges Geologiske Undersokelse. Bulletin	Govt. For.	9
Norsk Geologisk Tidsskrift	Assoc. For.	13
Norsk Polar-Institut. Arbok	Inst. For.	6
Norsk Polarinstitutt. Skrifter	Inst. For.	4
North Carolina. Geological Survey Section. Bulletin	Govt. State	1
North Dakota Geological Survey. Bulletin	Govt. State	3
Northeastern Geology	Assoc. U.S.	8
Northern Miner	Comm. For.	53
Northwest Geology	Univ. U.S.	1
Novinky Literatury: Geologie, Geografie	Govt. For.	1
Novye Dannye O Mineralakh (Min Muzei Im Ae Fersman)	Inst. For.	1
Nss Bulletin (National Speological Society)	Assoc. U.S.	4

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Oberrheinischer Geologischer Verein. Jahresbericht	Assoc. For.	4
Ocean Yearbook	Univ. U.S.	1
Oceanography & Meteorology. Kaisho to Kisho	Inst. For.	2
Oceanologica Acta	Comm. For.	17
Oceanology of the Academy of Sciences of the USSR	Assoc. U.S.	20
Oceanus	Univ. U.S.	20
Offshore Services and Technology	Comm. For.	1
Ofioliti	Inst. For.	13
Ohio State Univ. Inst of Polar Studies. Report	Univ. U.S.	2
Oil & Gas Journal	Comm. U.S.	48
Okeanologiia. Oceanology	Inst. For.	7
Oklahoma Geological Survey. Bulletin	Govt. State	6
Oklahoma Geological Survey. Circular	Govt. State	2
Oklahoma Geological Survey. Guidebook	Govt. State	1
Oklahoma Geology Notes	Govt. State	16
Ore Geology Reviews	Comm. For.	4
Oregon Dept. of Geol and Mineral Industries. Bulletin	Govt. State	3
Oregon Dept. of Geol and Mineral Indust. Spec Paper	Govt. State	3
Oregon Geology	Govt. State	3
Organic Geochemistry	Assoc. U.S.	64
Overseas Geology and Mineral Resources	Govt. For.	2
Palacky University, Olomouc. Geographica Geologica	Univ. For.	2
Palaeobotanist	Inst. For.	11
Palaeogeography, Palaeoclimatology, Palaeoecology	Comm. For.	78
Palaeontographica Americana	Inst. U.S.	5
Palaeontographica. Abt. A Palaeozoologie-Stratigra	Comm. For.	38
Palaeontographica. Abt. B Palaeophytologie	Comm. For.	17
Palaeontologia Africana	Univ. For.	1
Palaeontologia Jugoslavica	Inst. For.	2
Palaeontologia Polonica	Inst. For.	10
Palaeontologische Zeitschrift	Comm. For.	18
Palaeontology	Assoc. For.	25
Palaios	Assoc. U.S.	11
Paleobiologie Continentale	Univ. For.	4
Paleobiology	Assoc. U.S.	34
Paleobios	Univ. U.S.	4
Paleoceanography	Assoc. U.S.	18
Paleontologia Mexicana	Univ. For.	4
Paleontological Journal	Comm. For.	33
Paleontological Society. Memoir	Assoc. U.S.	1
Paleontologicheskii Zhurnal	Inst. For.	29
Papers in Meteorology and Geophysics	Inst. For.	2
Penn Bur of Topo and Geolsurv. Mineral Resour Rept	Govt. State	1
Penn Bur of Topo and Geol Surv. Information Circul	Govt. State	1
Pennsylvania Geology	Govt. State	2
Pesquisas (Univ. Fed. de Rio Grande Do Sul, Inst Geo.)	Univ. For.	10
Petroleum Geology	Comm. U.S.	4
Physics and Chemistry of Minerals	Comm. For.	35
Physics and Chemistry of the Earth	Comm. For.	3
Physics of Fluids	Univ. For.	68
Physics of the Earth and Planetary Interiors	Comm. For.	140
Planetary and Space Science	Comm. For.	75
Polar Research	Inst. For.	1
Polska A N. Instytut Geofizyki. Pubs D: Atmos Phys	Inst. For.	1

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Polska Akad Nauk. Inst Geofizyki. Publications	Inst. For.	2
Polska Akademia Nauk. Prace Muzeum Ziemi	Inst. For.	4
Powder Diffraction	Inst. U.S.	5
Precambrian Research	Assoc. For.	35
Preliminary Report of the Hakuho Maru Cruise	Univ. For.	2
Problems of the Arctic and the Antarctic	Inst. For.	1
Problemy Osvoeniia Pustyn	Inst. For.	1
Proc of the Int Symp on the Remote Sensing of Envt	Univ. U.S.	6
Progress in Experimental Petrology	Inst. For.	1
Progress in Oceanography	Comm. For.	1
Przeglad Geofizyczny	Assoc. For.	2
Przeglad Geologiczny	Inst. For.	17
Pure and Applied Geophysics	Comm. For.	28
Qazaq Ssr Ghylym Akadem. Izvestiia. Ser. Geologich	Inst. For.	6
Quarterly Journal of Engineering Geology	Assoc. For.	9
Quaternaire	Assoc. For.	1
Quaternary Research	Comm. U.S.	75
Quaternary Science Reviews	Comm. For.	11
Radiocarbon	Assoc. U.S.	29
Recent Progress of Natural Sciences in Japan	Inst. For.	2
Regional Catalogue of Earthquakes	Inst. For.	4
Remote Sensing of Environment	Comm. For.	7
Review of Paleobotany and Palynology	Comm. For.	56
Reviews in Engineering Geology	Assoc. U.S.	10
Reviews of Geophysics	Assoc. U.S.	86
Revista Brasileira de Geosciencias	Assoc. For.	23
Revista de Geofisica	Inst. For.	2
Revista del Instituo de Geologia y Mineria	Univ. For.	2
Revista do Instituto Geologico (Sao Paulo, Brazil)	Govt. For.	1
Revista Espanola de Micropaleontologia	Inst. For.	19
Revista Espanola de Paleontologia	Inst. For.	2
Revista Geologica de Chile	Govt. For.	4
Revue de Geomorphologie Dynamique	Inst. For.	3
Revue de Micropaleontologie	Univ. For.	19
Revue de Paleobiologie	Inst. For.	5
Rivista Italiana di Geotecnica	Assoc. For.	2
Rivista Italiana di Paleontologia e Stratigrafia	Univ. For.	71
Rock Mechanics and Rock Engineering	Comm. For.	13
Rocznik Polskiego Towarzystwa Geologicznego	Assoc. For.	16
Romania. Inst de Geologie Si Geofizica. Anuarul	Inst. For.	6
Romania. Inst de Geologie Si Geofizica. Dari de Se	Inst. For.	6
Sammlung Geologischer Fuhrer	Comm. For.	2
San Joaquin Geological Society. Selected Papers	Assoc. U.S.	4
Sbornik Geologickych Ved: Geologie	Govt. For.	11
Sbornik Geologickych Ved: Paleontologie	Govt. For.	10
Schweizerische Mineralog und Petrolog Mitteilungen	Assoc. For.	6
Science	Assoc. U.S.	431
Sciences de la Terre. Informatique Geologique	Univ. For.	8
Sciences Geologiques. Bulletin (Univ Louis Pasteur)	Univ. For.	12
Scientia Geologica Sinica (Ti Chih K'o Hsueh)	Inst. For.	17
Scientific American	Comm. U.S.	186
Scottish Journal of Geology	Assoc. For.	38
Scripps Inst of Oceanography. Annual Report	Univ. U.S.	1
Scripps Institution of Oceanography	Univ. U.S.	1

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Scripps Institution of Oceanography. Bulletin	Univ. U.S.	1
Scripta Geologica	Inst. For.	6
Sedimentary Geology	Comm. For.	57
Sedimentology	Assoc. For.	54
Seismic Instruments	Comm. U.S.	1
Seismological Research Letters	Assoc. U.S.	5
Seismological Society of America. Bulletin	Assoc. U.S.	104
Seismology and Geology (Ti Chen Ti Chih)	Govt. For.	3
Senckenbergiana Lethaea	Assoc. For.	14
Senckenbergiana Maritima	Assoc. For.	6
SEPM Special Publication	Assoc. U.S.	37
Shale Shaker	Assoc. U.S.	6
Smithsonian Astrophysical Observatory. Special Rep	Inst. U.S.	2
Smithsonian Contributions to the Earth Sciences	Inst. U.S.	1
Smithsonian Contributions to Paleobiology	Inst. U.S.	8
Soc Geol de France. Reunion Anuelle des Sci de Ter	Assoc. For.	1
Soc Geol Normandie et des Amis du Mus du Havre.Bull.	Assoc. For.	2
Soc Geologique du Nord (Lille, France). Annales	Assoc. For.	13
Sociedad Argentina de Mineria y Geologia. Revista	Assoc. For.	1
Sociedade Geologica de Portugal. Boletim	Assoc. For.	2
Societa Dei Naturalisti in Napoli. Bollettino	Assoc. For.	5
Societa Geologica Italiana. Bollettino	Assoc. For.	13
Societa Geologica Italiana. Memorie	Assoc. For.	14
Societa Paleontologica Italiana. Bollettino	Assoc. For.	14
Societe Belge de Geologie. Bulletin	Assoc. For.	22
Societe Geologique de Belgique. Annales	Assoc. For.	16
Societe Geologique de France. Bulletin	Assoc. For.	95
Societe Geologique de France. Compte Rendu Sommair	Assoc. For.	5
Societe Geologique de France. Memoires	Assoc. For.	15
Soil Science	Comm. U.S.	62
Soil Science Society of America. Journal	Assoc. U.S.	126
Sokuchi Gakkai Shi. Jour of the Geodetic Soc Japan	Assoc. For.	4
Solar Geophysical Data	Inst. U.S.	71
Solar Physics	Comm. For.	21
Sonderveroffentlichungen. Univ Koln. Geolog Inst	Univ. For.	3
South African Journal of Geology	Assoc. For.	30
South Carolina Geology	Govt. State	7
South Dakota Geological Survey. Bulletin	Govt. State	1
South Pacific Marine Geological Notes	Inst. For.	1
Southeastern Geology	Assoc. U.S.	7
Southern California Paleontological Society. Bull	Assoc. U.S.	17
Sovets Antarktichesk Ekspedit. Informatsio Biullet	Inst. For.	1
Sovetskaia Geologiia	Govt. For.	38
Soviet Geology and Geophysics	Comm. U.S.	39
Soviet Journal of Remote Sensing	Comm. For.	5
Space Science Reviews	Comm. For.	20
Special Library Assoc. Geog and Map Div.. Bulletin	Assoc. U.S.	6
Special Papers - Palaeontological Society of Japan	Assoc. For.	2
Special Papers in Palaeontology	Assoc. For.	6
Spisanie. Zeitschrift der Bulgar Geolog Gesellscha	Assoc. For.	5
Stanford University Publications. Geological Scien	Univ. U.S.	6
Stereo-Atlas of Ostracod Shells	Assoc. For.	2
Sterkiana	Univ. U.S.	1
Stockholm Contributions in Geology	Univ. For.	4

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Studia Geologica Polonica	Inst. For.	6
Studia Geophysica et Geodaetica	Inst. For.	5
Studia Univ Babes-Bolyai. Geologia-Geographia	Univ. For.	14
Studii Si Cercetari de Geol Geofiz Geog. Geologie	Govt. For.	4
Surtsey Research Progress Report	Assoc. For.	4
Surveys in Geophysics	Comm. For.	2
Sveriges Geologiska Undersoekning. Arsbok	Govt. For.	2
Systematic Zoology	Assoc. U.S.	19
Teaching Earth Sciences	Assoc. For.	7
Tectonics	Assoc. U.S.	49
Tectonophysics	Comm. For.	138
Tellus	Assoc. For.	13
Tennessee Division of Geology. Bulletin	Govt. State	1
Terra Nova	Assoc. For.	21
Texas Bureau of Economic Geology. Guidebook	Govt. State	3
Texas Bureau of Economic Geology. Rep. of Investigations	Govt. State	12
Ti Chih Hsueh Pao. Acta Geologica Sinica.	Assoc. For.	28
Tikhookeanskaia Geologiia	Inst. For.	4
Tohoku Univ. Science Reports. Ser 2: Geology	Univ. For.	8
Tohoku Univ. Science Reports. Ser 3: Min Pet Econ	Univ. For.	6
Tokyo Daigaku Jishin Kenyujo. Bull of the Earthqua	Univ. For.	5
Tokyo Daigaku Rigakubu. Chirigaku Kyoshitsu. Bulle	Univ. For.	2
Tokyo Daigaku. Journal of Fac of Sci. Geol, Min,	Univ. For.	1
Trans (Doklady) of the Ussr Acad Sci Earth Sci Sec	Comm. U.S.	93
Transact and Proc of the Palaeontol Soc of Japan	Assoc. For.	15
Transact of the Roy Soc of Edinburgh. Earth Scienc	Assoc. For.	24
Transactions. Inst of Mining and Metallurgy (Uk)	Inst. For.	18
Tulane Studies in Geology and Paleontology	Univ. U.S.	1
Union Geofisica Mexicana. Resumenes Reunion Anual	Assoc. For.	2
United States Earthquakes	Govt. U.S.	5
Univ Claude Bernard. Documents des Lab de Geologie	Univ. For.	1
Univ de Coimbra. Museu e Lab Min e Geo. Publicacio	Univ. For.	10
Univ de Granada. Cuadernos de Geologia	Univ. For.	4
Univ Mariae Curie-Sklodowska. Annales B: Geog, Geo	Univ. For.	1
Univ Nac Auton de Mexico. Inst de Geol. Revista	Univ. For.	8
Univ Nac Auton de Mexico. Inst de Geol. Boletin	Univ. For.	5
Univ of California Publications in Geological Scie	Univ. U.S.	45
Univ of Kansas Paleontological Contributions	Univ. U.S.	5
Univ of Kansas Paleontological Contributions Artic	Univ. U.S.	3
Univ of Michigan. Museum of Paleo. Contributions	Univ. U.S.	1
Univ of Queensland. Dept of Geology. Papers	Univ. For.	3
Univ of Sheffield Geological Society. Journal	Univ. For.	1
Univ of So Cal. Dept of Civil Engineering. Report	Univ. U.S.	13
Univ of Tskukuba. Inst of Geoscience. Science Repo	Univ. For.	4
Univ of Uppsala. Bulletin of the Geological Instit	Univ. For.	3
Univ Stuttgart. Inst fur Geol und Palaeo. Arbeiten	Univ. For.	4
Univ Van Amsterdam. Fysich-Geografisch. Publicatie	Univ. For.	1
Univ Wroclaw. Prace Geologizno-Mineralogiczne	Univ. For.	2
U.S. Bureau of Mines. Minerals Yearbook	Govt. U.S.	18
U.S. Geological Survey Bulletin	Govt. U.S.	116
U.S. Geological Survey Circular	Govt. U.S.	29
U.S. Geological Survey Open-File Report	Govt. U.S.	64
U.S. Geological Survey Professional Paper	Govt. U.S.	294
U.S. Geological Survey. Water Supply Paper	Govt. U.S.	69

APPENDIX 2. Cont.

UCLA Title (cont.)	Publisher type	No. of uses
Ussher Society. Proceedings	Assoc. For.	16
Ustredni Ustav Geologicky (Czechoslov). Rozpravy	Govt. For.	4
Ustredni Ustav Geologicky (Czechoslov). Knihovna	Govt. For.	1
Ustredni Ustav Geologicky (Czechoslov). Vestnik	Govt. For.	15
Utah Geological and Mineral Survey. Bulletin	Govt. State	11
Utah Geological and Mineral Survey. Circular	Govt. State	4
Utah Geological and Mineral Survey. Special Studies	Govt. State	1
Utrecht Micropaleontological Bulletins	Univ. For.	8
Veliger	Assoc. U.S.	8
Venus. Kairuigaku Zasshi	Assoc. For.	1
Vermont Geology	Assoc. U.S.	2
Vestnik Leningdradskogo Univ. Geologiia i Geografi	Univ. For.	14
Virginia Minerals	Govt. State	1
Voprosy Mikropaleontologii	Inst. For.	10
Vsesoiuznoe Mineralogicheskoe Obshchestvo. Zapiski	Assoc. For.	2
Vsesoiuznoe Paleontologic Obshchestvo. Erzegodnik	Assoc. For.	3
Washington Div. of Geol and Earth Res. Rep. of Inves.	Govt. State	1
Washington Div. of Geology and Earth Res. Bulletin	Govt. State	2
Water Resources Data California	Govt. U.S.	14
Water Resources Research	Assoc. U.S.	76
Water, Air, and Soil Pollution	Comm. For.	10
West Virginia Geol and Econ Surv. Rep of Inves.	Govt. State	3
Western Assoc of Map Libraries. Information Bullet	Assoc. U.S.	4
Western Australia. Geological Survey. Bulletin	Govt. For.	12
Wisconsin Geol and Nat History Surv. Info Circular	Govt. State	3
World Data Center A For Solid Earth Geoph. Rept Se	Inst. U.S.	1
World Data Ctr A For Glaciology. Glacial Data Rept	Inst. U.S.	1
Wyoming Geo-Notes	Govt. State	2
Wyoming Geological Association. Earth Science Bull	Assoc. U.S.	8
Wyoming Geological Association Guidebook	Assoc. U.S.	10
Wyoming. Geological Survey. Report of Investigatio	Govt. State	4
X-Ray Spectrometry	Assoc. For.	7
Yorkshire Geological Society. Proceedings	Assoc. For.	28
Zapadne Karpaty. Seria Geologia	Govt. For.	1
Zeitschrift der Deutschen Geologischen Gesellschaf	Assoc. For.	28
Zeitschrift fur Angewandte Geologie	Comm. For.	20
Zeitschrift fur Geologische Wissenschaften	Comm. For.	30
Zeitschrift fur Geomorphologie	Comm. For.	14
Zeitschrift fur Gletscherkunde und Glazialgeologie	Univ. For.	2
Zeitschrift fur Kristallographie	Inst. For.	36
Zentralblatt fuer Geol und Palaeo: Teil I Geologie	Comm. For.	16
Zentralblatt Fuer Geol und Palaeo: Teil II Palaeo	Comm. For.	13
Zisin. Journal of the Seismological Soc. of Japan	Assoc. For.	2
Total		743

APPENDIX 2. Cont.

STANFORD Title	Publisher type	No. of uses	Theses cites
Academia Republicii Socialiste Romania. Studii si ceret	Inst. For.	4	0
Acta Crystallographica. Section A. Foundations of cryst	Assoc. For.	92	14
Acta Crystallographica. Section B. Structural science	Assoc. For.	53	0
Acta Crystallographica. Section C. Crystal structure co	Assoc. For.	2	2
Acta Geodaetica, Geophysica et Montanistica	Inst. For.	2	0
Acta Geologica Sinica	Govt. For.	5	0
ACTA Geophysica Polonica	Inst. For.	1	0
Acta Geophysica Sinica	Assoc. For.	1	0
Acta Palaeontologica Polonica	Inst. For.	0	3
Acta Palaeontologica Sinica	Comm. For	5	0
ACTA Petrolei Sinica	Assoc. For.	19	0
Acta Seismologica Sinica = Ti chen hsueh pao	Inst. For.	77	0
Akademiia Nauk SSSR. Doklady. Earth sciences sections	Comm. U.S.	40	2
Akademiia Nauk SSSR. Izvestiia. Seriia geologicheskaia	Inst. For.	4	2
Akademiia Nauk SSSR. Tikhookeanskaia geologiia. Geology	Comm. U.S.	3	0
Akademiia Nauk. Azerbaidzhanskoi S S R., Baku. Izvesti	Inst. For.	3	0
Alaska Geological Society. Journal	Assoc. U.S.	2	5
Alcheringa	Assoc. For.	0	1
AMC Journal	Assoc. U.S.	14	0
Ameghiniana	Assoc. For.	1	1
American Association of Petroleum Geologists. AAPG Explorer	Assoc. U.S.	37	0
American Association of Petroleum Geologists. Bulletin	Assoc. U.S.	379	225
American Ceramic Society. Bulletin	Assoc. U.S.	82	1
American Ceramic Society. Journal	Assoc. U.S.	237	2
American Crystallographic Association. Transactions	Assoc. U.S.	3	0
American Gas Association Monthly	Assoc. U.S.	2	0
American Institute of Mining, Metallurgical, & Petroleum	Assoc. U.S.	206	147
American Journal of Science	Univ. U.S.	548	151
American Mineralogist	Assoc. U.S.	503	71
American Petroleum Institute. Production Dept. Annual m	Inst. U.S.	2	0
American Quaternary Association. Abstracts	Assoc. U.S.	1	0
American Society of Photogrammetry. Proceedings	Assoc. U.S.	7	0
Annales de Limnologie	Univ. For.	1	0
Annales de Paleontologie	Comm. For.	0	3
Annales des Mines	Govt. For.	7	0
AOSTRA Journal of Research	Assoc. For.	30	0
Applied Clay Science	Comm. For.	2	0
Applied Geochemistry	Assoc. For.	35	0
Applied Spectroscopy	Assoc. U.S.	28	0
Aquatic Sciences	Inst. For.	3	0
Arizona Geological Society. Digest	Assoc. U.S.	2	13
ARPEL Boletin Tecnico	Comm. For.	1	0
Asociacion Geologica Argentina Revista	Assoc. For.	11	0
Association of Engineering Geologists. Bulletin	Assoc. U.S.	7	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Atlantic Geology, Journal of the Atlantic Geoscience So	Assoc. For.	12	0
Atmospheric & Oceanic Physics	Assoc. U.S.	43	0
AusIMM Proceedings/Australasian Institute of Mining &	Inst. For.	9	0
Australia. Bureau of Mineral Resources, Geology & Geoph	Govt. For.	1	0
Australian Journal of Earth Sciences	Assoc. For.	3	1
Australian Journal of Soil Sciences	Inst. For.	5	5
Australian Petroleum Exploration Association. APEA jour	Assoc. For.	15	1
Austria. Geologische Bundesanstalt. Jahrbuch	Govt. For.	1	0
Barcelona (Province). Institute de Investigaciones Geol	Govt. For.	3	0
Basin Research (published by Blackwell)	Assoc. For.	2	0
Bay Area Regional Earthquake Preparedness Project. Netw	Govt. state	1	0
Boletim de Geociencias da PETROBRAS. Petroleo Brasileir	Inst. For.	2	0
Bolletino di Geofisica, Teorica ed Applicata	Inst. For.	2	0
Boreas: An International Journal of Quaternary Research	Univ. For.	4	0
Breslau. Uniwersytet. Prace geologiczno-mineralogiczne	Univ. For.	1	0
Brigham Young Univ., Provo, Utah. Dept. of Geology. Geo	Univ. U.S.	3	2
British Ceramic Society. Transactions and Journal	Assoc. For.	29	0
Brussels. Sciences de la Terre	Inst. For.	1	3
Bulgarian Geophysical Journal	Inst. For.	2	0
Bulgarska akad. na nauk., Sofia. Geol. institut. Paleon	Inst. For.	0	1
Bulletin Geodesique	Assoc. For.	135	0
Bulletin of Canadian Petroleum Geology	Assoc. For.	9	7
Bulletin of the Chinese Academy of Geological Sciences.	Inst. For.	5	1
Bulletin of the Chinese Academy of geological sciences.	Inst. For.	0	2
Bulletin of the Nanjing Institute of Geology and Minera	Inst. For.	2	1
Bulletin of Volcanology	Assoc. For.	76	9
California Geology	Govt. state	41	0
California. Division of Oil and Gas. Annual Review of C	Govt. state	1	4
Canadian Geophysical Bulletin	Assoc. For.	2	0
Canadian Institute of Mining and Metallurgy. CIM bullet	Assoc. For.	43	4
Canadian Journal of Earth Sciences	Govt. For.	234	34
Canadian Journal of Remote Sensing	Inst. For.	16	0
Canadian Mineralogist	Assoc. For.	75	15
Canadian Mining Journal	Assoc. For.	6	0
Canadian Society of Exploration Geophysicists. Journal	Assoc. For.	1	0
Carbonates and Evaporites	Assoc. U.S.	1	0
Caribbean Journal of Science	Assoc. U.S.	8	0
Casopis pro mineralogii a geologii	Inst. For.	3	0
Catena	Univ. For.	1	0
Caves and Caving	Assoc. U.S.	30	0
Centres de recherches exploration-production Elf-Aquita	Inst. For.	4	1
Chemical Geology and Isotope Geoscience	Comm. For.	396	10
Chemie der Erde	Comm. For.	21	5
Chinese Journal of Geochemistry (Ti ch'iu hua hsueh)	Inst. For.	11	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Chung-kuo ti chih ko hsueh yuan yuan pao. Hsi an ti ch	Inst. For.	0	20
Clay Minerals	Assoc. For.	21	2
Clay Science	Assoc. For.	3	0
Clays and Clay Minerals: Journal of the Clay Minerals S	Assoc. U.S.	163	9
Climatic Change	Comm. For.	27	0
Coastal Research	Univ. U.S.	6	0
COGS Computer Contributions	Assoc. U.S.	9	0
Cold Regions Science and Technology	Comm. For.	3	0
Collection of Structural Geology	other	71	0
Commission on Ore-forming Fluids in Inclusions. Proceed	Assoc. U.S.	3	0
Compass of Sigma Gamma Epsilon	Assoc. U.S.	2	1
Computer Applications	Univ. For.	1	1
Computer Oriented Geological Society. COGSletter	Assoc. U.S.	1	0
Computers and Geosciences	Comm. For.	110	13
Congreso Geologico Argentino. Actas	Univ. For.	1	0
Continental Shelf Research	Comm. For.	10	0
Contributions to Mineralogy and Petrology	Comm. For.	748	157
Contributions to Tertiary and Quaternary Geology (Meded	Assoc. For.	1	0
Cretaceous Research	Comm. For.	2	0
Current Topics in Chinese Science. Section F, Earth Sci	Comm. U.S.	1	0
Dansk geologisk forening, Copenhagen. Bulletin of the G	Assoc. For.	0	9
Deep-sea Research. Part A. Oceanographic research paper	Comm. U.S.	24	0
Deutsche Geologische Gesellschaft, Berlin. Zeitschrift	Assoc. For.	3	1
E & MJ. Engineering and Mining Journal	Comm. U.S.	101	2
Earth and Mineral Sciences	Univ. U.S.	1	0
Earth and Planetary Science Letters	Comm. For.	914	128
Earth Science (Chikyu kagaku), [Tokyo]	Assoc. For.	6	0
Earth Surface Processes and Landforms	Assoc. For.	22	0
Earth, Moon and Planets	Comm. For.	4	0
Earth-science Reviews	Comm. For.	26	7
Earthquake Prediction Research: EPR	Assoc. For.	8	2
Earthquake Research in ChinaChung-kuo ti chen yen chiu	Comm. U.S.	15	0
Earthquakes and Volcanoes	Govtus	1	0
Eclogae Geologicae Helvetiae	Assoc. For.	6	2
Economic Geology	Assoc. U.S.	315	108
Egyptian Journal of Geology	Assoc. For.	0	6
Energy Exploration and Exploitation	Comm. For.	5	0
Engineering Geology	Comm. For.	34	0
Environmental Geology and Water Sciences	Comm. For.	38	0
EOS: Transactions, American Geophysical Union	Assoc. U.S.	137	121
Episodes	Assoc. For.	18	0
Erzmetall	Comm. For.	2	0
Estudios Geologicos	Inst. For.	1	0
European Journal of Mineralogy	Assoc. For.	94	13

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Evolution	Assoc. U.S.	3	0
Exploration Geophysics	Assoc. For.	1	0
First Break	Assoc. For.	43	2
Fizio-Tekhnicheskie problemy razrabotki poleznykh iskop	Inst. For.	3	0
France. Bureau de la recherches geologiques et minieres	Govt. For.	4	0
France. Bureau de recherches geologiques et minieres.	Govt. For.	2	0
France. Bureau de recherches geologiques et minieres. B	Govt. For.	2	0
Geo-Marine Letters	Comm. For.	14	0
Geoarchaeology	Comm. U.S.	21	3
Geobios	Univ. For.	1	2
Geobyte	Assoc. U.S.	54	0
Geochemical Journal	Assoc. For.	14	0
Geochemistry International	Assoc. U.S.	28	2
Geochimica et Cosmochimica Acta	Assoc. For.	886	209
Geochronique	Govt. For.	2	0
Geoderma	Comm. For.	81	1
Geodinamica acta	Comm. For.	5	0
Geoexploration	Comm. For.	7	4
Geofisica Internacional	Univ. For.	6	0
Geofizicheskii zhurnal [English]	Comm. For.	4	0
Geofizikai kozlemenyek : A Magyar Allami Eotvos Lorand	Inst. For.	2	0
Geoforum	Comm. For.	6	0
Geographical Analysis	Univ. U.S.	7	6
Geokhimiia	Inst. For.	28	2
Geologica Carpathica	Inst. For.	1	0
Geologica Romana	Univ. For.	3	0
Geological Association of Canada. Program with abstract	Assoc. For.	5	1
Geological Journal	Assoc. For.	10	1
Geological Magazine	Univ. For.	79	11
Geological Society of America. Abstracts with Programs	Assoc. U.S.	277	179
Geological Society of America. Bulletin	Assoc. U.S.	553	366
Geological society of America. GSA Today	Assoc. U.S.	26	0
Geological Society of China. Proceedings	Assoc. For.	3	0
Geological Society of India. Journal	Assoc. For.	2	0
Geological Society of Japan. Journal	Assoc. For.	19	6
Geological Society of Malaysia. Bulletin	Assoc. For.	1	0
Geologie Africaine. Association of African Geological S	Assoc. For.	4	0
Geologie en Mijnbouw	Assoc. For.	31	8
Geologie Mediterraneenne	Univ. For.	2	1
Geologiia i geofizika	Govt. For.	3	4
Geologiia nefti i gaza	Govt. For.	6	0
Geologische Rundschau	Assoc. For.	46	4
Geologisches Jahrbuch. Reihe D: Mineralogie, Petrograph	Govt. For.	5	0
Geologiska foreningen i Stockholm. Forhandlingar	Assoc. For.	6	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Geologists' Association, London. Proceedings	Assoc. For.	1	1
Geology	Assoc. U.S.	499	183
Geology Today	Assoc. For.	12	0
Geomimet. Asociacion de ingenieros de minas, metalurgis	Assoc. For.	0	1
Geophysical Exploration	Assoc. For.	1	0
Geophysical Journal (international)	Assoc. For.	505	129
Geophysical Magazine	Govt. For.	8	0
Geophysical Prospecting	Assoc. For.	40	18
Geophysical Prospecting for Petroleum. Shih yu wu t'an	Govt. For.	2	0
Geophysical Research Letters	Assoc. U.S.	283	49
Geophysics	Assoc. U.S.	397	172
Geophysics, The Leading Edge of Exploration	Assoc. U.S.	15	0
Geophytology	Assoc. For.	1	1
Geos	Univ. For.	1	0
Geoscience Canada	Assoc. For.	8	6
Geostandards Newsletter	Assoc. For.	10	0
Geotectonics	Assoc. U.S.	20	8
Geothermal Energy	Comm. U.S.	1	0
Geothermal Hot Line	Govt. state	6	0
Geothermal Resources Council. Bulletin.	Assoc. U.S.	0	1
Geothermal Science and Technology	Comm. U.S.	7	0
Geothermics (MacMillan)	Inst. For.	50	0
Geotimes	Assoc. U.S.	84	3
Gerlands Beitrage zur Geophysik	Comm. For.	4	0
Global Biogeochemical Cycles	Assoc. U.S.	8	0
Global Tectonics and Metallogeny	Assoc. For.	2	0
Gluckauf (with English translation)	Comm. For.	22	0
Grana	Assoc. For.	2	6
Ground Water	Assoc. U.S.	112	11
Gulf Coast Association of Geological Societies. Transactions	Assoc. U.S.	17	8
Hesse. Landesamt fuer boedenforschung. Abhandlungen	Govt. For.	2	0
High Temperature Science	Comm. U.S.	4	0
Hokkaido Daigaku, Sapporo, Japan. Faculty of Science. J	Univ. For.	0	1
Hydrocarbon Processing	Comm. U.S.	39	0
Hydrological Processes	Comm. U.S.	30	0
Hydrometallurgy	Comm. For.	7	0
Ice	Assoc. For.	5	0
In Situ	Comm. U.S.	9	0
India. Geological Survey. Records	Govt. For.	1	0
Indian Journal of Earth Sciences	Assoc. For.	2	0
Indian Mineralogist	Assoc. For.	1	0
Industrial Minerals	Comm. For.	31	0
Industrie Ceramique	Assoc. For.	1	0
Institut Oceanographique. Annales de l'Institut Oceanog	Inst. For.	5	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Institute of Petroleum. Quarterly Journal of technical	Inst. For.	6	0
Institution of Mining & Metallurgy, London. Bulletin	Inst. For.	4	0
Institution of Mining and Metallurgy, London. Transactions	Inst. For.	31	5
Instituto Mexicano del Petroleo. Revista	Assoc. For.	7	0
Institutul de Speologie <<Emil Racovita.>> Travaux de l	Govt. For.	7	0
International Geology Review	Assoc. U.S.	33	5
International Institute for Aerial Survey and Earth Sci	Inst. For.	22	0
International Journal for Numerical and Analytical Methods	Comm. U.S.	116	0
International Journal of Coal Geology	Comm. For.	5	0
International Journal of Mineral Processing	Comm. For.	14	0
International Journal of Remote Sensing	Comm. For.	107	2
International Journal of Rock Mechanics and Mining Scie	Assoc. For.	151	16
International Journal of Speleology	Comm. For.	1	0
International Seismological Centre, Edinburgh. Bulletin	Inst. For.	1	0
International Union of Geodesy and Geophysics. Chroniqu	Assoc. For.	3	0
ISOCHRON/WEST: A Bulletin of Isotopic Geochronology	Govt. state	15	8
ISPRS Journal of Photogrammetry and Remote Sensing	Assoc. For.	20	0
Israel Geological Society. Annual meeting	Assoc. For.	1	0
Israel Journal of Earth-Sciences	Govt. For.	5	0
Japan. Geological Survey. Bulletin.	Govt. For.	3	1
Japan. Geological Survey. Bulletin.	Govt. For.	3	1
Japan. National Research Center for Disaster Prevention	Govt. For.	1	0
Japanese Association of Mineralogists, Petrologists and	Assoc. For.	14	0
Jokull	Univ. For.	1	3
Journal of African Earth Sciences	Comm. For.	37	0
Journal of Applied Crystallography	Assoc. For.	69	1
Journal of Canadian Petroleum Technology	Assoc. For.	51	23
Journal of China University of Geosciences	Univ. For.	6	0
Journal of Coastal Research: Jcr	Inst. U.S.	8	4
Journal of Earth Sciences (Nagoya, Japan)	Univ. For.	2	0
Journal of Foraminiferal Research	Assoc. U.S.	2	45
Journal of Geochemical Exploration (Elsevier)	Assoc. For.	38	1
Journal of Geodynamics	Comm. U.S.	16	5
Journal of Geological Education	Assoc. U.S.	57	0
Journal of Geology	Univ. U.S.	242	64
Journal of Geomagnetism and Geoelectricity	Assoc. For.	17	3
Journal of Geophysical Research	Assoc. U.S.	1661	628
Journal of Glaciology	Assoc. For.	10	0
Journal of Hydrology	Comm. For.	247	24
Journal of Metals	Assoc. U.S.	23	0
Journal of Metamorphic Geology	Comm. For.	105	9
Journal of Micropaleontology	Assoc. For.	0	10
Journal of Paleontology	Assoc. U.S.	8	39
Journal of Petroleum Geology	Comm. For.	27	4

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Journal of Petroleum Science and Engineering.	Comm. For.	30	1
Journal of Petrology	Comm. For.	222	82
Journal of Physical Oceanography	Assoc. U.S.	87	1
Journal of Physics of the Earth	Assoc. For.	66	5
Journal of Sedimentary Petrology	Assoc. U.S.	203	60
Journal of Soil Science	Univ. For.	38	6
Journal of South American Earth Sciences	Comm. For.	16	0
Journal of Southeast Asian Earth Sciences	Comm. For.	9	0
Journal of Stratigraphy. (Chinese)	Inst. For.	3	0
Journal of Structural Geology	Comm. For.	181	25
Journal of the Geological Society of London	Assoc. For.	132	36
Journal of Vertebrate Paleontology	Univ. U.S.	1	0
Journal of Volcanology and Geothermal Research	Comm. For.	101	25
JPT. Journal of Petroleum Technology	Assoc. U.S.	230	161
Korean Institute of Mineral and Mining Engineers. Jour	Assoc. For.	3	0
Kozan chishitsu	Univ. For.	11	3
Kyoto Daigaku. Rigakubu. Memoirs. Series of geology and	Univ. For.	2	0
Kyoto. University. Disaster Prevention Research Instit	Inst. For.	1	0
Kyushu University. Dept. of Geology. Science reports	Univ. For.	1	1
Lethaia: An International Journal of Palaeontology and	Univ. For.	7	5
Limnology and Oceanography	Assoc. U.S.	47	0
Lithology and Mineral Resources	Comm. U.S.	10	0
Lithos	Govt. For.	60	12
Log Analyst	Assoc. U.S.	51	3
Malacologia	Univ. U.S.	11	0
Malacological Review	Univ. U.S.	2	0
Mapping Sciences and Remote Sensing	Assoc. U.S.	1	0
Marine and Petroleum Geology	Assoc. For.	27	0
Marine Geodesy	Comm. U.S.	5	0
Marine Geology	Comm. For.	63	17
Marine Geophysical Researches	Comm. For.	14	1
Marine Micropaleontology	Comm. For.	24	17
Marine Mining	Comm. U.S.	3	0
Maritimes	Univ. U.S.	1	0
Mathematical Geology	Comm. U.S.	215	52
Mercian Geologist	Assoc. For.	1	1
Metals Week	Comm. U.S.	287	0
Meteor forschungsergebnisse. Reihe A/B: Allgemeines, Ph	Comm. For.	1	0
Meteoritics	Assoc. U.S.	13	0
Mexico (City) Univ. Nacional. Instituto de Geologia. Re	Univ. For.	1	1
Meyniana	Univ. For.	0	2
Micropaleontology	Inst. U.S.	10	53
Mineralium deposita - Official Bulletin of the Society	Assoc. For.	18	0
Mineralogia Polonica	Assoc. For.	2	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Mineralogica et Petrographica Acta	Univ. For.	0	1
Mineralogical Journal	Assoc. For.	4	1
Mineralogical Magazine	Assoc. For.	115	16
Mineralogical Record	Comm. U.S.	22	0
Mineralogical Society of Japan. Journal	Assoc. For.	6	0
Mineralogy and Petrology	Comm. For.	27	0
Mining Engineering	Assoc. U.S.	44	3
Mining Journal	Comm. For.	41	0
Mining Magazine	Comm. For.	53	0
Mining, Geological and Metallurgical Institute of India	Inst. For.	1	0
Modern Geology	Comm. U.S.	27	4
Moscow University Geology Bulletin	Comm. U.S.	6	0
Moskovsskogo obshchestvo ispytatelei prirody. Otedel ge	Assoc. For.	2	0
Mountain Geologist	Assoc. U.S.	3	0
Namibia. Geological survey. Communications of the Geolo	Govt. For.	1	0
NatturufraDingurinn	Assoc. For.	1	0
Natural Hazards	Comm. For.	1	0
Nature	Comm. For.	1170	66
Nederlands Geologisch Mijnbouwkundig Genootschap. Verh	Assoc. For.	0	2
Neues Jahrbuch fuer geologie und palaeontologie. Abhand	Comm. For.	0	22
Neues Jahrbuch fuer Mineralogie. Monatshefte	Comm. For.	29	5
Neues Jahrbuch fur geologie und palaontologie. Montashe	Comm. For.	1	12
Neues Jahrbuch fur Mineralogie. Abhandlungen	Comm. For.	46	1
New Mexico Geology	Govt. state	8	0
New Zealand Journal of Geology and Geophysics	Govt. For.	5	4
Newsletters on Stratigraphy	Comm. For.	5	1
Norsk Geologisk Tidsskrift = Norwegian Journal of Geolo	Assoc. For.	9	0
Northeastern Geology	Assoc. U.S.	3	0
Northern Miner	Comm. For.	12	0
Northwest Geology Magazine	Univ. U.S.	9	0
Oceanologica Acta	Comm. For.	7	1
Oceanology	Assoc. U.S.	3	0
Oceanology	Govt. For.	3	0
Oceans	Assoc. U.S.	27	1
Oceanus	Univ. U.S.	42	3
Offshore Technology Conference. Proceedings	Univ. U.S.	22	1
Ofioliti	Assoc. For.	4	1
Oil and Gas Geology	Assoc. For.	14	0
Oil and Gas Journal	Comm. U.S.	951	86
Oil Geophysical Prospecting	Govt. For.	11	0
Oilfield Review (Schlumberger)	Comm. For.	9	0
Oklahoma Geology Notes	Assoc. U.S.	1	0
Ore Geology Reviews	Comm. For.	19	0
Oregon Geology	Govt. state	9	1

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Organic Geochemistry	Assoc. U.S.	150	6
Pacific Oil World	Assoc. U.S.	26	0
Pacific Petroleum Geologist	Assoc. U.S.	1	0
Palaeography, Palaeoclimatology, Palaeoecology	Comm. For.	47	20
Palaeontographica. Abteilung A	Comm. For.	7	8
Palaeontographica. Abteilung B	Comm. For.	28	24
Palaeontological Society of Japan, Tokyo. Transactions	Assoc. For.	2	0
Palaeontologische Zeitschrift	Comm. For.	4	4
Palaeontology	Assoc. For.	3	16
Palaios	Assoc. U.S.	7	0
Paleobiology	Assoc. U.S.	2	0
Paleoceanography	Assoc. U.S.	34	0
Paleontologia Cathayana	Inst. For.	1	0
Paleontological Journal	Assoc. U.S.	5	0
Paleorient	Govt. For.	2	0
Palynology	Assoc. U.S.	0	21
Pan American Institute of Geography and History. Revist	Inst. For.	4	0
Paris. Museum National d'Histoire Naturelle. Bulletin.	Inst. For.	1	0
Pennsylvania Geology	Govt. state	1	0
Periodico di Mineralogia	Inst. For.	2	0
Petroleum Engineer International	Comm. U.S.	62	4
Petroleum Geology	Comm. U.S.	1	1
Petrologie	Comm. For.	1	0
Photogrammetric Engineering and Remote Sensing	Assoc. U.S.	56	5
Physical Geography	Comm. U.S.	4	0
Physics and Chemistry of Minerals	Comm. For.	102	5
Physics of the Earth and Planetary Interiors	Comm. For.	197	16
Physics of the Solid Earth	Assoc. U.S.	10	0
Pipeline and Gas Journal	Comm. U.S.	7	0
Polar Research	Inst. For.	1	0
Pollen et Spores	Inst. For.	8	0
Portugal. Servicos Geologicos. Comunicacoes	Govt. For.	1	0
Powder Diffraction	Inst. U.S.	6	0
Precambrian Research	Assoc. For.	137	1
Prikladnaia Geofizika	Inst. For.	2	0
Proceedings of the San Diego Society of Natural History	Assoc. U.S.	3	4
Progress in Physical Geography	Comm. For.	4	1
Proyecto Energetico	Govt. For.	2	0
Pure and Applied Geophysics	Comm. For.	185	14
Quarterly Journal of Engineering Geology	Assoc. For.	16	0
Quaternary Research	Comm. U.S.	31	9
Quaternary Science Reviews	Comm. For.	12	1
Radiocarbon	Assoc. U.S.	14	11
Razvedka i okhrana nedr	Govt. For.	5	0

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Recent Developments in World Seismology	Inst. For.	43	0
Regional Geology of China	Inst. For.	30	0
Remote Sensing of Environment	Comm. For.	114	9
Remote Sensing Reviews	Comm. U.S.	19	0
Review of Palaeobotany and Palynology	Comm. For.	14	17
Reviews of Geophysics	Assoc. U.S.	203	33
Revista Brasileira de Geociencias	Assoc. For.	8	0
Revista de Geofisica	Univ. For.	2	0
Revista Espanola de Micropaleontologia	Inst. For.	3	5
Revista Geologica de Chile	Govt. For.	11	0
Revue de Geomorphologie Dynamique	Inst. For.	1	0
Revue de l'Institut Francais du Petrole	Inst. For.	5	2
Revue de Micropaleontologie	Univ. For.	2	8
Revue Roumaine de Geologie, Geophysique et Geographie	Inst. For.	1	0
Rivista Italiana di Paleontologia e Stratigrafia	Univ. For.	4	1
Rock Mechanics and Rock Engineering	Comm. For.	9	0
Rocks and Minerals	Assoc. U.S.	47	0
Royal Society of Edinburgh. Transactions. Earth Science	Assoc. For.	0	3
Royal Society of New Zealand, Wellington. Journal of the	Assoc. For.	1	1
Royal Society of Western Australia. Journal	Assoc. For.	0	2
Russia (1923- USSR) Ministerstvo vysshego obrazovaniia	Govt. For.	0	1
Schweizerische mineralogische und petrographische mitte	Assoc. For.	32	1
Science	Assoc. U.S.	721	61
Sciences geologiques. Bulletin	Univ. For.	1	0
Scottish Journal of Geology	Assoc. For.	12	3
Sedimentary Geology	Comm. For.	63	2
Sedimentology	Assoc. For.	92	9
Seismological Society of America. Bulletin	Assoc. U.S.	490	109
Seismological Society of America. Eastern Section. Sei	Assoc. U.S.	55	1
Seismology and geology = Ti ch'en ti chih	Inst. For.	98	0
Senckenbergiana Maritima	Assoc. For.	2	0
Shale Shaker	Assoc. U.S.	18	0
Skillings' Mining Review	Comm. U.S.	51	1
Societa Geologica Italiana, Rome. Bollettino	Assoc. For.	3	0
Societe Belge de Geologie. Bulletin	Assoc. For.	1	0
Societe Geologique de Belgique. Liege. Annales	Assoc. For.	1	0
Societe Geologique de France. Bulletin	Assoc. For.	19	7
Society of Economic Paleontologists and Mineralogists.	Assoc. U.S.	8	6
Soil Science	Comm. U.S.	91	32
Soil Science Society of America. Journal	Assoc. U.S.	260	45
South African Institute of Mining and Metallurgy. Journal	Assoc. For.	1	2
South African Journal of Geology, being the Transactions	Assoc. For.	17	0
South African Mining and Engineering Journal. South Afr	Comm. For.	3	0
Southeastern Geology	Assoc. U.S.	1	3

APPENDIX 2. Cont.

STANFORD Title (cont.)	Publisher type	No. of uses	Theses cites
Sovetskaia geologiia. Moskva	Govt. For.	4	0
Soviet Geology and Geophysics	Comm. U.S.	23	1
Soviet Journal of Remote Sensing	Comm. U.S.	7	0
Soviet Mining Science	Comm. U.S.	8	0
Soviet Physics. Crystallography	Inst. U.S.	25	2
Soviet Soil Science	Comm. U.S.	4	1
SPE Drilling Engineering	Assoc. U.S.	33	1
SPE Formation Evaluation	Assoc. U.S.	450	175
SPE Reservoir Engineering	Assoc. U.S.	63	15
Studia Geophysica et Geodaetica	Inst. For.	2	1
Surveys in Geophysics	Comm. For.	4	2
Tectonics	Assoc. U.S.	150	73
Tectonophysics	Comm. For.	640	134
Tellus. Series A: Dynamic meteorology and oceanography	Assoc. For.	33	0
Tellus. Series B: Chemical and physical meteorology	Assoc. For.	12	0
Terra Nova	Assoc. For.	22	12
Texas Energy	Univ. U.S.	1	0
Ti chiu ko hsueh: Wuhan ti chih hsueh yuan hsueh pao.	Univ. For.	6	0
Tohoku Daigaku, Sendai, Japan. Science reports. Secon	Univ. For.	7	3
Tohoku Daigaku, Sendai, Japan. Science reports. Third s	Univ. For.	1	0
Tokyo. Daigaku. Jishin Kenkyujo. Bulletin of the Earthq	Univ. For.	21	11
Tokyo. Daigaku. Kagakubu. Journal. Section II. Geology,	Univ. For.	9	0
Transport in Porous Media	Comm. For.	95	0
Tsukuba Daigaku, Chikyu Kagakukei. Science reports of t	Univ. For.	3	0
Vsesoiuznoe mineralogicheskoe obshchestvo. Zapiski	Assoc. For.	17	0
Water Resources Research	Assoc. U.S.	325	239
World Mining Equipment	Comm. U.S.	17	0
World Oil	Comm. U.S.	672	8
Wyoming Geological Association. Earth Science Bulletin	Assoc. U.S.	4	0
Wyoming. University. Dept. of Geology. Contributions to	Univ. U.S.	2	0
Yen k'uang ts'e shih (Journal of rock and mineral analy.)	Inst. For.	1	0
Yorkshire Geological Society. Proceedings	Assoc. For.	1	1
Zeitschrift fur Angewandte Geologie	Govt. For.	3	0
Zeitschrift fur Geologische Wissenschaften	Comm. For.	1	0
Zeitschrift fur Geomorphologie. Annals of geomorphology	Comm. For.	6	0
Zeitschrift fur Gletscherkunde und glazialgeologie	Univ. For.	4	0
Zeitschrift fur Kristallographie	Inst. For.	63	1
Zisin. Seismological Society of Japan. Journal	Assoc. For.	2	0
Zitteliana.	Inst. For.	1	0
Total: 479 Journals		25915	5679

INTERNATIONAL EXCHANGES OF PUBLICATIONS: THE U.S. GEOLOGICAL SURVEY LIBRARY SYSTEM'S PERSPECTIVE

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Abstract—Exchange operations are typically conducted by large research libraries as an adjunct to other acquisitions activities. Exchanges denote a two-way interaction, providing for information dissemination as well as acquisitions. The official geoscience agencies of most states and countries of the world, as well as many museums and other special libraries, engage in exchanges.

This paper describes the historical background and current operation of publication exchanges of the U.S. Geological Survey Library. It discusses several rationales and principles for establishing publications exchanges, types of exchange arrangements, and some practical issues related to maintaining the effectiveness and efficiency of exchange operations, with an emphasis on informal foreign exchanges.

Exchanges promote international cooperation and understanding in science and can benefit almost any institutional informational environment. With an awareness of limitations and problems to be faced, a wisely monitored exchange program can result in significantly increased access to foreign geoscience literature.

INTRODUCTION: THE RESPONSIBILITIES OF A SPECIAL LIBRARY

Two basic characteristics of special libraries distinguish geoscience information centers, regardless of size, from public (i.e., popular) or general libraries:

1. *the scope of collections* concentrates on regional and topical aspects of the geosciences, but also within this subject/area specialization, the collection of information is more detailed, technical, and comprehensive than any general collection. All types of materials are included—not only commercial books and journals but also newsletters, dissertations, government documents, field trip guides, technical reports, and so on; both published and unpublished materials are included from a wide variety of sources: local, national, and foreign.

2. an *emphasis on client services* reflects a close, knowledgeable relationship with library users. For example, reference and lending services are more likely to be individualized, or user-oriented, incorporating various methods of formal and informal information retrieval and delivery. The classification of materials and bibliographic analyses by which users are directed to information are likely to be tailored to accommodate special scientific and technical terms or local research priorities.

In a similar vein, the process of acquisitions may be proactive, scanning trends in the literature, or demand-oriented, immediately responsive to users' expressed needs. Striving to provide the best information possible, acquisitions librarians rely on personal and organizational networks in addition to traditional commercial sources, and acquisitions are not necessarily restricted by geographic or linguistic limitations.

Publications exchanges are particularly suited to specialized information services. They are a form of information dissemination, facilitating distant scientific communication and cooperation, and they are one of the best alternative means of acquiring materials from foreign sources.

RATIONALES FOR EXCHANGES

A traditional reason for establishing foreign publications exchanges stems from the internationalization of scientific activities in general. As a form of information dissemination, exchanges facilitate scientific communication and understanding. To that extent, organizational exchanges are only an outgrowth of the personal contacts and networks by which individual researchers have always communicated ideas and techniques among themselves.

Besides good scientific practice, Clark (1990, p. 171) suggests an additional enticement of increased status for academic researchers:

> By publishing the latest discoveries at its own institution, and offering these publications as exchanges, the faculty and institution gain in prestige. An extensive serials collection augmented by exchanges also may help to attract outstanding faculty and, therefore, grants. Exchanges help provide foreign materials to support post-graduate research, foreign student programs, and international studies.

More importantly, from a scientific perspective, a heightened motivation for foreign exchanges derives from a "new science of the earth," which seeks information globally in order to understand Earth as a dynamic ecological system (Silver and DeFries, 1990). The international interests, which were always a significant aspect of many geoscience disciplines such as paleoclimatology, seismology, and tectonics, have been given an urgent new impetus by the advent of such environmental issues as hazardous waste disposal and global warming.

As indicated in a new journal dedicated to "global environmental change," scientists are increasingly aware that "humankind in the biosphere" needs interdisciplinary and "transboundary" approaches and solutions to problems (Price, 1990). International exchanges among agencies and institutions of all kinds will help geoscientists form the broad links needed for future research.

This emerging scientific consciousness of global change parallels contemporary economic and geopolitical realities. The interdependence of national economies requires a comprehensive understanding of international resources. Although the extent of U.S. dependence on foreign mineral resources is hardly new, increasing competition in the international marketplace adds new emphasis to our concern. A study by the Committee on Global and International Geology of the National Research Council (1987, p. 1) concluded that

> (1) international geoscience needs to be strengthened to support the national interests of the United States;
> (2) geoscience personnel and the knowledge they possess should be more effectively used in helping to formulate foreign policy; and
> (3) U.S. economic and scientific interests can be strengthened by strong involvement of American geoscientists in U.S. international programs.

From the narrower perspective of library acquisitions, the traditional rationale for engaging in exchanges is still valid, particularly in regard to certain types of documents or materials from noncommercial sources. The primary aim of exchanges is to acquire publications that are not available by purchase, "or for which exchange is more economically advantageous than purchasing" (Clark, 1990, p. 170). Many governmental publications, technical reports from publicly supported institutions, field-trip and meeting reports, and other examples of our "gray" literature are never issued with the intention of commercial availability. In many foreign countries, economic or political factors may limit the quantities of publications available or their means of distribution. Many small professional societies do not maintain permanent offices for ongoing sales of publications.

In other cases, even where commercial avenues exist for acquiring materials, it may be more convenient or economical to avoid the financial procedures of a monetary exchange. Details of payment such as purchase orders, invoices and vouchers, monetary exchange rates, vendor communications, and so on are largely eliminated by direct exchanges. In established exchanges, materials may be received much more quickly than otherwise, especially when the materials exchanged are delivered automatically.

USGS LIBRARY BACKGROUND

In the U.S. Geological Survey, the importance of international exchanges was recognized at the outset as an inherent part of promoting scientific accomplishments. In 1882, when the Survey was still housed in the Smithsonian National Museum and shared laboratory facilities of the American Museum of Natural History, the establishment of a library had a high priority. John Wesley Powell's *Third Annual Report of the Director* (U.S. Geological Survey, 1883, p. xvii) states:

> A technical working library is urgently needed....Only the most imperative wants have been met by purchase, since it is hoped that the system of interchange provided for by law will ultimately afford the Survey, in exchange for its publications, nearly all that is desired.

While that remark might have been intended to deflect or minimize the extent of future budget requirements, it also presented the first librarian, Charles C. Darwin, with a large challenge, and his successors with an enviable heritage.

By 1885, the increase in Library acquisitions "coming in great measure from scientific exchanges, ha[d], during the year, almost doubled the contents of the library" (U.S. Geological Survey, 1885, p. 98). The Librarian reported that as of June 30, 1884, 8,714 of 11,515 (75%) books on hand were received by exchange, and 6,400 of 6,900 pamphlets (93%) were received by exchange.

Besides documenting this early physical measure of the contribution of exchanges to the collection, the Librarian also outlined the rationale for the Library's work:

> The tools of the field geologist are the hammer, trowel, compass, clinometer, and magnifying glass; but the no less essential tools of the same geologist when employed in elaborating the results of his field studies are books; for no original investigator regards his work as complete until he has ascertained the results of researches in the same or related fields by all other investigators. Thus a library is a necessary part of the working geologist. (U.S. Geological Survey, 1888, p. 13)

By 1889, the Librarian reported that 8,223 pamphlets and books were received from exchanges out of a total for the year of 8,746 (and 31,118 of 45,601 total items held). In addition, correspondence activities related to the exchanges also specifically cited a "circular sent out in March 1886...for the purpose of verifying addresses...the exchange list [of] over 1500 addresses [was] thoroughly revised and enlarged." (U.S. Geological Survey, 1889, p. 207)

Fifteen years later (1905-6), another report describes two types of exchanges, and the increasing scope of activity:

> All the book publications...are regularly sent to 400 foreign and 350 domestic exchanges. Four hundred and fifty sets of map publications are also distributed. Considerable additions to the library are received from those to whom circular lists of new publications are sent and who select the particular publications desired. The lists, containing more than 3,000 addresses, are kept up to date in the library. (U.S. Geological Survey, 1906, p. 92)

Two further statistics demonstrate the growth of exchange activities. In 1909, the exchange list consisted of 260 libraries in the U.S. and 575 in foreign countries (a total of 835). In the following year, the total had increased to 910 addresses, and the correspondence consisted of 3,327 letters received and 3,364 letters written, although it should be noted that the latter figures include correspondence related to publications and map sales as well as exchanges.

As one historical review said of the USGS, the "Survey got off to a good start" (Cloud, 1980, p. 155). Keeping pace with the growth of the Survey, the Library was aided in its collection development through its early role in indexing geologic literature, beginning with the *Bibliography of North American Geology*, issued as USGS Bulletins, and continuing to the present through cooperation with the Geological Society of America's compilation of *Bibliography and Index of Geology Exclusive of North America* and their successor, American Geological Institute's *Bibliography and Index of Geology*.

The Library's interest in international exchanges and foreign materials reflects the interests and needs for information of USGS scientists participating in international programs of the Survey; doing research related to work by other national and international organizations; or concerned with global geoscience problems. The role of the USGS in international geological research was officially expanded in 1962 by P.L. 87-626, 43 U.S.C. 31(b), authorizing examination of geological structures, mineral resources, and products outside the national domain. Description of some of the Survey's international work is provided in reports by Berquist (1976), Taylor (1976), and North and Faries (1987).

CURRENT OPERATION OF THE USGS PUBLICATIONS EXCHANGES

The USGS exchanges are directly supervised by the Exchange and Gifts (E&G) Unit within the Acquisitions Section of the USGS Library in Reston, Virginia. The Acquisitions Section coordinates all acquisitions throughout the Library System, consisting of the Reston Library and branch libraries in Denver, Colorado, Flagstaff, Arizona, and Menlo Park, California. Besides informational outreach to the many USGS field offices, there are special efforts to provide additional library resources to the USGS offices in Anchorage, Alaska; Spokane, Washington; the Hawaiian Volcano Observatory; and more recently, to the USGS Center for Inter-American Mineral Investigations, in Tucson, Arizona.

Consisting of one professional librarian and one assistant, the E&G Unit arranges publications exchanges for all of the libraries and is responsible for all acquisitions that are free (for example, from other governmental agencies), including the receipt of all gifts to the library in Reston, and materials received through official depository status. The library in Reston is a selective Government Printing Office (GPO) Depository Library, as is the library in Menlo Park.

USGS materials available for exchange include the Bulletins, Circulars, Professional Papers, Techniques of Water-Resources Investigations, Water-Supply Papers, and the periodical *Earthquakes & Volcanoes*. These series can be established as automatic distributions, either separately or in combination, or provided in response to selective requests. Selections can be made from the monthly list, *New Publications of the USGS*, or its annual cumulation, *Publications of the USGS*. The latter title and the USGS Yearbook and geologic maps are also available upon request but are not maintained on automatic mailing lists. In the past, the *Journal of Research of the USGS* was a popular exchange title during the years of its publication, 1973–1978.

The correspondence files in the E&G Unit contain more than 1600 foreign addresses, of which approximately 950 represent an automatic distribution of publications. The following figures present the geographic profile of exchange addresses:

Table 1. Geographic distribution of USGS exchanges.

Europe	658
Asia	299
Latin America	205
Africa	178
Canada	113
Australasia	85
Middle East	70
USSR	63
Total	1671

A yearly average of 1750 monographs and an estimated 60% of 8,000+ current serial titles are received through exchange. Unfortunately for the purpose of this report, there are no figures exclusively on foreign materials received.

In the Reston Library, which has a total staff of 50, it is true that "rather than being an isolated part...the gifts and exchange personnel need to be involved in almost every aspect of the library's operation" (Clark, 1990, p. 168). Interactions are frequent with serials, acquisitions, and cataloging personnel. The E&G Unit does precataloging searches and some bibliographic searching related to collection development or in response to exchange partners' requests.

It is important to recognize, however, that much of the work involved with exchanges is integrated within other Library System operations:

- primary collection development and selection is done by subject specialists in the Reference Sections in each of the libraries;
- most preorder searching is done by other Acquisitions staff;
- all serials receiving and routine claiming is done by the Serial Records Unit at each location;

and also importantly, outside the Library:

- all regular mailing of exchange material is done by the Government Printing Office, Washington, D.C.; selective requests received by the E&G Unit are mailed by the USGS Branch of Distribution in Denver, Colorado. Mailing lists, although monitored for changes by the E&G Unit, are actually maintained by the GPO and another USGS office.

Besides the duties mentioned above, it is the primary responsibility of the E&G Unit to conduct all correspondence relating to publications exchanges, their establishment, address changes, and fulfillment of requests. In so doing, the E&G Unit must attempt continually to negotiate reasonable balances in the exchanges and to maintain their effectiveness.

To carry out these operations, the E&G Unit maintains the following files:

• a file of completed correspondence, weeded of routine requests on a periodic basis, provides a historical record of the conduct of each exchange;

• a file of "pending" correspondence, filed geographically by date, tracks all outgoing requests for materials by the Library, with additional backup copies and information available in the Order Unit of the Acquisitions Section);

• a 3 x 5 card file of addresses, filed geographically by type of sending (i.e., materials being sent on an automatic basis), which is duplicated in part by computer printouts from the GPO;

• a 3 x 5 card file of organizational names and multiple cross-references, which also records the type of sendings (automatic or otherwise) and the serial titles received from each exchange.

The cross-references within this file, serving as a main "locator," are especially useful for identifying foreign names, abbreviations, and geographical and organizational divisions, for both current and past exchange partners. It is also used to indicate the pending (potential) exchanges, and organizations that do not provide materials on exchange.

The balance of exchanges is monitored by means of the serial titles recorded in the latter file, and through general questionnaires and other specific correspondence. Historically, the Survey has been generously committed to information dissemination without the expectation of complete return on its investment of exchange materials. This eliminated the need for detailed tracking procedures in the exchange operations. As the Survey's budget becomes increasingly constrained by economic conditions, more emphasis is being placed upon eliminating nonessential distributions of publications; reducing imbalances in exchanges, and generally paying closer attention to exchange "accounts." A strictly economic balance of exchanges is not the current USGS intention; extensive financial record-keeping would require increased operational staff resources, and would not benefit the geoscience organizations with whom we conduct exchanges.

To handle the large volume of work, most exchange correspondence is drafted on electronic word-processors and form letters are employed whenever possible. The E&G Unit is also undertaking the transfer of data from its manual files to a microcomputer database to improve the control and use of this information.

BARRIERS TO EXCHANGE

The main barriers to publications exchanges are much the same as for other avenues of international and intercultural communication:

1. language differences restrict the audience of users for foreign language materials;
2. differences in cultural/educational levels limit the application or transferability of research;
3. political antagonism and governmental instability inhibit the freedom of information;
4. limited economic resources cannot provide equipment and materials for publishing;
5. weak institutional/infrastructural resources cannot provide trained personnel, managerial continuity, and so on;
6. postal rates for overseas mail present a direct, unreimbursed cost for the sender in an exchange.

The latter barrier, linked to the economic resources available for exchanges, exists in developed and developing countries alike, and ways of lessening this burden would be of common benefit.

The indirect costs of maintaining exchanges are less of a "barrier" but still a serious limiting factor: "to believe that exchange programs are free is a fallacy, for the hidden costs alone must be considered as very real expenses" (Bluh and Haines, 1982, p. 153). The "hidden" costs of exchanges deal with the internal logistics of administering and carrying out the exchanges. Aside from the cost of the publications exchanged, elements to be addressed include:

• personnel/staff time needed for correspondence;

• record-keeping to monitor exchanges, maintain equitable balances, and so on;

• storage space needed for surplus exchange publications;

• personnel/staff time needed for shipping materials;

• cost of packaging materials;

• mailing list maintenance time/costs.

Although the degree of significance of these administrative elements varies, depending upon the number and type of exchanges and organizational means for distributing publications, they present an ongoing challenge for maintaining cost-effectiveness and control of any exchange efforts.

PRAXIS: MAKING EXCHANGES WORK

Several basic manuals and reports in recent library literature (Busse, 1964; Lane, 1980; Kavacic, 1982; Barker, 1986; McKinley, 1986; Garg and Ojha, 1988; Clark, 1990) are useful guides for initiating and conducting exchange operations. Zilper (1985) and Deal (1989) present surveys of exchange operations in academic libraries. All of these works offer insights and practical suggestions that will be helpful in various organizational settings.

As a starting point, the UNESCO *Handbook on the International Exchange of Publications* (Busse, 1964) offers the following "maxims":

> 1. Look upon the exchange of publications as a form of scientific conversation with your equals.
> 2. Do not aim at having as many exchange connexions as possible; but rather endeavour to find the partner who is best suited to your particular purpose.
> 3. Exchange involves work; therefore, be as liberal as you can, and avoid, as far as possible, a meticulous reckoning up of relative values.
> 4. A law, valid for all conceivable cases of exchange, does not exist. Do not attempt to mould your entire exchange activities on a uniform pattern. Rationalize, by all means, the pertinent technical operations, but do not fail to regard each one of your partners in exchange as an individual case, entitled to individual treatment. (Busse, 1964, p. 18).

With these fundamentals in mind, what issues need to be considered for establishing, expanding, or improving an exchange operation?

Types of Exchanges

Exchanges can be established as automatic or selective distributions. Automatic distributions of serials involve a greater commitment of material and delivery resources, including the maintenance of mailing lists. However, once established, these exchanges can function very efficiently. Selective exchanges of monographs are usually based on choices being made from announcements or lists of publications. For the supplier, material costs are decreased, but mailing and other processes can be more complicated. Whereas an automatic distribution has a known, fixed cost, supplying selected items involves variable costs, repetitive efforts and additional record-keeping.

In some exchanges, materials are published and distributed from one location, but correspondence and materials in exchange are sent to some different address(es). These or similar variations are inevitable, particularly in exchanges arranged through centralized libraries and large academic institutions. Caution and patience are needed to minimize the inevitable delays and problems of communication in these more complicated exchange arrangements.

Materials Used for Exchange

Libraries with access to the official publications of their own organization have a simpler task of establishing exchanges, but some negotiations or work may be involved in identifying titles that are not available on exchange; in categorizing publications by subject or type; or in providing indexes or lists of works.

Many university libraries and libraries within governmental agencies are able to arrange exchanges of publications from other units within the university, or from related organizations. These other departments or groups might welcome the opportunity to expand the dissemination of their publications, or to relinquish that role to a library exchange program.

Purchasing titles for exchange is another option. It is only practical when the purchased title(s) offered or those received in exchange can be acquired with significant discounts. These bartered exchanges differ from the more informal arrangements that are the primary focus of this paper; they entail more complicated accounting procedures and careful planning and administration.

An economical source of publications for exchange is surplus items; duplicates and discarded volumes from the library's existing collection (including serial runs replaced by microform copies); or donated materials. Gifts may come from a variety of sources: current staff within an organization; external organizations; or professionals in the community. Accepting gifts is an aspect of public relations, demonstrating to donors a concern for the conservation of resources. The use of surplus gifts for exchanges is conducive to the continued acquisition of other gifts more directly and immediately useful to the library. In accepting large donations from individuals, U.S. librarians should be aware of tax law provisions regarding gifts and their disposition (Clark, p. 175–179).

Reprints are another common exchange material, especially among academic departments and small research institutions. Some organizations reissue articles by their staff either as separate series or as collections of reprints. Reprints offer several advantages for exchanges: (1) individual articles contain the intellectual focus of the most immediate value for research; irrelevant items in a journal or book can be eliminated; (2) reprints are much easier and cheaper to mail; and (3) reprints require a smaller amount of storage space.

Disadvantages of collecting reprints as exchange material are the need to avoid duplication with the original publication sources and the need to make the reprints known to users. The cataloging and processing of reprints (or other nontraditional materials) may entail expending more time and effort than for monographic or serial titles. However, cataloging useful reprints may be less wasteful, and more convenient to the user, than obtaining the same articles through interlibrary loan. Increased emphasis on analytical description of document contents is also more responsive to users' needs. New trends in online services and computer cataloging technologies that provide access to smaller bibliographic units may enhance the feasibility and desirability of using reprints for exchanges.

Communications

Written correspondence is an indispensable part of any exchange work and is especially necessary for establishing foreign exchanges and for the continual negotiation and revision of informal agreements. Telephone and other telecommunication technologies speed some exchange services, but these are largely useless for many foreign partners, particularly in developing countries.

Form letters, preprinted postcards and simple questionnaires should be used whenever possible for situations that occur repeatedly; when necessary, direct personal letters need to be handled as quickly and effectively as possible. Electronic word-processing equipment is an obvious boon to handling correspondence, allowing lists and form letters to be generated, stored, and revised to meet various changing circumstances.

To facilitate foreign exchanges, several examples of forms employ brief, multilingual messages for requests and replies to requests. The standard foreign phrases and exchange terms should be known to exchange workers even if not employed in their own correspondence. Despite all indications that English is a practical expedient sufficient for most exchange correspondence, it is always beneficial to increase language capabilities by formal training; by having the appropriate bilingual dictionaries available; and by having language-skilled persons available for consultation and translation assistance.

Some useful correspondence tips to facilitate exchanges include the following: (1) enclosing complimentary samples and lists of publications when proposing new exchanges; (2) providing return address labels and clearly indicating a return address for continuing correspondence; and (3) always identifying letters by date and appropriate reference numbers. Acknowledgments (sometimes required) and informal notes also contribute to maintaining good relations.

Addresses

Knowing where to send a new exchange request is not always immediately evident, but potential sources can usually be identified through bibliographic references. Since organizational resources and structures vary, only practice will best determine whether a particular exchange should be conducted directly with the publication source or mediated through a library.

Most large libraries have the basic directories that will be most useful for finding addresses, and an enterprising reference or exchange staff will keep several special sources of contacts on hand. For starters, the annual "Directory of Geoscience Departments," published by American Geological Institute, provides convenient access to Canadian as well as U.S. academic sources, and an annual list in *Geotimes* (October issue) includes many foreign professional societies. The *Worldwide Directory of National Earth-Science Agencies and Related International Organizations*, updated irregularly by the USGS, provides a convenient list of governmental sources. In addition to standard reference works such as *World Guide to Scientific Associations and Learned Societies* or *World of Learning*, a selection of specialized directories, organizational membership lists, and indexes of international meetings and conferences is essential to a far-reaching exchange program. (A working list of reference sources for locating potential exchange addresses is appended.)

Record-keeping

Exchanges entail various requirements for record-keeping:

> Records of publications sent to exchange partners...payment records, partners' mailing addresses, receipt records, and balance sheets or their equivalent...requests for new...titles, claims, replacement requests, and cancellation requests to and from partners must be recorded and acted upon" (Jones and McKinley, 1985, p. 52).

Garg and Ojha (1988) report on a manual system for managing exchanges. Jones and McKinley (1985) describe a more sophisticated program that has attempted to automate its control of exchange serials. In their situation, a systematic review of the serial titles being received was necessary to compensate for the loss of a staff member in the labor-intensive exchange operation: "An objective and disciplined evaluation of each exchange agreement is an economic necessity and can best be achieved through the dispassionate manipulation of elements of machine-readable records." (Jones and McKinley, 1985, p. 58). Another value of the system described was the production of an "imbalance alert," (Jones and McKinley, 1985, p. 57), but staff time was still required to review the computer-produced exchange balance sheets, and presumably to consider monographs received that were not recorded by the system.

The most significant requirement of record-keeping concerns the maintenance of equitable balances in exchanges based on some measurable factor. Exchanges of comparable serials (for example, one journal title for another, newsletter for newsletter, yearbook for annual report, and so on) and piece-for-piece exchanges are the simplest and most easily justified.

Requirement for a strictly monetary balance in exchanges not only adds to the burden of record-keeping, but also is counterproductive to exchanges dealing with noncommercial materials and "gray" literature, and in dealing with foreign publications for which prices are not easily determined, or for which the exchange price is not an accurate measure of value. Exchange partnerships rarely balance quite equally; it is more productive to stress the development of continuing working relationships, which over time bestow benefits to both partners.

PROSPECTS FOR THE FUTURE

Prospects for the continuing viability of exchanges for acquiring publications are promising, although by no means universally assured. By their nature, exchanges are informal and flexible adaptations of self-interest; over an extended period, they will usually need various degrees of adjustment by one partner or another. Continuing economic and political changes in international affairs are inevitable, and avenues for informal, nonmonetary exchanges should always be left open, if not expanded.

Information technologies have proven to be useful expedients to information-sharing among domestic libraries. They can greatly enhance the operation of exchanges, but for many foreign countries these technologies will remain impractical for a long time.

Besides serving our need for greater understanding of international geoscience, exchanges exemplify the concepts of multiple use and resource-sharing. These are becoming increasingly important for ecological and economic considerations of sustainable development.

CONCLUSION

Some types of publications that are not available through commercial sources may be obtained through exchanges. During bad economic times, when shrinking budgets restrict purchases, the possibilities of alternative acquisitions strategies become even more attractive.

Publications exchanges can provide a significant avenue for informational flow in almost any institutional environment. Exchanges are especially useful in overcoming barriers in foreign literature acquisition. However, they are not a panacea: not all materials can be obtained through exchange and exchanges are not "free."

A wisely managed exchange program that matches the needs and resources of each partner can play a useful role in facilitating the international transfer of information. Librarians are encouraged to meet the challenges of tomorrow by starting exchanges today.

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Jones, Herbert, and McKinley, Margaret, 1985, Automated exchanges control; an interim report, *in* Stine, Diane, ed., Projects and procedures for serials administration: New York, Pierian Press, p. 51–59.

Kavacic, Mark, 1982, Acquisition by gift and exchange, *in* Samore, Theodore, ed., Acquisition of foreign materials for U.S. libraries: Metuchen, New Jersey, Scarecrow Press.

Lane, A. H., 1980, Gifts and exchange manual: Westport, Connecticut, Greenwood Press, 121 p.

McKinley, Margaret, 1986, The Exchange Program at UCLA; 1932 through 1986: Serials Review, v. 12, no. 1, p. 75–80.

National Research Council. Committee on Global and International Geology, 1987, International role of U.S. geoscience: Washington, D.C., National Academy Press, 95 p.

North, G. W., and Faries, N. B., 1987, International information activities of the U.S. Geological Survey: Reference Librarian, no. 17, p. 93–105.

Price, M. F., 1990, Humankind in the biosphere; the evolution of international interdisciplinary research: Global Environmental Research, v. 1, no. 1, p. 3–13.

Silver, C. S., and DeFries, R. S., 1990, One earth, one future; our changing global environment: Washington, D.C., National Academy Press, 196 p.

Taylor, G. C., 1976, Historical review of the international water-resources program of the U.S. Geological Survey, 1940–70: USGS Professional Paper 911, 146 p.

U.S. Geological Survey, 1883, Annual report, 3 (1881–82), 564 p.

________ 1885, Annual report, 6 (1884–1885), 570 p.

________ 1888, Annual report, 7 (1885–1886), 656 p.

________ 1889, Annual report, 8 (1886–1887), 474 p.

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Zilper, Nadia, 1985, Assessment of contemporary research materials exchanges between American and Soviet libraries, *in* Choldin, M. T., ed., Books, libraries and information in Slavic and East European studies: Proceedings, 2nd International Conference on Slavic Librarians and Information Specialists: New York, Russica Publishers, p. 485–505.

APPENDIX. Selected reference titles for locating geoscience organizations outside the United States.

General Sources

Directory of European professional & learned societies. (4th ed., 1989). CBD Research Ltd., Beckenham, England.

Directory of United Nations databases and information services. (4th ed., 1990). United Nations, New York.

Directory of world museums. (2d ed., 1981). Facts on File, New York.

Encyclopedia of associations: international organizations. (25th ed., 1991). Gale Research Inc., Detroit, Michigan.

Europa world year book. (31st ed., 1990). Europa Publications, Ltd., London, England.

International research centers directory. (5th ed., 1991). Gale Research, Inc., Detroit, Michigan.

World guide to special libraries. (2d ed., 1990). K. G. Saur/ R. R. Bowker Co., New York.

World guide to scientific associations and learned societies. (5th ed., 1990). K. G. Saur/R. R. Bowker, New York.

World of learning. (41st ed., 1991). Europa Publications, Ltd., London, England.

Yearbook of international organizations. (27th ed., 1990). K. G. Saur, Munchen et al.

Special Sources

Directory of engineering societies and related organizations. (13th ed., 1989). American Association of Engineering Societies, Washington, D.C.

Directory of geoscience departments in universities in developing countries. (3rd ed., 1983). Association of Geoscientists for International Development, Bangkok, Thailand.

Directory of geoscience departments. (29th ed., 1990). American Geological Institute, Alexandria, Virginia.

Directory of geoscience organizations: Geotimes. (October 1990). American Geological Institute, Alexandria, Virginia.

E&MJ international directory of mining. (1989/90 ed.) Engineering and Mining Journal, Maclean Hunter Pub. Co., Chicago, Illinois.

Fossil collections of the world; an international guide. (1st ed., 1989). International Palaeontological Association, Washington, D.C.

Geophysical directory. (1991 ed.). Geophysical Directory, Inc., Houston, Texas.

International Union of Geological Sciences directory. (4th ed., 1990; Supplement, 1991). IUGS Secretariat, Geological Survey of Norway, Trondheim.

World geo guide; consultants, contractors equipment manufacturers. (10th ed., 1981). Byggforetagens Service AB, Stockholm.

Worldwide directory of environmental organizations. (3rd ed., 1989). California Institute of Public Affairs, Claremont, California, in cooperation with Sierra Club and International Union for Conservation of Nature and Natural Resources.

Worldwide directory of national earth-science agencies and related international organizations. (1984 ed.). U.S. Geological Survey/U.S. Government Printing Office, Washington, D.C.

Conferences and Meetings Sources

Directory of published proceedings. Series SEMT: science, engineering, medicine, technology. (monthly). InterDok Corp., Harrison, New York.

MInd; the meetings index. (bimonthly). InterDok Corp., Harrison, New York.

Scientific meetings. (quarterly). Scientific Meetings Publications, San Diego, California.

National Sources

Canada
Canadian almanac & directory. (143rd ed., 1990). Canadian Almanac & Directory Pub. Co., Toronto.

Directory of associations in Canada. (10th ed., 1989). Micromedia Ltd., Toronto.

Scientific and technical societies of Canada. (1986 ed.). National Research Council of Canada, Ottawa.

China
China phone book and business directory. (1988–). China Phone Book Co., Ltd., Hong Kong.

Directory of Chinese libraries. (1982 ed.). China Academic Publishers/CNPIEC, Beijing, dist. by Gale Research Co., Detroit, Michigan.

England
Directory of geo-analytical facilities in British universities, colleges, polytechnics and research institutions. (1990 ed.). Whittles Publishing, Caithness, England.

Geologist's directory. (4th ed., 1988). Institution of Geologists, London.

Japan
Directory of Japanese scientific periodicals. (1988 ed.). National Diet Library, Tokyo.

Switzerland
Geoscience Switzerland. (1989 ed.). EAWAG/ETH, Dubendorf.

SCHEMES FOR REDISTRIBUTING GEOLOGICAL LITERATURE

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Abstract—Unwanted collections of books, journals, and maps held by individuals and libraries can be given to library users, sold to used-book/journal/map dealers, or placed in domestic or international collections where they are needed. It is, however, often difficult to identify where the materials are needed and how to get them there. Societies, government agencies, publishers, foundations, and individuals have assumed varying responsibilities for identifying donors and recipients of these materials, in addition to providing information about the shipment of unwanted publications. This paper presents an ideal literature redistribution scheme based on a summary of some existing organizations that redistribute publications worldwide.

INTRODUCTION

Human beings like to collect objects. Geoscientists tend to keep the textbooks they used in school, publications of the organizations to which they belong, and publications pertaining to their research. Some scientists seem to collect geoscience books for their inherent or speculative value. A widely held perception is that books published in the late nineteenth and early twentieth centuries have monetary value; a contrary axiom holds that science books published that long ago contain dated information that has no current value. Neither perception is valid; most 50- to 100-yr-old geoscience books have little monetary value. The publication date of geoscience books is much less important than for publications of the other physical sciences. The graphics and verbal descriptions of older geoscience literature are relevant, and the older literature is required for much of the research carried out by geoscientists.

THE PROBLEM

At some point, lack of space hinders future growth and the collector (individual or librarian) must make choices about what to keep and what to eliminate. Collections are also disbanded when the owner dies and the heirs do not want to maintain the collection. What happens to these collections? How do the heirs decide what to do with the materials? This paper is about redistribution of unwanted collections of books, serials, and maps, especially those on the subject of geoscience.

There are many alternatives for dispersal of the collection. Easiest and most direct is to put the material into the trash. This adds to landfills or to incinerator fumes. In addition, it is a loss of information to the knowledge base of the world. There are individuals and libraries who want the literature. An alternative is to box everything and leave the boxes with an unsuspecting library. It is, however, preferable for the donor to call or write the library and briefly describe the subject content and physical condition of the collection. Although this requires much more time from the donor, publications could be listed and the list provided to the library. The list could be used for tax purposes or could be submitted to used-book or periodical dealers, or used-book stores (Schmidt, 1990).

When a library receives donated publications, what does it do with them? In many libraries, all gifts go directly to a Gift Section or Department. Sometimes a branch library will accept the gift. If a gift is accepted, the book may be used as second copy, especially if the physical condition of the Library's copy is inferior to that of the gift. Before any ownership markings are applied, it is important to decide what will be done with the materials because many publicly supported libraries have limitations on what can be done with the materials once they are officially marked.

DISPERSAL OF THE REJECTED PUBLICATIONS

After the collection is evaluated, only a small portion of the publications might be retained. What happens to the remainder of the collection? In the letter of acknowledgment to the donor, the options available to the Library for dispersion of individual items in the collection should be enumerated.

Numerous alternatives exist to creating environmental problems and information loss by trashing unwanted and duplicate materials. Duplicate publications may be sold during regular book sales. Some libraries hold auctions, and others sell the odd piece during the year. I have conducted an annual, regionally advertised book sale for over a decade. These sales have created the base for a Geology Library Endowment Fund that now amounts to more than $30,000. Individuals with varied subject backgrounds and local used-book dealers have purchased modestly priced (but costlier than found at garage sales) publications. In better economic times, publications were sold to other geoscience libraries to fill in gaps or to enhance a subject area.

Within some libraries, matching unwanted publications with a library user who can use them takes the form of a "freebie" table, box, or shelf. Library users are invited to take, at no cost and usually with no questions asked, any publications—reprints, maps, books, journal issues, or government documents—they want.

Distribution outside the local library environment becomes more complicated, as the donor must somehow alert the potential recipient to the availability of the publication, the method of transport, and details about the payment for transport. Sometimes an equal exchange of publications is possible, but more often a library is willing to give another library the publication titles listed in electronic-mail postings, newsletters, and other, usually societal, publications. Outside one's own nation, transportation and payment for transport are more significant obstacles to redistribution. Because some governments do not permit the refunding of postage, the originating library should first write to the recipient library to clarify shipping and payment arrangements. A need by individuals and libraries for literature exists in many parts of the world. Foreign exchange to purchase the literature is meager, if existent.

DEVELOPMENT OF PROGRAMS

In the 18th century, Alexis de Tocqueville wrote of the American obsession with spreading knowledge through education. An educated citizenry was viewed as essential to building a new democratic nation based on citizen participation. Since World War II, a broadly held U. S. perception is that no matter how poor newly formed developing nations are, they should have access to books and other educational materials. Donated-books programs were created and carried on largely by private charitable groups and societal groups. Among the first U.S. groups were Lutheran Braille Workers (1945), Readers' Service of the Presbyterian Church (1947), Direct Relief International (1948), the Darien Book Aid Plan (1949), the Asia Foundation's Books for Asia Project (1954), the Scarsdale Women's Group Operation Bookshelf (1954), the Brother's Brother Foundation (1957), and Project HOPE (1958). William Childs, in *American Donated Books Abroad*, estimates more than 85 million books were distributed by U.S. donated-book groups between the late 1940's and the mid-1980's (Childs, 1989). In addition to charitable and societal groups, individuals, government agencies, foundations, and for-profit organizations have been created (see Table 1).

Matching the donor and recipient seems to be the main problem. Donors do not know who might want their publications, although they may have a particular part of the world in which they would like the publications to be placed. Table 2 lists the primary geographic distribution of many shipments. Potential recipients do not know from whom the publications can be obtained. Both groups may perceive transportation cost to be a limiting factor. Visiting scientists might take a few publications home with them for their library, but usually there are other personal priorities. Efforts between U.S. and Mexican libraries find Customs to be tricky; sometimes a Customs broker is used to facilitate the border crossing. Robert Seal, University Librarian at The University of Texas at

Table 1. Type of redistributing organization.

For-Profit
BookQuest™/Serials Quest™
Universal Serials and Book Exchange (USBE)

Non-Profit
Brother to Brother International, Inc.

Individual
F. L. Klinger

Societal
Sub-Saharan Africa Foundation Journal Distribution Program
Association of Geoscientists for International Development
ALA Duplicates Exchange Union
ACS Project Bookshare
SLA Sci-Tech Division Duplicates Exchange Program
SEPM-Developing Country Libraries Program

Foundation
Brother's Brother
Books for Asia (Asia Foundation)
Foundation for Books to China

Governmental
Canadian Book Exchange Center
Center for Interamerican Mineral Resources Investigations
Library of Congress Gifts and Exchange Division
Smithsonian International Exchange Service

Table 2. Primary geographic distribution of shipments (an organization may have multiple targets).

Africa
American Association for the Advancement of Science (Sub-Saharan) (AAAS)
Canadian Organization for Development through Education (CODE)
Sudan-American Foundation for Education, Inc. (Sudan)

Asia
Books for Asia
Foundation for Books to China

Canada
Canadian Book Exchange Center

Table 2. cont.

Latin America
Center for Interamerican Mineral Resources Investigations-USGS
Multiple Areas
Association of Geoscientists for International Development (AGID)
Brother to Brother International, Inc.
Brother's Brother
Canadian Book Exchange Center (secondary)
Canadian Organization for Development through Education (CODE) (mostly Africa, Caribbean, and Pacific)
Darien Book Aid Plan, Inc.
International Book Bank, Inc. (currently stressing Eastern Europe) (IBB)
Society of Sedimentary Geologists (SEPM)
Smithsonian International Exchange Service (SIES)
Universal Serials and Book Exchange (USBE)
U.S.A.
Duplicates Exchange Union (ALA)
Duplicates Exchange Program (SLA Sci-Tech Division)
F. L. Klinger
Library of Congress

El Paso, stated that Mexican libraries sometimes find it difficult to locate a vehicle large enough to make the trip across the border to pick up publications worthwhile.

CATEGORIES OF REDISTRIBUTION PROGRAMS

In an effort to identify redistribution programs, a library literature review was conducted, and Geoscience Information Society (GIS) colleagues were contacted. Letters to the redistributing organizations were followed up by telephone calls, more correspondence, and the receipt of pamphlets, annual reports, and other documentation.

As a result, several categories of donors and groups formed to assist would-be donors can be identified. An individual or group's goal may be to (1) match the donor and the recipient, (2) aid in the distribution of the material after the donor and the recipient have been identified, (3) collect and make available for selection a broad collection of material at identified sites in specific nations, (4) publish the addresses of those who want materials on diverse subjects and those materials available for redistribution, (5) distribute lists of available publications on a regular schedule, or (6) combine several of the above functions. Examples of organizations from each of the above categories are listed below.

(1) Match the donor and the recipient
- Book Quest™/Serials Quest™ (Owings Mills, MD)
- Brother to Brother International, Inc. (Tempe, AZ)
- Brother's Brother Foundation (Pittsburgh, PA)
- Darien Book Aid Plan, Inc. (Darien, CT)
- International Book Bank, Inc. (Baltimore, MD)
- F. L. Klinger (Bethesda, MD)

(2) Aid in the distribution of materials after the donor and the recipient have been identified
- Smithsonian International Exchange Service (Washington, D.C.)

(3) Collect and make available for selection a broad collection of material at identified sites in specific nations

Books for Asia (San Francisco, CA)
Center for Mineral Resources Investigations (Tucson, AZ)
International Book Bank, Inc. (Baltimore, MD)
Library of Congress (Washington, D.C.)
Sudan-American Foundation for Education, Inc. (Arlington, VA)
USIA (Washington, D.C.)

(4) Publish the addresses with broad subject materials wanted and those available for redistribution
Canadian Book Exchange Center (Ottawa, Ont.)

(5) Distribute lists of available publications on a regular schedule
Association of Geoscientists for International Development (Toronto, Ont.)
Canadian Book Exchange Center (Ottawa, Ont.)
Canadian Organization for Development through Education (Ottawa, Ont.)

(6) Combine several of the above functions
American Association for the Advancement of Science (1&2), (Washington, D.C.)
Duplicates Exchange Union (ALA) (4&5) (Statesboro, GA)
Society of Sedimentary Geology (1&2) (Bloomington, IN)
SLA Sci-Tech Division Duplicates Exchange Program (4&5) (Pittsburgh, PA)
Sudan-American Foundation for Education, Inc. (Arlington, VA)

REDISTRIBUTION PROGRAMS

Association for the Advancement of Science (AAAS) Sub-Saharan Africa Journal Distribution Program

1333 H St. NW
Washington, D.C. 20005, U.S.A.
Phone: (202) 326-6650
Principal Officer: Lisbeth Levey
FAX: (202) 371-9526

Founded in 1985, this agency provides more than 250 subscriptions of scholarly journals to approximately 200 universities and research libraries in 38 Sub-Saharan Africa countries. Its efforts are funded by the Carnegie Corporation of New York, the Ford Foundation, and the U.S. Agency for International Development (USAID). Shipping is assisted by the U.S. Information Agency (USIA) and the United Nations Centre for Science and Technology for Development (UNCSTD). The Sub-Saharan institutions supply a "needs inventory" that is supplemented by advice from donor societies and experts on research conditions in the African institutions. Most journals are published by AAAS-affiliated societies and are made available at little or no cost. Recently the program expanded to include scholarly journals in the social sciences and the humanities via active cooperation from the American Council of Learned Societies (ACLS).

American Library Association Duplicates Exchange Union

American Library Association
Duplicates Exchange Union
50 East Huron St.
Chicago, IL 60611, U.S.A.
Phone: (912) 681-5114
Contact Person: Jane Johnson
Georgia State College Library
Landrum Box 8074
Statesboro, GA 30460-8074, U.S.A.
FAX: (912) 681-5034

Founded in 1940 as the Periodicals Exchange Union, the organization was renamed the Duplicates Exchange Union in 1944. Operating under the auspices of the Association for Library Collections and Technical Services of the American Libraries Association (ALA), this group, primarily composed of small college and public libraries, tries to find a place for duplicate or unwanted materials.

Membership is free and there is no charge per transaction. Repayment of postage in excess of $1 is requested. To continue membership, members are required to issue at least one list per year of items, grouped by format, that are free and in usable condition. A date beyond which the materials will not be available should be included on the list. Each page should include the address and the date. Lists of wanted and priced items should not be sent to member libraries. Upon receipt of the DEU exchange list, members can request items by circling the item wanted and returning it, along with mailing labels, to the originating library. No phone calls are permitted, but written requests may be sent. Requests are filled in order of receipt.

Association of Geoscientists for International Development (AGID)

Book/Journal Donation Service
910 Avenue Rd.
Toronto, Ont. M5P 2K6, Canada
Phone: (416) 481-4731

Project Leader: Owen White

For the past 15 years, the AGID Book/Journal Service has been recycling geoscience literature to nearly 30 developing countries. Shipping is provided by AGID, the Canadian Organization for Development through Education (CODE), and the Third World Academy of Sciences (Trieste, Italy). Former GIS member Tony Berger played a significant role in the growth and development of the Service. Donations are sought through advertisements in *AGID News* and notices in various Canadian publications. Specialists in the discipline then evaluate the usefulness of the offered donations. The group's selection policy emphasizes current textbooks of a nonlocal nature. Journals are becoming an important part of the distributed publications. Donors ship materials at their own expense to the storage depot at CODE, which packages and sends the publications to the recipient. (All correspondence should be directed to the above AGID address.) At least once a year, a list of available titles is compiled and airmailed to Third World institutions that have requested the lists. Availability of the lists is noted in *AGID News*. After the deadline for return of the lists has passed, the available material is allocated to the requesting libraries. If the recipient can pay shipping costs, AGID requests payment. (CODE requires repayment for their services.) Payment is sent 25% of the time.

BookQuest™/SerialsQuest™

c/o ABACIS Inc. (a Faxon company)
135 Village Queen Dr.
Owings Mills, MD 21117, U.S.A.
Phone: (800) 627-2216
or (301) 581-0394

Contact Person: Roz Garrett

FAX: (301) 581-0398

This for-profit company maintains an online database that can be searched to locate publications that are available for sale or surplus. Annual subscribers to the online database are libraries, rare, out-of-print and used-book dealers, and domestic and international serial vendors who are seeking publications or trying to get rid of publications. Computer searching of lists of books and/or journals wanted by subscribers is performed nightly. Dial-up searching is available via an IBM-compatible computer or a Macintosh. Fees are assessed for online connect time, listing fee, and other ordered services.

Books for Asia

451 Sixth St.
San Francisco, CA 94103, U.S.A.
Phone: (415) 982-4640

Director: Matthew G. King

This program is a project of the Asia Foundation, a private U.S. grant-giving organization. It receives public and private funding, including an annual appropriation from the U.S. Congress, USAID, and contributions from corporations, foundations, and individuals. Books and journals are sent to San Francisco at the donor's expense. The Foundation repackages these materials and distributes publications to 15 Asia Foundation field offices. Unless they are classics of literature and history, books that are less than 10 years old and that are in good condition are reshipped. Scientific and professional journals are welcome, provided that they are in a continuous run dating to the present or previous year. Of all materials, 70% are textbooks donated by educational publishers in all fields. When the materials arrive in the Asia Foundation field office, they are displayed for educators, librarians, and research personnel who can select the publications they want. If recipients are unable to select materials in person, they can arrange for a collection to be prepared by Asia Foundation staff and shipped to the requesting institution.

Brother to Brother International, Inc.

19 W. Alameda Dr. #102
P.O. Box 27634
Tempe, AZ 85285-7634, U.S.A.
Phone: (800) 642-1616
or (602) 967-7871

Program Manager: Diana French
FAX: (602) 966-5018

Six paid employees and approximately 60 volunteers staff this nonprofit, nondenominational organization. Their goal is to place food, medical supplies, and other materials that would otherwise be discarded by matching charities (recipients) with private business (donors) worldwide. It acts as a clearinghouse to match institutions having printed materials to donate with those who need the publications. Computerized recordkeeping is utilized. Shipment of materials is arranged between the donor and the recipient.

Brother's Brother Foundation

824 Grandview Ave.
Pittsburgh, PA 15211, U.S.A.
Phone: (412) 431-1600

Officers: Luke Hingson, Executive Director
Greg Kearns, Book Program Director
FAX: (412) 431-9116

Founded in 1958, this organization emphasizes distribution of domestic and international health and educational resources to the needy. It provides health care, books, farm tools, vegetable seeds, medical supplies, and other contributed materials both in the U.S. and abroad. As a non-profit, tax-exempt, charitable foundation, it solicits products from producers. Encyclopedias, general and technical reference materials, medical books, and books (excluding textbooks) for elementary and secondary school children are solicited from publishers and schools. Past recipients of container shipments have been groups in Africa, the Caribbean, the People's Republic of China, Poland, and the Philippines and charitable projects in the United States. Requesting libraries send guidelines of categories of materials desired and the age of the students to the Foundation. The Foundation then matches what is available with what is wanted. Shipping costs are arranged between the donor and the recipient.

Canadian Book Exchange Center

85 Bentley Ave.
Nepean, Ont., KlA 0N4, Canada
Phone: (613) 952-8904

Contact Person: Pierre Gamache

FAX: (613) 954-9891

Under the terms of Canada's National Library Act, all Canadian federal government libraries are obligated to send their surplus publications to the Canadian Book Exchange Center operated by 10 employees of the National Library. The Exchange compiles lists of (1) periodicals, (2) monographs, excluding fiction, (3) Canadian publications, and (4) foreign publications. These lists are distributed 10 times per year. Membership is free. Federal libraries are given selection priority for all genres except fiction. Donors and recipients pay their own shipping charges. Publications not selected by Canadian libraries can be sent elsewhere by special permission from Part IIC of the National Library Directive. The Canadian Book Exchange Center records, by Dewey Decimal classification numbers, the frequency of distribution by journal and monograph title.

Canadian Organization for Development through Education (CODE)

321 Chapel Street
Ottawa, Ont., KlN 7Z2, Canada
Phone: (800) 268-1121

Contact Person: Scott Walter

FAX: (613) 232-7435

Begun by a group of Toronto teachers in 1959, this program is primarily staffed and funded by volunteers. Historically, its international recognition has been in literacy and human-resource development. Current emphasis is shifting to the support of autonomous publishing through the provision of funding, equipment, paper, and other supplies. Books donated by publishers or "gently used" books are accepted for distribution. CODE seeks books for all levels of education, general reading, adult education, technical/vocational, and medical texts. In the past, lists of available publications have been distributed to schools and libraries in Africa, the Caribbean, and the Pacific. The Canadian International Development Agency often supplies matching funds.

Center for Interamerican Mineral Resources Investigations

210 E. 7th St.
Tucson, AZ 85705, U.S.A.
Phone: (602) 670-5510

Contact Person: Norman J Page

FAX: (602) 670-5113

This Center, a part of the U.S. Geological Survey, investigates the mineral resources of Latin America. Working in Latin America with Latin American geoscientists and in their libraries, USGS geoscientists identify literature that would make the Latin American libraries more complete. As a result, this Tucson office accepts most geoscience literature for dispersal to the libraries. The Center has limited storage, so the literature stays in Tucson a short time. Distribution costs to Latin America are paid from the Center's budget.

Darien Book Aid Plan, Inc.

1926 Post Rd.
Darien, CT 06820, U.S.A.
Phone: (203) 655-2777

Contact Person: Patricia Brown

This local, nonprofit volunteer organization founded in 1949 has as its goal the building of a foundation of peace, understanding, and friendship by the free distribution of books. The organization has sent recently published books in good condition, for every age, to 167 nations. Requests on official stationery or with the organization's seal from libraries, schools, universities, Peace Corps volunteers, and government and service agencies have been honored. The donor is responsible for shipment to the Connecticut center, which sends on the materials after repackaging to meet the needs of the recipient.

International Book Bank, Inc. (IBB)

608-L Folcroft St.
Baltimore, MD 21224, U.S.A.
Phone (301) 633-2929
or (800)-US-GRANT

Contact Person: John Enns, President
Rosamaria Durand, Executive Director

FAX : (301) 633-3082

This nonprofit private, voluntary organization, created in 1987, solicits books from publishers and other sources to make new or barely used material available to readers in developing nations. It acts as a clearinghouse to procure, sort, screen, warehouse, and ship educational materials. A computerized inventory allows schools, libraries, and other organizations to select what they want from materials that have been screened for condition and content. Current emphasis is on providing materials to Eastern Europe, especially books that stress democratic values, market-oriented economics, American civilization, and history. Scholarly journals are sometimes shipped if they form part of a specialized collection or if specifically requested by a recipient. The Bank works closely with USIA, the Peace Corps, UNESCO, CODE, USAID, and the National Association of College Stores (NACS) for procurement and distribution worldwide.

F. L. Klinger

5013 Alta Vista Ct.
Bethesda, MD 20814, U.S.A.
Phone: (301) 530-1985

Operating out of his home, Fred Klinger is a matchmaker. He accepts lists of unwanted geoscience duplicates and items desired from libraries and individuals. When he finds a match, he provides the requesting library with the name and address of the donor. The donor specifies if postage is required. Occasionally Mr. Klinger sends out lists of duplicates to groups with which he has placed materials.

Library of Congress: Gifts and Exchange Division

Room B03 — Chief: Judy McDermott
Madison Memorial Bldg.
Washington, D.C. 20540, U.S.A.
Phone: (202) 707-9511 or (202) 707-9512

The Library of Congress declares as surplus much of the transferred materials it receives from federal agencies. No lists of the surplus materials are prepared, nor are the materials arranged in any order. A representative from any eligible organization ("educational institutions," "public bodies" [agencies of local, state or national governments], and "nonprofit tax-exempt organizations") having a letter of introduction can come to the James Madison Memorial Building of the Library of Congress during the hours of service and make selections. Contents and size of the available material are always changing. The selector is responsible for shipment of the materials to her/his institution.

SEPM - "Developing Countries' Libraries Committee"

Department of Geological Sciences — Contact Person: Abhijit Basu
Indiana University
Bloomington, IN 47405, U.S.A.
Phone: (812) 855-6654

The Society of Sedimentary Geology (SEPM) provides subscriptions of its journals to those libraries whose requests have been approved by the SEPM "Developing Countries' Libraries Committee." Those libraries are then contacted and their needs are identified. The "needs list" is currently being computerized for quick retrieval and updating. The Society absorbs the cost of their journals, and distribution occurs directly from the journal's printer. SEPM advises their members via the *SEPM Newsletter* of developing world libraries that are in need of books and the categories of books they prefer. It will also provide instructions on how SEPM will assist with shipping costs of surplus material to the Smithsonian International Exchange Service (SIES), which will then forward the books to their international destination.

Smithsonian International Exchange Service (SIES)

1111 North Capitol St. NE — Contact Person: Thomas J. Matthews
Washington, D.C. 20560, U.S.A.
Phone: (202) 357-1964 or (202) 357-2073

As a part of the broad function of the Smithsonian Institution to "increase the diffusion of knowledge among men" the exchange service began to exchange publications in 1849. Two years later, it offered to other groups the opportunity to use the service for the international exchange of publications. Materials sent to SIES are not donations to the Smithsonian and, therefore, there is no documentation for tax purposes. Individuals must donate their publications to an institution, which can then donate to the Smithsonian. Using congressional appropriations to the Institution, SIES provides for the shipping of publications to identified libraries. SIES does not maintain a list of recipient libraries. The donating group must identify the library and the library's need, package the material to very specific requirements, and then transport the materials to SIES. Approval of shipment to the Smithsonian is required. Caution: before using this service be sure to obtain, carefully read, and explicitly follow the instruction sheet entitled "Regulations Regarding Weight and Preparation of Packages for Overseas Mailing."

Special Libraries Association Sci-Tech Division, Duplicates Exchange Program

c/o Software Engineering Institute
4500 5th Ave.
Pittsburgh, PA 15213, U.S.A.
Phone: (412) 268-7725

Contact Person: Karola M. Fuchs

FAX: (412) 268-5758

Becoming active in 1989, this program offers SLA members an opportunity to dispose of surplus publications. Approximately 50 members select books, a single issue, or a backrun of journals, and other formats of sci-tech literature from duplicate lists. Members are required to send a typewritten list of their offerings at least once a year to the other members and the Chair of the Program. The list should include the name of the contact person and should be in alphabetical order by title within each type of publication (i.e., periodicals A-Z, conference proceedings A-Z, etc.). Requesting libraries should correspond directly with the contact person, indicate the publications wanted, and supply mailing labels. The offering libraries send the publications to the requesting libraries on a first-come, first-served basis. Notifications of the lack of availability of wanted publications need not be sent. Offering libraries pay the transportation costs, and the receiving library refunds costs in excess of $2 with a check or postage stamps.

Sudan-American Foundation for Education, Inc.

c/o Guy Detrick
201 Davis Dr., Unit Z
Sterling, VA 22170, U.S.A.
Phone: (703) 525-9045

Principal Officers: John T. Rigby, President
Lee Burchinal, Executive Director

CD-ROMs and their players, glassware, teaching aids, books, and journal runs of the past 10 years are among the kinds of donations of goods and services that this volunteer organization wants for distribution to 25 Sudanese universities. When the materials in all college-level subject areas are received in Virginia, they are repackaged into wooden crates. Oceanic transport, provided by USAID, USIA, and SIES, takes the needed material to a Sudanese port city and on to the local college that coordinates the activities. Book displays are set up, and university representatives are sent to choose the titles they want. A fee per title, in Sudanese pounds, helps pay for the shipping from the coordinating university to the selecting university.

Universal Serials and Book Exchange (USBE)

2969 West 25th Street
Cleveland, OH 44113-5399, U.S.A.
Phone: (216) 241-6960

Contact Person: John or Marilyn Zubal

FAX (216) 241-6966

In February 1990, USBE reopened in Cleveland, Ohio, in the Zubal facility and under the family management that has long been involved with procurement and sale of journals. Libraries can become annual members for $150. A catalog of more than 15,000 journal titles (with no designation of available volumes or issues) is distributed several times per year. Purchase of a single numbered issue is $7 (plus shipping) with a volume costing a minimum of $28. USBE welcomes the donation of unwanted titles. Journals and books not sold to members are available for donation to libraries in developing nations. Such nonmember libraries may send representatives to USBE to select what they need. USBE prepares the materials for shipping, but the recipient must provide transportation.

SUMMARY

This is not a complete list of groups interested in redistributing literature; these 20 organizations were selected from a wide variety of programs. Other organizations exist that distribute books to specific parts of the world, usually organized by people studying, or with ancestry in, that part of the world. Table 2 lists organizations by geographic area of targeted recipients. This paper has concentrated on those organizations interested in geoscience literature. Some of the largest geoscience organizations (the American Association of Petroleum Geologists, the American Geological Institute, the American Geophysical Union, and the Geological Society of America) have no redistrbution programs. Each group does contribute subscriptions to AAAS for their distribution program to Sub-Saharan Africa. These groups also suggest organizations wanting and redistributing publications.

In related disciplines, the American Chemical Society's (ACS) Office of International Activities collects and distributes recent chemistry books and journals through Project Bookshare. The American Physical Society's International Physics Group and the International Centre for Theoretical Physics have similar goals in physics literature. Most subject disciplines have comparable programs.

With the availability of donation programs, surplus geological literature should not be trashed; instead it should be recycled to a library that needs it. Many librarians, especially in developing nations, have limited or no budgets for purchasing geoscience books, journals, and maps, whereas collections of these materials go begging for appropriate homes. A need exists for a group to put together the best attributes of the groups described above in order to accomplish the redistribution of geoscience literature.

On the basis of what I have learned, I conclude that the ideal scheme would include

- donors who are
  - individuals willing to donate runs of journals and books in good condition,
  - professional organizations willing to donate continued subscriptions,
  - book publishers willing to donate current books, or
  - librarians willing to take the time to identify a need and to respond to it.

Donors would enclose in the shipment a self-addressed card listing the contents to be returned to the sender.

Domestic organization would use a clearinghouse model, which would

- have a full-time, enthusiastic, efficient staff
- have the availability of FAX and computers having large memories
- have large telephone and postage budgets
- publicize broadly
- have access to private and government agencies to assist with shipping costs, when necessary
- use the BookQuest™/Serials Quest™ model that would offer free software packages to create the "wanted" or "for trade" titles
- have overnight searching of the data base for "wanted" titles
- offer searching by author, title, keyword, publisher, place of publisher, series, ISSN or ISBN, date published, edition, sources, status (for sale, wanted or trade), and subject area
- have inexpensive dial-up access for online searching.

For international distribution of material, the donor organization would

- be similar to domestic clearinghouses in terms of staff and capabilities
- be located near a seaport and have a warehouse for economies of scale in international shipping
- be multilingual
- have familiarity with or access to information about shipping regulations of many nations
- have access to private and government agencies to assist with shipping costs.

Ideal recipients are those who

- are willing to accept older materials marked

"withdrawn," etc., when appropriate for the subject
are willing to share the shipping cost, if possible
will maintain adequate security to insure that the materials stay in the library
provide expeditious processing for access to the books.

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Levey, Lisbeth, AAAS, April 17, 1991
Matthews, Thomas, SIES, April 16, 1991
McDermott, Judy, Library of Congress, May 15, 1991
Seal, Robert, The University of Texas at El Paso, September 26, 1991
Shanks, Kathy, AAPG, April 16, 1991
Spilhaus, A. F., Jr., AGU, April 21, 1991
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INTERNATIONAL DATA EXCHANGES THROUGH THE WORLD DATA CENTERS: SOME NEW EXPERIMENTS IN DATA MANAGEMENT

Stanley Ruttenberg

University Corporation for Atmospheric Research
P. O. Box 3000
Boulder, Colorado 80307

Abstract—Geophysics, as a global science, depends on data not only from many places but also over long time periods. These data are needed to describe fully the various processes that interact over a broad spectrum of space and time and between disciplines. Exchange of observations, as well as of derived information, is crucial for monitoring and explicating geophysical processes. Data exchange has long been a part of geophysical development, evolving to its present state through a series of increasing challenges. The notion of what constitutes "useful" data has evolved, for example, from inscriptions on clay tablets, to handwritten numbers or descriptions kept in a few major libraries, to published reports and books containing data, to data now available, or "published," on computer-readable media. Scientifically, we are now in a period of exploration of the complex interactions between the geosphere and the biosphere, including the role of human activities, to understand Earth's complex system, which is always changing. Newer approaches are therefore needed for data collection, for data processing to derive information from the numbers, for archiving with needed descriptive information on how the data were taken, and for distributing data to users. These activities collectively are called "data management," which is now becoming part of the funded scientific research instead of being treated as an afterthought. Data management is what is required so that we may realize full return from the enormous investments now being made in data-collection systems.

A SHORT HISTORY OF DATA EXCHANGE

In earlier centuries, scientists studying the earth made many useful observations, but these had limited possibilities for wide distribution in the ages before publication and easy communication. The great libraries, Alexandria, for example, contained much important hand-copied material, and scholars visited these information repositories to study the works of others. In succeeding centuries, development of publication technology led to easier distribution of data and information, and hence promoted wider application of knowledge.

In the 1950s, the International Geophysical Year (IGY) enterprise resulted, by design, in the largest collection of related geophysical data ever taken over the globe. The IGY included detailed specifications of which data were to be collected and shared internationally. The IGY data challenge was to ensure that the IGY data would be archived safely so that future generations could use them; publication of the observations in station or campaign books was not considered satisfactory in an age of rapid technological development just prior to the age of modern computers. This challenge was met by a proposal to establish World Data Centers to receive and archive these data. The IGY World Data Centers were established in the USA (WDC-A) and in the USSR (WDC-B), and smaller discipline-oriented centers were established in Europe, Japan, and Australia (WDC-C). They operated under guiding principles developed by the IGY Special Committee of the International Council of Scientific Unions (ICSU). The IGY Centers were primarily data libraries to which IGY data were entrusted for safekeeping and copying for users. They were, and still are, organized and funded by national agencies. ICSU, its scientific bodies, and its Panel on World Data Centres play a general supervisory role.

The IGY data experience was seminal to establishing new concepts of data management. First, after IGY was over, it was decided that the World Data Centers should continue, with the concurrence of the national supporting agencies. Second, it was decided that the ICSU Guides to Data Exchange would continue to be useful to ensure a continuing availability of geoscience data to monitor episodic events such as earthquakes, and to monitor changing geophysical characteristics such as atmospheric and oceanic circulation, solar activity, and the earth's magnetic field. Third, it was decided that any new ICSU international data-gathering programs in geophysics should contain data management plans, which specified the types and formats of data to be made available internationally through the World Data Centers, and that the WDC System should continue to support the international data exchange of these programs.

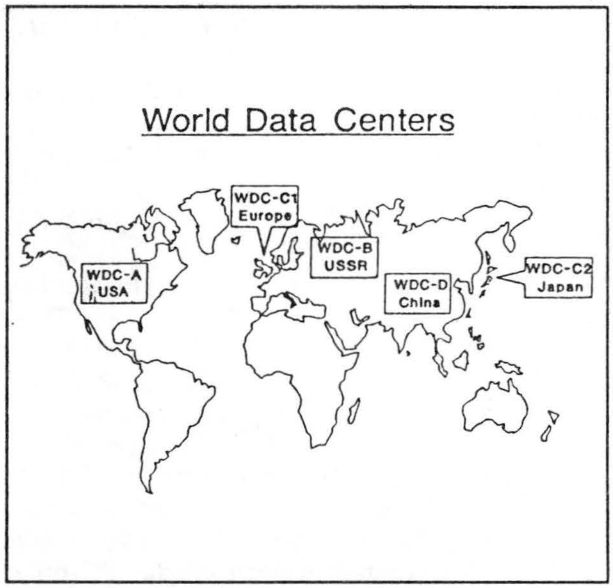

Figure 1. Geographical distribution of the ICSU World Data Center System.

THE PRESENT WDC SYSTEM

The World Data Center System has proven to be a flexible one, operated by national agencies but coordinated informally and loosely by international bodies. It has grown to about 40 discipline centers in some 11 countries. It continues to be responsive to new programs and new needs.

Geographical Distribution

In the several decades since IGY, the WDC system has evolved. A few data centers closed their operations, transferring their data holdings to related centers. A few new discipline centers have been added in Europe, such as a Center for Recent Crustal Movements, in response to a new ICSU program, and recently a Center for Soil Geography and Classification in The Netherlands, in response to the International Geosphere-Biosphere Programme, a Study of Global Change. A new complex center, consisting of centers covering most of the disciplines, has been established in China (WDC-D). Figure 1 shows schematically the locations of the WDC System components. The World Data Center System, its components, and its guiding principles are described in publications of the WDC Panel, as listed in the bibliography (ICSU, 1987, 1989).

It is of interest to note for this organization that WDC -D includes a WDC for Geology. The International Union of Geological Sciences and its Committee on Geological Data (COGEODATA) have been invited to advise the WDC Panel on any requirements or desiderata for international exchange of geological data. Some of the World Data Centers for Solid Earth Geophysics are taking part in such programs as the Circum-Pacific and Circum-Atlantic programs, which have strong geological components, but strictly geological data have not been identified for additional archiving or exchange. Of course, these days the dividing line between geology and geophysics is getting harder and harder to identify and describe, as both sciences continue to mature and evolve together.

New Data Activities

Collection of numbers and descriptions, as raw data, is only a small part of what we call modern data management. Scientists need not only these raw data but also conversions to scientific variables, in the case of remotely sensed observations, as well as extractions from high-bit-rate satellite-observing systems of real scientific information. Moreover, even from these converted data, higher-order information products are needed, such as global or regional gridded fields or additional variables calculated from the primary variables. These challenges are being met by the WDCs becoming more closely related to scientific programs and to scientists who supply and use data. For example, the WDCs work with users to meet such needs as collation of related data, compilation of multidisciplinary or multithematic data sets, and extraction from primary data of several kinds of information products, such as indices of solar and geomagnetic activity. The WDCs also collaborate with working scientists everywhere on such matters as quality assessment and appropriate documentation of data sets so that any researcher can use the data with confidence.

Better Modes of Data Exchange and Accessibility

Our era is often called the "Information Age." Scientists, educators, and government decision makers want modern and reliable data that characterize the planet. Although publication on hard copy (paper, microfilm, microfiche, and so on) is the only long-term archival storage medium recognized by the U.S. Library of Congress, numbers in books are not very useful in the computer-based information age. Today the wide use of powerful computers has essentially made printed numbers obsolete; scientists need numbers in digital form on computer-readable media. Scanning printed tables is possible, in principle, but scanning is expensive and not 100% reliable in practice.

Since desktop personal computers are now widely used in addition to mainframes for large number-crunching, a recent emphasis is on electronic media for these computers, which normally do not have tape drives as input. Thus, WDCs now are putting smaller data sets on diskettes (1.4 to 2.8 megabytes, unpacked; up to twice that amount using packing algorithms), and a variety of optical disks, such as those being discussed and demonstrated at these sessions. These inexpensive data carriers hold 670 megabytes, unpacked. They are so handy and inexpensive that they are becoming the general medium of choice, even though we would like a few gigabytes for some data sets. One-of-a-kind CD-ROMs can be made for about $35; for 100 copies the unit cost drops to about $10, including the mastering. The WDCs are now publishing a wide variety of data on CD-ROMs.

Analog-to-Digital Conversions

The wide use of personal computers and the use of diskettes and CD-ROMs to store, exchange and access data, and the needs of new programs that require availability of older historical data, have stimulated experiments by the WDC System in translating older analog and tabular data to digital form for inclusion in modern digital data sets. The WDCs need these older data to be converted so that their digital data sets can represent longer time series or broader geographical areas. The scientists and their institutions benefit from digitizing data because they can then have their own data in more readily usable form.

With these benefits in mind, WDC-A and WDC-B and related institutions have conducted a pilot program of digitizing tabular geomagnetic data, mainly of USSR geomagnetic observatories. Data from some 200 stations years have now been digitized and are incorporated in the series of solar-terrestrial CD-ROMs published by WDC-A. Similarly, all the cosmic-ray observations since the IGY have been digitized and published on a CD-ROM, through which it was discovered that there are format and other discrepancies in the data that can be identified and fixed. Digitizing data and publishing large data sets on CD-ROMs thus have a significant benefit aside from ready accessibility—it is easier to implement quality assessment procedures using digitized fields. Since CD-ROMs are so inexpensive, pilot or experimental data sets can be given wide distribution for use and evaluation; one of the best ways to test data sets for quality is for scientists to use them. After such distribution and use, improved versions can be released readily. This is the philosophy of a major new data management experiment to be described in the last section of this paper.

Of course, not all older analog and tabular data can be converted—the costs are prohibitive. Some selections can be made by the WDCs, based on their experience in which kinds of data are in most demand, but the scientists and their scientific organizations also need to be involved to get advice on priorities.

MULTITHEMATIC DATABASE FOR STUDIES OF GLOBAL CHANGE

One of the new international programs is concerned with the various time changes taking place on the planet, with emphasis on human time scales, i.e., decades to centuries. The steady increase in the concentration of carbon dioxide in the atmosphere, for example, measured with very high reliability since 1957 and extrapolated back to the beginnings of the industrial age, has caused much speculation about "greenhouse" warming.

Other kinds of human activity are also modifying the planet's surface and hence the feedback between the surface and the oceans and atmosphere. An extensive study in the early 1980s of the earth system, sponsored by NASA (NASA, 1988), outlined many of the possible mechanisms through which human and natural activities are changing the Earth's environment and discussed a conceptual model of the complex earth system and the data needed to build and test such models and to monitor change.

At about this time the international science community developed a proposal for a decade-long study, the International Geosphere-Biosphere Programme (IGBP), encompassing the Earth's geosphere and biosphere, both including human activities, their nature and interactions, relating to change on the scale of decades to centuries. A series of IGBP publications, especially Report 12, The Initial Core Projects (IGBP Secretariat, 1988), lays out the scientific rationale of the IGBP and begins to discuss the data needs.

The concern of scientists in the 1970s about greenhouse warming and sea-level rise was based on results from the best available models and on some measurements of global temperatures. Global temperature measurements, while available for the past 100 years or so, are quite unreliable. No matter how exquisitely one calibrates a thermometer, how and where it is used are the determining factors in how reliable a temperature is and how representative it is of the region. For example, surface temperatures from surface climatological stations have been reviewed for North America (Karl and others, 1989), and this document discusses the various factors that must be accounted for to derive a long and reliable time series of temperature: design and placement of the instrument shelter, location and aspect moves, changes in times of the day of observations, changes in how daily means are derived, changes in local environment (e.g., from rural to urban), and so on. The revised 1901–1987 USA station data are the best in the world at the moment; through international organizations such as the U.N.'s World Meteorological Organization (WMO), many other countries are getting to the task of revising their own historical data. Sea-surface temperatures are just as complex: wooden, canvas, or metal buckets used to take surface samples, time elapsed between taking the sample and making the measurement, and conversion to ship engine cooling-water intake temperature and the various intake depths of various ships are examples of the kinds of factors that must be taken into account to derive a coherent long-time series. This has now been done by colleagues in the United States and United Kingdom. These data sets now show some, but questionable, rising trends of temperature, questionable because the data sets still contain unresolvable inconsistencies and because the representativeness of only a few thousand land observations and imperfect ocean coverage still raises questions of just what a "global mean temperature" means. Moreover, we know from past proxy measurements that temperatures have varied much in cycles of many periods, and we cannot say, with only a hundred or so years of data, whether we have a real trend or only a long cycle.

The postulated rise of sea level, stemming from melting of the Greenland and Antarctic ice sheets, is another question on which some new light has been shed. Glaciologists have calculated that no matter how fast or how far global temperature may rise, within the bounds of physical reason, the great ice sheets cannot melt very fast in situ. In fact, a small increase of temperature, if accompanied by increased water-vapor content of atmosphere and increased meridional circulation, may increase precipitation over these ice sheets so that in the short term they might actually grow. In addition, the land is still rebounding from the great weight of the most recent Pleistocene ice sheets, further compounding the task of accurate determination of change in absolute sea level. The best current estimate is that in the next century there might be a sea-level rise on the order of tens of centimeters, not tens of meters (Stewart and others, 1990). Many kinds of reliable and widespread observations, as well as theoretical studies, however, are needed to fix these possible boundaries more accurately.

These two small examples show how much need there is for reliable long-term observations of the physical part of the earth system. The biological part of the system is in even worse shape, vis-à-vis reliable and useful data. Quantitative data on human activities—population dynamics, agricultural and animal production, deforestation and afforestation, biomass burnings, energy use and associated emissions, industrial emissions of radioactively active gases, urbanization patterns—are equally lacking in global completeness and reliability.

The IGBP Global Change Database Project

Early in the discussions of IGBP and its data needs, several "barriers" to data use were discussed:

- Lack of knowledge of what data exist, where, and how to get them
- Lack of ready and practical accessibility of some data, even though possible in principle
- Costs of data duplication

These factors led to several pilot projects. The first data barrier is being overcome through an international effort to derive a high-level Master Directory of Global Change data sets (NASA, 1990).

The other barriers were a challenge that could be met, some of us thought, through international collaboration in compiling data and actions by the WDC System to make such data available. Thus, a pilot project was organized to demonstrate that many applicable data sets could be compiled, put together into a common data structure, made available on inexpensive computer-readable format, and reviewed and used internationally as a step toward improving the various non-satellite data sets contained in the global-change database. As a start on this work, following preliminary international suggestions at the First IGBP Scientific Advisory Council Meeting in Stockholm in 1988, the World Data Center Panel of the International Council of Scientific Unions (ICSU) requested WDC-A (Boulder, NOAA National Geophysical Data Center) to compile a pilot database to demonstrate that integrated multithematic data could be distributed at low cost, especially to developing countries. Several years of the land-surface Vegetation Index derived from satellite observations were selected as the primary data set, accompanied by other data sets that describe various properties of the land surface needed to interpret the Vegetation Index. The Vegetation Index is thought to be one of the most useful kinds of global data that characterize the status of the land vegetation cover, although interpreting this satellite-derived index quantitatively is a considerably more difficult task.

To distribute the database on a moderate number (10) of computer diskettes, the African continent was selected for the first pilot database. Included for display and manipulation of these data was a user-friendly but powerful and inexpensive geographical information system (GIS), Idrisi, developed at the Department of Geography, Clark University; Idrisi developers generously agreed that Idrisi could be included with the African Diskette Pilot Database. Some 100 African Diskette Pilot Project sets have been distributed to scientists of many countries, including Africa; these colleagues have agreed to review the data sets and provide advice for improving the database. Several groups are also exploring how to develop curriculum material using our database.

It was clear when compiling the Africa database that *every data set in the base was flawed in some way*. For example, the available Vegetation Index data are derived from raw operational observations, uncorrected for instrument drift in any one satellite, and unadjusted for sensitivity differences between different satellites; in fact, the satellite instruments from which the Vegetation Index is derived do not contain on-board calibration capability for the Vegetation Index channels—sensitivity changes must be inferred. However, data from 4 years from one satellite, NOAA 9, were selected to eliminate any inter-satellite offset. No atmospheric scattering or absorption corrections were applied, nor were geometrical corrections arising from both the change in solar illumination angle through the changing seasons of the year or from the slow precession of the satellite orbit (the equator-crossing time of NOAA 9 satellite drifted several hours during its 5-year or so lifetime). Such corrections were still being developed by the working experts who use such data. The various other data sets—soils, land-cover and land-use, ecosystem-classification, and so on—have been compiled by many scientists for a variety of their own purposes. These data sets are generally composites from very disparate sources; they have been compiled on a global basis by their authors with many personal judgments involved. The sources also cover a wide range of time so that the compilations do not generally represent a true "snapshot" of the particular variable concerned.

Some concern was expressed by expert users of Vegetation Index data about the potential problem of wide distribution of data sets that do not meet the most stringent standards of quality, and that could lead to misleading results, such as indications of change arising from artifacts in the data. The designers of the pilot project decided, however, to incur some risk in a limited release of the "best-available" data, flawed though these may be, as a way to inform scientists about the potential value of such data and to stimulate further experimentation with them, in the ex-pectation that eventually reprocessed, improved data would be available. Under the stimulus of new satellite programs now being planned and the concurrent need for improved data-management techniques for global-change studies, work is now underway to reprocess Vegetation Index data to higher quality, first on a global medium-resolution/sampling basis (about 9-km sampling resolution) and later on as a global full-resolution basis (about 2-km actual resolution).

Improving the non-satellite data will be quite a different matter. Here is where scientists of many regions can collaborate, under the aegis of the Global Change Program, to make substantial improvements of many data sets needed to interpret vegetation-cover data (i.e., Vegetation Index). The ICSU WDC Panel and WDC-A are initiating one pilot effort with the Institute of Atmospheric Physics, Chinese Academy of Sciences. There is good reason to anticipate, under the impetus of the Global Change Program, collaboration of local scientists in other regions that will eventually result in a much improved global database of land-cover, land use, vegetation classifications, soils, hydrological quantities, human activities, and time-series climatic data of the same time resolution (1 to 2 weeks) as the Vegetation Index.

A key to the philosophy of this project has been the notion that the most rapid and useful improvements will result from the open and community-wide peer review process, in which exchange and inter-comparability are facilitated by the database design and software conventions. In this way, the limitations of "best available data" will lead faster to improved databases to support the immense task of defining and understanding global change and its implications for human society.

As a follow-up to the Africa Diskette Pilot Project, NOAA WDC-A and the U.S. Environmental Protection Agency (EPA) are collaborating to distribute global data sets for modeling use. A first version of a CD-ROM has been distributed for peer review; this CD-ROM contains a fully global database of most of the data used for the Africa Diskette Pilot project. NOAA/EPA plan public releases of further CD-ROMs containing improved data sets as they become available.

Desiderata of a Global Database System

The IGBP Global Change program provides a crucial motivation to repair defects in the various global data systems and to provide the mechanisms for worldwide scientific evaluation. Several tests are postulated of the effectiveness of data systems needed for studies of global change:

(1) Are needed data readily available, preferably in computer-usable format, at low cost? The Global Change Diskette Pilot Project was an experiment to see if the ICSU WDC System could respond to such requirements. I believe that WDC-A and the ICSU WDC Panel have developed a useful mechanism and demonstrated critical aspects of what must be done to apply it to global-change data requirements. The hard parts are to come: how to fill that mechanism with reliable, credible, well-documented data? The task will be easier if scientists work as partners with data specialists.

(2) Are available data sets described well enough so that researchers anywhere can find them? Under IGBP, the Master Directory under development will provide this mechanism. Scientists and agencies everywhere should describe for the Master Directory (a standardized brief form is used) their data holdings that will be useful for others in studies of regional and global change.

(3) Can data taken by one researcher, or one agency, be used readily by others? Is the neces-

sary ancillary descriptive information on instruments and their calibrations, observing methods, exposure (if appropriate), methods of calculating or estimating derived products, and so on, complete and co-located with the data? Scientists generally do not like to allocate precious resources to ensuring that their data, even if put into the public domain, can be used easily by others. Scientists generally prefer that "research" funds be used for "science," not data management; for global-change research, however, good data management is a prerequisite. Funding agencies, therefore, need to make sure that sufficient independent data-management support is available to guarantee that data collected with the support of research funds are also usable for other research; to do otherwise is to throw away some of the capital investment in the data-taking enterprises.

(4) Will data taken by this generation of scientists be usable by the next generation? That is, will the entire data process—collection, verification, description, proper archiving, and means for low-cost copying—pass the 20-year-or-longer test? This criterion implies the need for long-term commitments of agencies and data centers to maintain data sets in retrievable conditions and to ensure that all the needed information to use the data is available, either incorporated with the data themselves or closely associated within the archives so that inadvertent separation of data and descriptions is minimized. Part of our data problem today is that yesteryear's data do not meet this 20-to-50-year test. An enormous effort is being put into rescuing older data and verifying them so that long time series are available to answer such questions as what real changes have taken or are now taking place. Should we not avoid placing a similar burden on our colleagues of the future?

Some Relevant International Actions

Each country should examine its data archives and allocate resources to recovering, describing, and correcting/adjusting its relevant data holdings to address such questions relating to documenting and understanding any real changes in climate or environment. Some help is available, for example with older weather/climate data, through the WMO. Possibly the Food and Agriculture Organization (FAO) and UNESCO could support such national data rescue in their domain of interest. The United Nations Environmental Programme's GRID is also a mechanism to help get useful national and regional data into the public domain.

Recently an IGBP Data and Information Systems Office (IGBP-DIS) has been established in Paris, supported by the governments of France and the United States. IGBP-DIS Paris may well be the logical focal point for discussing and coordinating such improvements of data sets.

ACKNOWLEDGEMENTS

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INFORMATION TRANSFER ACROSS POLITICAL BOUNDARIES

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Abstract—Evidence for both the need and reality of information transfer across political boundaries is ever-present, though the discrepancy between the two may be less apparent. We are part of one planet that is a web of economic, political, social, and natural systems, all of which require efficient and effective information transfer for their management. Our greatest "successes" in information flow range from our species' noblest responses to cries for relief from natural disasters to our more bellicose responses to screams for escape from perceived political emergencies. Information flow is essential, and limitations to that flow are crippling.

In spite of the many individuals and organizations that work to increase information flow, we are painfully aware of filters that limit information transfer. Examples include filters that are created openly, covertly, or accidentally. These filters, which result from a lack of resources or inappropriately allocated resources, may be constructed between economic giants as they compete for existing and potential markets or constituencies or between competitors of vastly different size or power.

When we cross political boundaries, be they internal or international, we find that the effects of these filters on information flow tend to be one way—restricting the flow of information from the powerful to the less powerful, or from the more developed to the less developed world. This paper describes the filters so that efforts can be made to limit their effectiveness in denying information to significant parts of the world.

OVERVIEW

> Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.
>
> S. Johnson, 1775 (Boswell, 1791)

What I will argue in this paper is that the present system for transferring any type of information is hampered because of filters created by political boundaries. In this age of information explosion, the difference between the two kinds of knowledge of which Dr. Johnson spoke is increasing, and fewer are able to acquire either kind of knowledge. Yet, the problems are not unsolvable; it is within our power to eliminate or decrease the effect of the filters.

We will look at two types of political boundaries. One will be the boundaries that are international in nature, more particularly, boundaries between nations. The second type of political boundary discussed will be internal, that is, boundaries that restrict information flow within a country.

CROSSING INTERNATIONAL POLITICAL BOUNDARIES

Background

The landmark study of the Club of Rome, *Limits to Growth,* talked about the interconnectedness of things, stating that we are part of a web of economic, political, social, and natural systems (Meadows and others, 1972). The reality of this web is apparent in each day's news—trade talks, our demand or appetite for limited resources, the dynamism of Eastern Europe or the Middle East, environmental issues such as ozone depletion and global warming, social issues such as starvation or disease, and of course, the economics and human impact of war. We do in fact live in a shrinking world of economic interrelationships, environmental interdependence, military fallout, and yet enormous potential for humanitarian actions.

In this web it is apparent that information is power, the power to control one's destiny. Therefore, either because we are inherently part of the web, or more selfishly because we want to empower groups we need to hear from, we must facilitate information flow. Improved information transfer aids in the development of nations by protecting national power, helping to conduct foreign trade, or permitting efficient distribution of activities (Pool, I., 1990). Unfortunately, in the international arena, information has been concentrated among countries of the North, and is often unavailable in the South. High costs, inadequate infrastructure, or simply the lack of access to the necessary computer technology all contribute (White, 1990). No matter what the reasons, we must develop ways to share the information in order to have a more creative role in the web. We must empower in order to expand our own influence and impact.

Problems in Information Flow across Political Boundaries

Information, specifically science information, has the potential to impact issues such as national security, economics, and future intellectual development. The relationship between provider and receiver of information is often a focal point for problems. In focusing on the problems we have to look at both the providers and the receivers of information as the flow crosses international boundaries. For example, on the provider side a United States government policy on science and technology information transfer may limit access to competitive or hostile nations yet at the same time it may be sacrificing long-term benefits for short-term political statements (U.S. House Committee on Science, Space, and Technology, 1991). Access to the information is also limited by the provider by imposing legal and financial restrictions on users, with preferential access granted to special users, in turn giving them competitive advantages (Lenk, 1982). These preferred customers are often defined in a way that may or may not be best serving the society or the world. For example, much of the technology transferred between the North and South by transnational corporations is technique and know-how, the important point being that the information transferred is chosen carefully to benefit those large corporations and their home economies in the North, rather than serving the needs of the South (King, 1982).

On the receiver end, the problems range from providing the necessary infrastructure to providing an atmosphere in which information flow is encouraged. Also on the receiving side is the most basic barrier to information transfer, literacy, which must be addressed at all levels of society. Although the adult literacy rates increased between 1970 and 1985, over 1 billion adults worldwide are still illiterate, and 300 million children are not in primary or secondary school (U.N. Development Programme, 1991). Figure 1 points out three measures of relative development comparing the North to the South that may well show information flow potential—women's access to information (a wasted resource which we will discuss in more detail later), tertiary school enrollment, the number of radios, and the number of scientists and technicians (United Nations, 1991; Fig. 1). The number of scientists and technicians per 1,000 people (Fig. 2) emphasizes their importance in creating, translating, or critiquing scientific information (U.N. Development Programme, 1991).

What to Do

Another way of studying the problem of information transfer is by looking at solutions and thinking about priorities as set by the developing countries. For example, in developing countries more than in industrialized countries, military expenditure is significantly higher than expenditure on health and education (U.N. Development Programme, 1991; Fig. 3). The whole war economy is being responded to without consideration of what is being sacrificed (Waring, 1988), and priorities are indeed inconsistent with needs. Of course, the potential for change coexists with the changing political environment. We can only hope that priorities do indeed change.

If we were to ask the scientists in the developing countries of their concerns, we would hear of very specific issues. Orrego (1989) found in an assessment of one group of scientists that the concern was primarily the timely availability of scientific publications. Both budget and delivery problems limit journal access, and therefore, make performing science difficult.

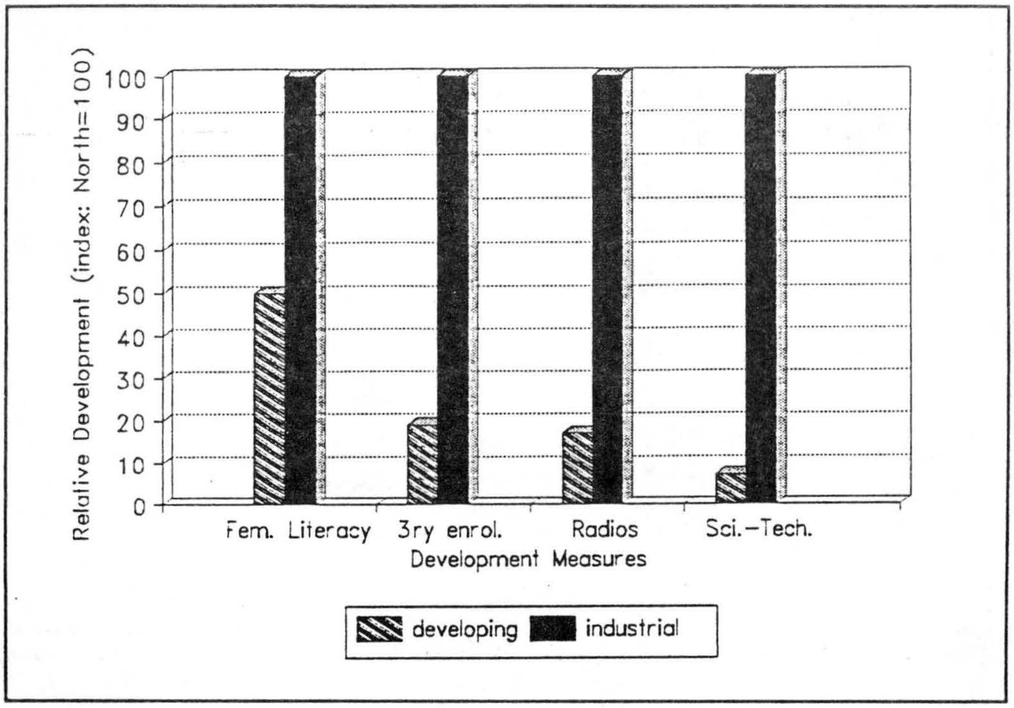

Figure 1. Gaps between developing and industrial countries in four key development indicators. (Data from UNDP, 1991, p. 132–133.)

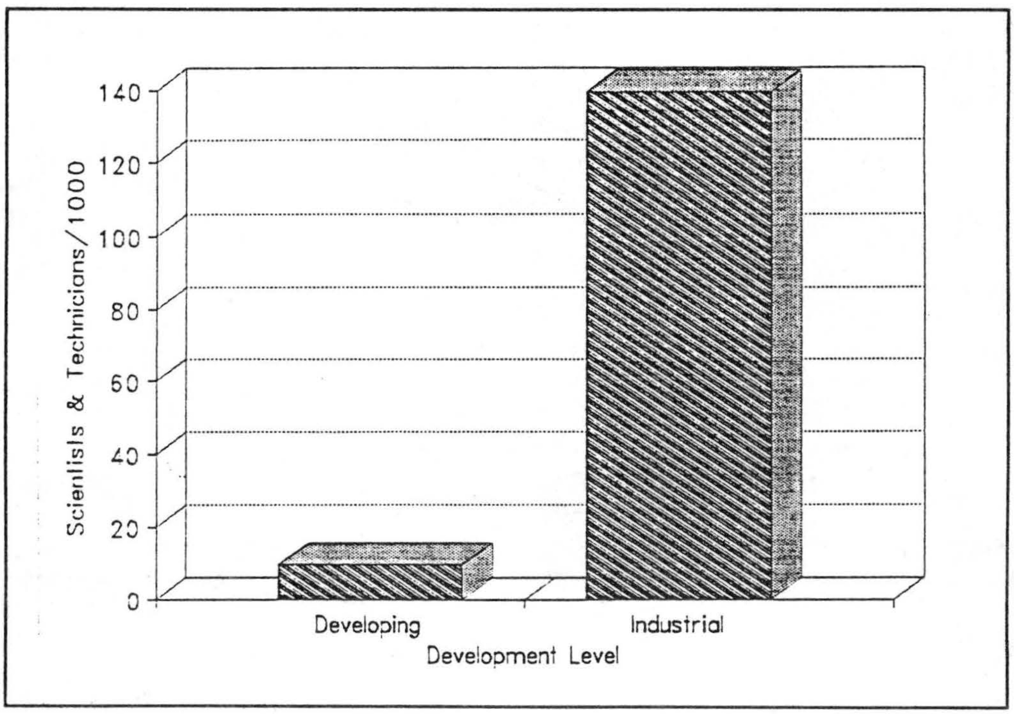

Figure 2. Scientists and technicians per 1,000 people in developing and industrial countries. (Data from UNDP, 1991, p. 128–129.)

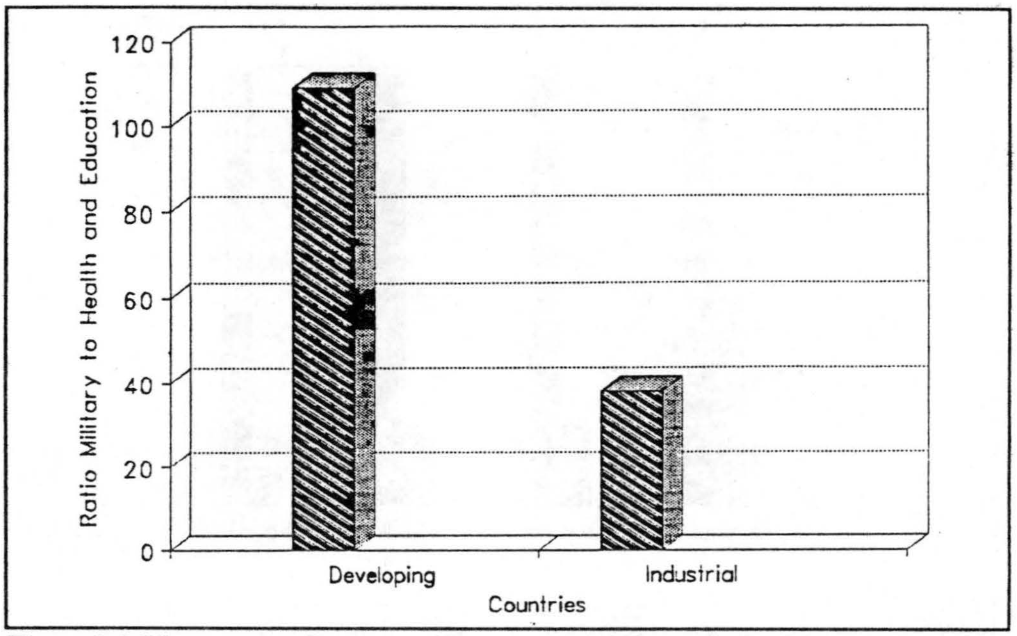

Figure 3. Military expenditure in relation to expenditure for health and education, developing and industrial countries. (Data from UNDP, 1991, p. 156–157.)

Ultimately, an entirely new framework governing the transfer of information is essential in the international arena. Programs that should contribute to information transfer between the North and South can be very specific, such as those put forth by Orrego (1989); these include international cooperation on articles, development programs, regional courses or workshops, collaborative research projects, and fellowships. More specific technological recommendations surround the communications systems needed for information transfer (Pool, I., 1990). These would develop approaches that are location specific—such as being aware of the limitation inherent in the location (e.g., information transfer by television may work in Europe, but information transfer by wired speakers may be necessary in some of the villages of the developing countries). Additionally, the industrialized countries should work to revise the export control laws to take into account the negative impact of overly tight controls on information flow (U.S. House Committee on the Judiciary, 1989). Certainly, the United States has lagged behind other countries in proposing reforms on export controls (U.S. House Committee on Science, 1991).

Yet, the basic underlying problem, and one that is addressable, is weak human capital. As stated in the Human Development Report (1991, p. 71):

> In the longer term, however, if the poor can learn to read and write and gain more awareness of their ability to meet their needs through local government, they will be able to exercise their democratic rights more independently—and hold local officials more accountable for their actions.

Thus, commitment will follow.

None of us can deny that resources are essential for any improvement, particularly to changes in human capital, and finding the necessary capital will depend on individual developing countries deciding that their own improvement is a high priority. Information transfer hinges on basic strength of the people in a society. By an analysis of public spending (U.N. Development Programme, 1991), we can see that each country does set, and in turn fund, its priorities. For example, depending on the percentage of GNP as public expenditure, the percentage of public expenditure for social issues,

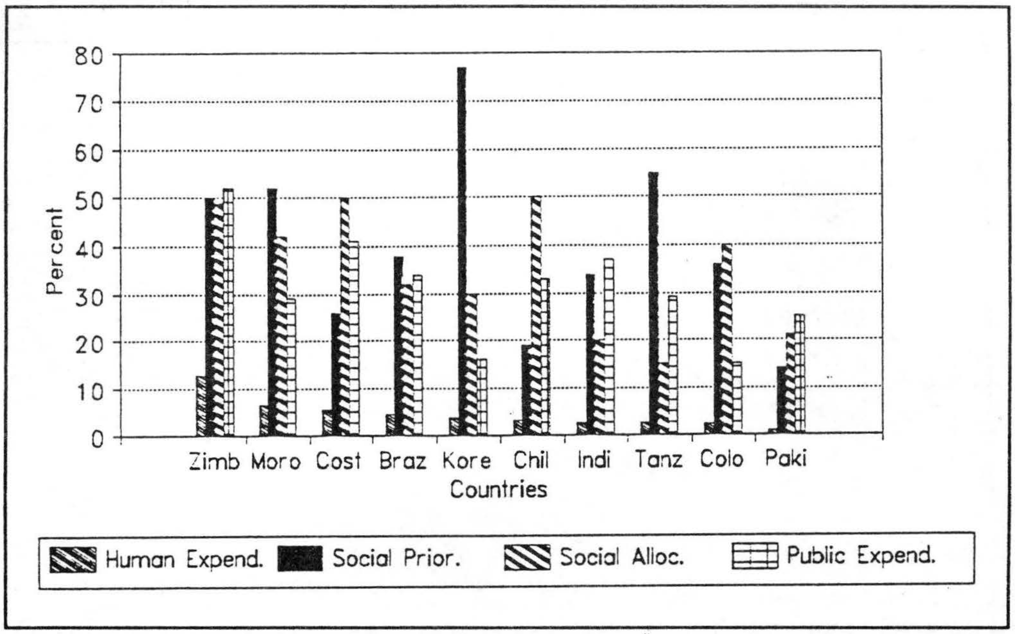

Figure 4. Social spending by developing countries as successive ratios. (Data from UNDP, 1991, p. 41.)

and the percentage for social priorities within those social issues, each country produces a very different effect on society (U.N. Development Programme, 1991; Figs. 4 and 5). Human development is dependent, of course, on all these decisions. Comparing the different developing countries reveals the varied impact and forces the issue of priorities to the forefront. It is a question of what is appropriate at any given stage of development. Which is the correct choice for public expenditure in a given country—military equipment, a large city library, a new hospital, or a small rural clinic? Is a new university needed or is basic education? Nations at different stages of development obviously would have distinctive need and should make appropriate decisions.

The industrialized countries also must set their own priorities in relation to the developing countries. Information transfer is limited by the filters of poverty and limited human capital, and we can effect change in those filters. The industrialized countries can assist with international aid. This too has a multiplying effect, one decision affecting several subsequent decisions (U.N. Development Programme, 1991). If the percentage of GNP given for aid is low, or lower than the 0.7% GNP that was internationally agreed upon (U.N. Development Programme, 1991; Fig. 6), then we are not doing what should be done. After the decision to give aid, decisions on where that assistance should be applied still need to be made. The percentage of aid applied to the social sector (such as monuments versus armaments) and the percentage of the social sector that is high priority for human development (such as large city library versus elementary schools) all contribute to what ultimately reaches important targets, and the degree to which the industrialized world is contributing to human development. We can follow the compounding effect with the accompanying figures (U.N. Development Programme, 1991; Figs. 7 and 8). Once again, it is a question of priorities.

Summary

It is, then, possible to attack the problems once they are identified. Certainly, there are organizations that can help us harness our enthusiasm and give direction to our energy. Yet, in the end, we must decide and set priorities. As

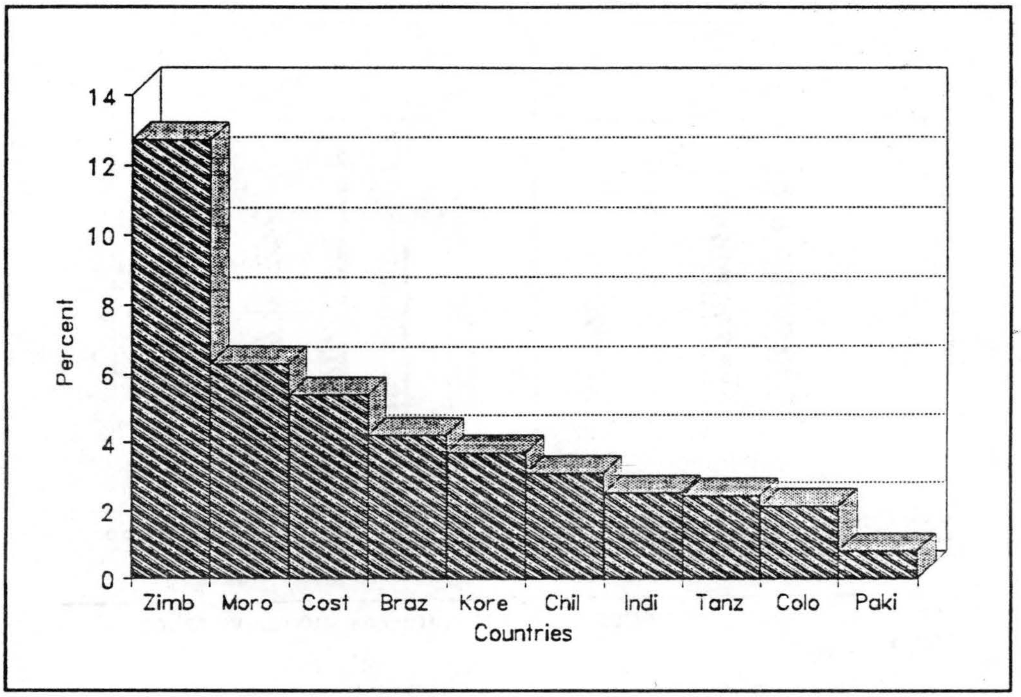

Figure 5. Social spending by developing countries as a ratio to human expenditure. (Data from UNDP, 1991, p. 41.)

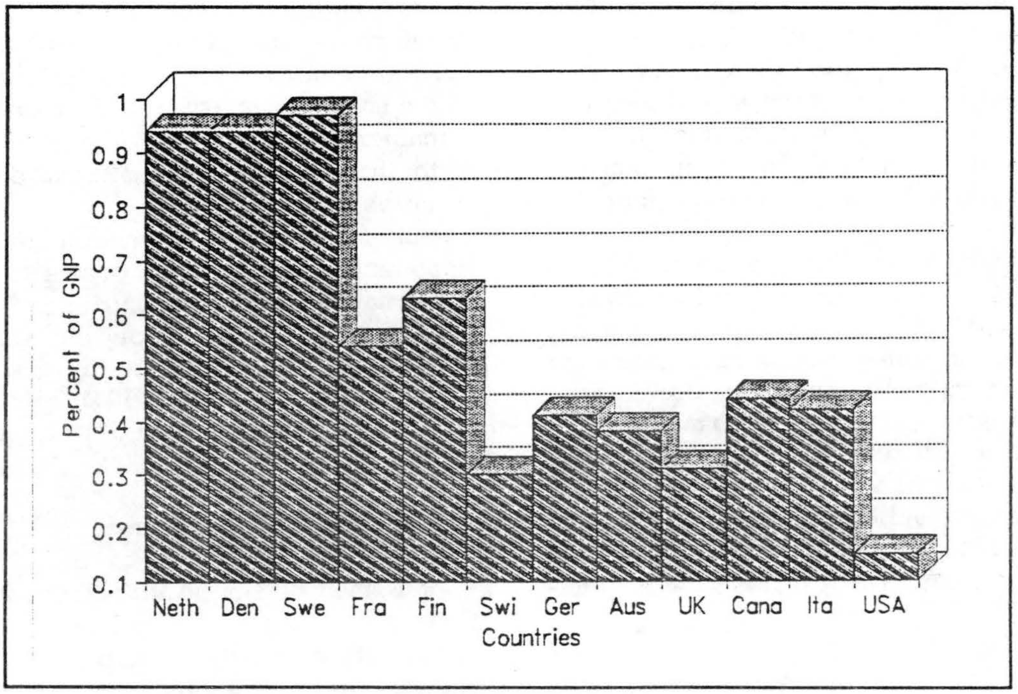

Figure 6. Aid from industrialized countries as a percentage of GNP. (Data from UNDP, 1991, p. 54.)

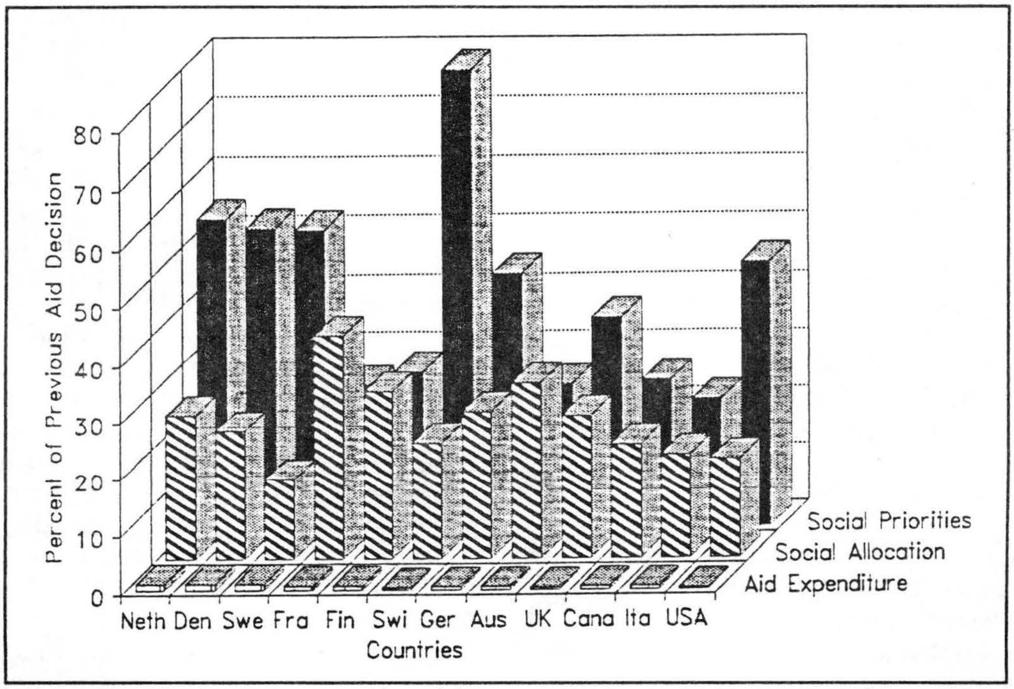

Figure 7. Aid from industrialized countries as successive ratios. (Data from UNDP, 1991, p. 54.)

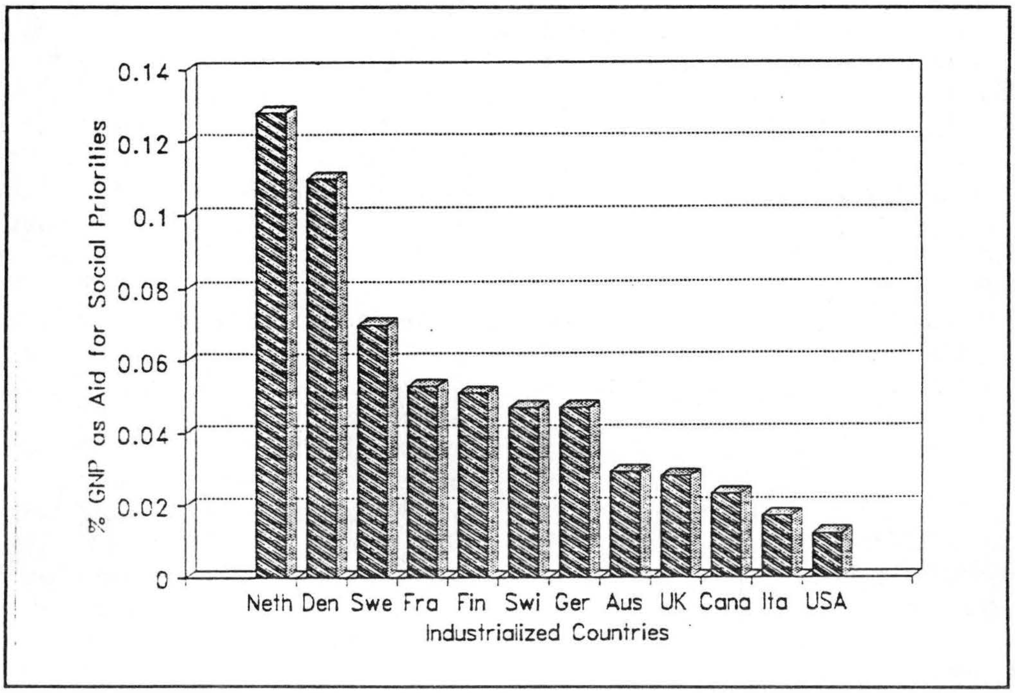

Figure 8. Human expenditure aid in industrialized counties. (Data from UNDP, 1991, p. 54.)

stated in the Human Development Report (U.N. Development Programme, 1991), "the lack of political commitment, not of financial resources, is often the real cause of human neglect." It is that human neglect that makes information transfer across international boundaries difficult at best. If we improve human capital, empowering the have-nots, then we can pull the system away from the existing, one-sided, parasitic state in which we presently find ourselves.

CROSSING INTERNAL POLITICAL BOUNDARIES

Introduction

We have discussed issues of information transfer across national political boundaries, being very much aware that information is power, the power to control one's destiny. We know that without that power, entire nations are being denied an opportunity to be part of the positive forces that create or mold our world. What we will look at now are the restrictions to information flow that are less distant. Although these are boundaries that are more immediate, being within national borders, they too are political, born of decisions and nondecisions by each of us and our representatives. The same intellectual poverty and resultant actual poverty caused by information denial are here at home—and we are a part of the cause and should be part of the solution.

We can divide internal problems with information transfer into two general categories. First, there are problems where the information or the structure for information exists, yet is is not utilized either for its own value or to stimulate additional information flow. Second, there are problems in information transfer related to educating individuals who later would serve as creators and interpreters of information.

Technology Transfer

We discussed the first category, technology transfer, in the international sector, pointing out that the need for secrecy and the fear of competition severely limit information transfer. Within national boundaries these same problems in technology transfer show up as filters between the federal government and business, or as filters between the businesses themselves. Though the United States government should be acting as a source of encouragement in information transfer, unfortunately, while the technology for information advances and the complexity of the information increases, the number of people who have access to information is decreasing. The U.S. government could do more by providing support for activities such as cooperative research projects, workshops and seminars, increased licensing, industry-sponsored research, lab availability, information dissemination, and personnel exchanges (U.S. House Committee on Science, 1988; U.S. House Committee on Science, 1990). However, as the Office of Technology Assessment points out, the U.S. government lacks an overall strategy that might help maximize the return on R&D investment (Office of Technology Assessment, 1984). Park (1988, p. 2) observed that "the same actions that delay technology transfer to our military adversaries or economic competitors inevitably impede the transfer of information within our own borders."

Problems with the Pipeline

Background

The second area of concern in intranational information transfer is the educational pipeline, a pipeline that should increase the number of individuals capable of creating or interpreting science information. We will look at the pipeline, demographic issues affecting the pipeline, and causes of leakage from the pipeline and propose some rather straightforward improvements.

Technology is exploding, and therefore the economy of our nation will be based on the availability of a work force capable of dealing with that technology (Oakes, 1990). However, the demographic changes in our national population suggest that the group traditionally trained for roles in the science/engineering work force, the white males, is a shrinking pool (Finkbeiner, 1987). A drop in birthrate allows some to forecast that the number of 18-24-year-olds will drop 23% by 1995, and that shrinking pool will have an impact on what comes out the pipeline (Oakes, 1990). Yalow (1985, p. vii) looked at the problem slightly differently by stating, "Although zero population

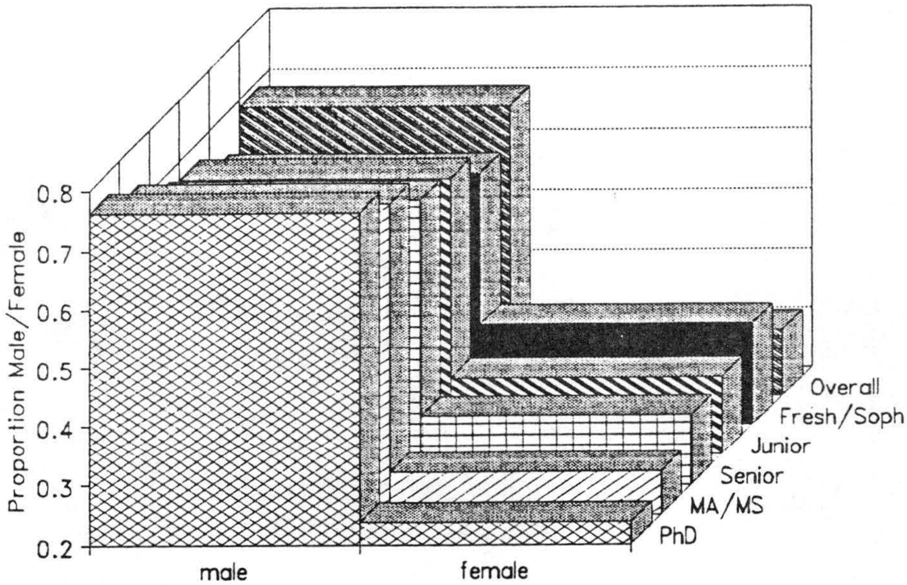

Figure 9. Earth sciences enrollment, male vs. female, 1990. (Data from AGI.)

growth may be desired, negative population growth, particularly among our gifted, does not serve the common good." It is the group of those traditionally trained gifted people that is decreasing. This shortage of technical personnel will certainly have consequences on our economic growth, our international competitiveness, and our national security (Atkinson, 1989).

The supply to the pipeline is decreasing in terms of the traditional individuals, so we look to the pipeline to provide others to fill that role. However, the pipeline is preferential—it narrows more quickly for women than for men and faster for blacks than for women (Finkbeiner, 1987). We need to pull more people into science from all parts of the population. This goes well beyond the motivation that representation by all groups is a "good" or "just" thing. It is an issue that even the unethical or amoral must heed. Understanding science is crucial to our national survival, and if enough people are not available from the group traditionally drawn upon, then the typically under-represented groups must be lured into these fields. The issue has evolved from a problem of equity for women and minorities to one of shortage of scientists (Freckman, 1989; Blockstein, 1990).

Today only 15% of employed scientists, mathematicians, and engineers are women, only 2% are blacks, and only 2% are Hispanics (Oakes, 1990). We are far from being able to realize the kind of contribution that can be made by this significant portion of the population. Enrollment in earth science higher education and awarding of earth science degrees both for women and for minorities (American Geological Institute, 1991; Figs. 9–12) indicate the problem of unacceptably low participation, as do data on representation by women and minorities in science fields (National Science Foundation, 1990). For example, in mathematics, at present rates of improvement in the number of women with Ph.D.s in mathematics it will take another 2,281 years before percentages of men and women Ph.D.s are equal to percentages in the general population (Anderson, 1989).

Deeper social roots to the problem

The next step is to try to comprehend the circumstances underlying the issue of low female and minority representation in the science/engineering pipeline, allowing us to approach

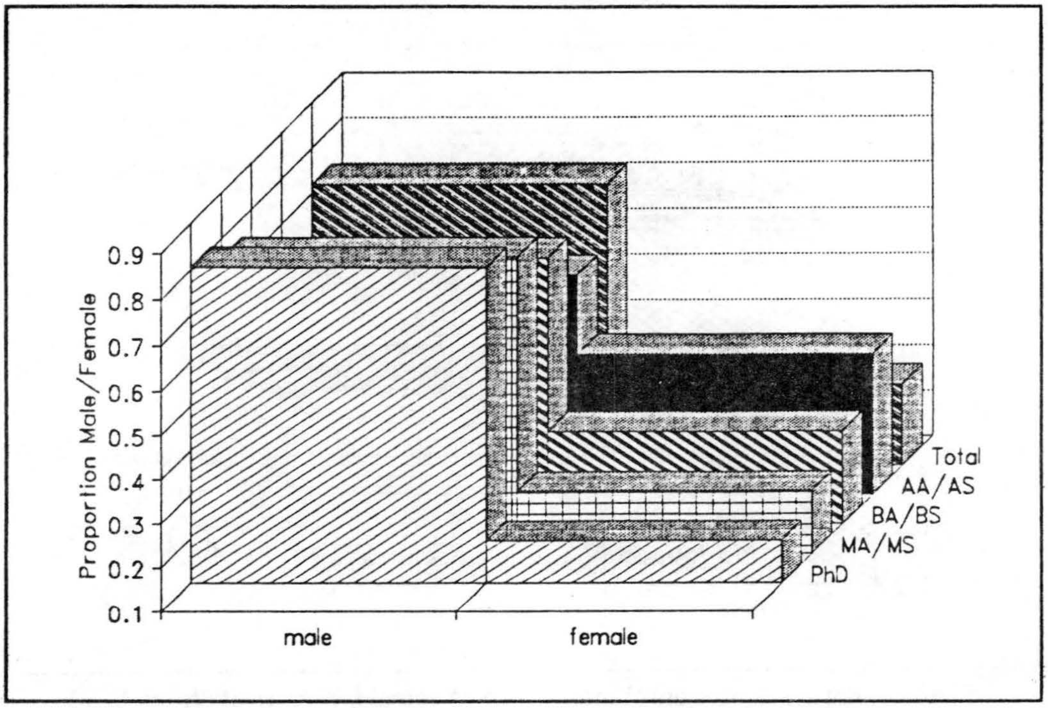

Figure 10. Earth sciences degrees awarded, male vs. female, 1990. (Data from AGI.)

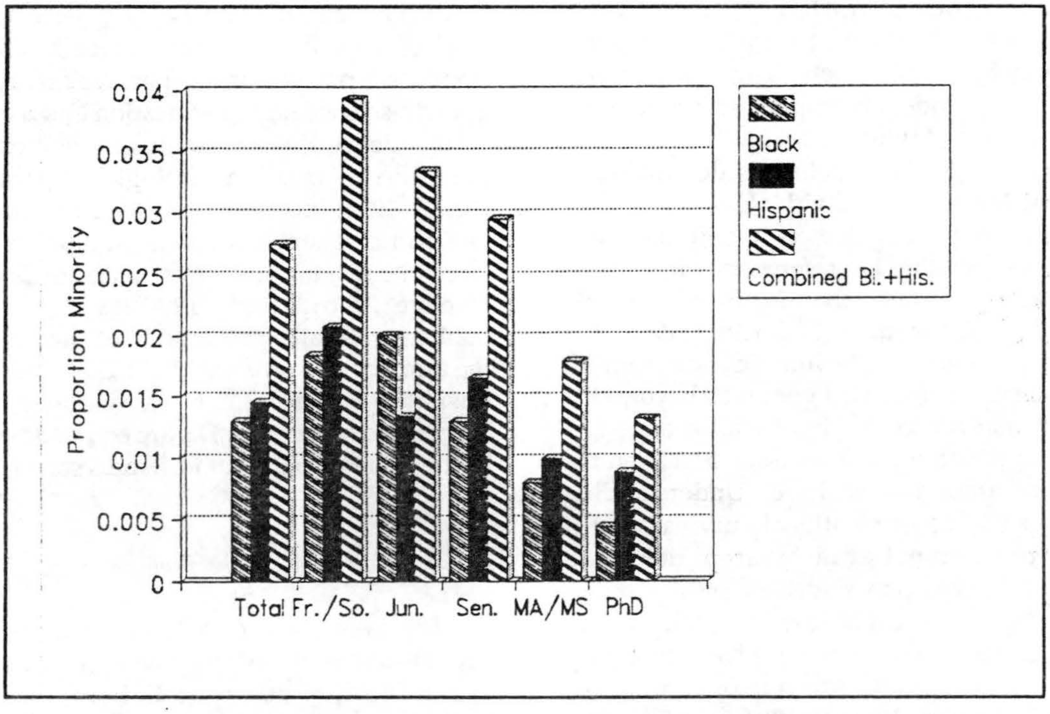

Figure 11. Minority enrollment in earth sciences, 1990. (Data from AGI.)

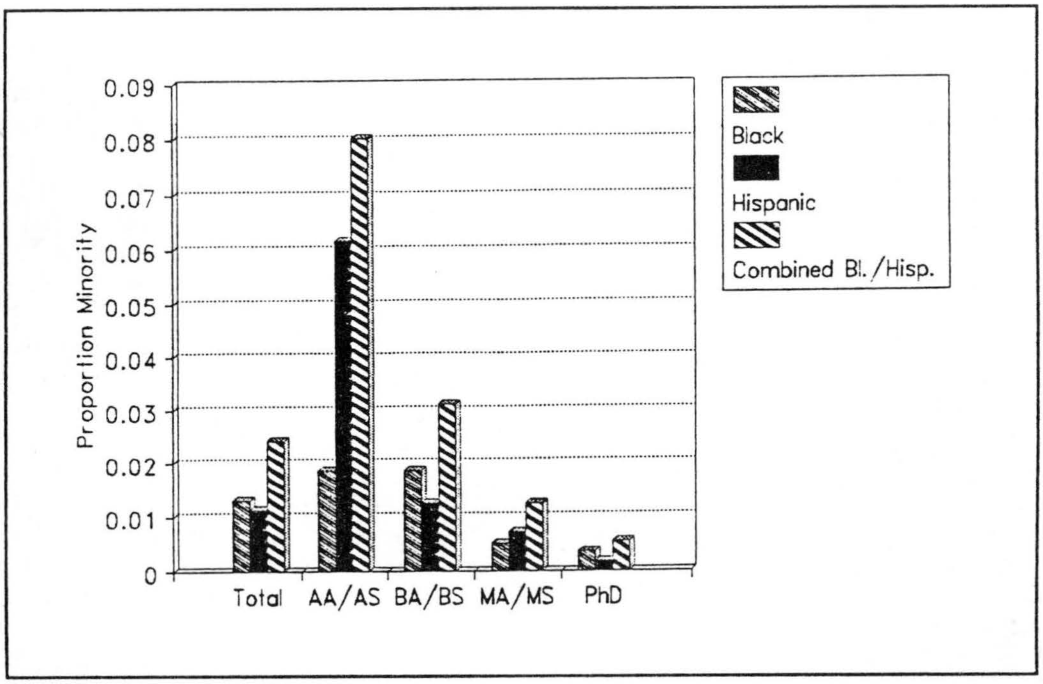

Figure 12. Earth sciences degrees awarded to minorities, 1990. (Data from AGI.)

possible solutions more aggressively. If we follow the pipeline, we notice that each group loses ground in relation to science and math at different times for distinct reasons, and therefore we can identify ways of attacking the problems. For example, in elementary school the pipeline loses primarily blacks and Hispanics because of low achievement related to opportunities and interest. Additionally, strong tracking in high school reinforces these earlier decisions. Although blacks and Hispanics may have positive attitudes toward science early on, they tend toward vocational choices (and are encouraged to do so). It is found that women tend to leave the pipeline in high school because science and math are not appealing—these subjects do not fit their self-image. Finally, the college portion of the pipeline loses many women as the perceived lack of relevance and negative image (related to perhaps the awareness of unfair opportunities) build on an already weak showing (Oakes, 1990).

In looking at these patterns, Oakes (1990) considers the crucial point being the coming together of sex, race, class, and schooling, in that the differences may well be the result of the groups having less access to positive reinforcement. For example, family status (that may result in less money spent on out-of-school activities such as music lessons, travel, and museums), parental education level, and parental involvement and expectations all correlate highly with achievement (see also Holden, 1986). If we combine these factors with historical discrimination and the general problems related to an underclass that is being developed as a weak and socially isolated labor force (Wilson, 1990), then we can understand why groups are trapped into being perpetually ill-fitted for the pipeline.

Oakes (1990) expands on certain schooling experiences being additional elements essential to success, including (1) access to educational resources, (2) access to guidance and encouragement (including role models), (3) access to math and science content, and (4) teacher expectations. Unfortunately, not only are many of these schooling-related experiences not designed for those not already in the pipeline, but they are generally unavailable to members of low socioeconomic groups. In many ways we severely limit opportunities because the quality of our educational systems tends to correlate closely with the economic status of the families in the system—a serious impact on the number of minorities leaving the pipeline.

If we dig even deeper into the problems we find, for example, that throughout school-age years minorities experience increased difficulties with higher reading levels and display weak literacy skills (National Center for Education Statistics, 1990; Fig. 13). Literacy and reading skills by race/ ethnicity fit what would be expected from Wilson's (1987) description of the urban underclass. Various measures of science schooling and science proficiency also point out a progressively worsening situation. For example, differences in science performance (National Center for Education Statistics, 1990; Fig. 14), substantiated by results in other standardized tests such as Advanced Placement tests and the SATs (National Science Foundation, 1990), point to the depth of the problem.

Other pressures on these groups also contribute to our losing them, such as socialization pressures while in school and the realization that opportunities are different for those who are not white males. The Office of Technology Assessment reported that women in science and engineering have higher unemployment rates, lower salaries, and fewer opportunities for promotion (Blockstein, 1990). With data on unemployment and underemployment rates, salaries, and management possibilities (Blockstein, 1990; NSF, 1990; Figs. 15 and 16), it is easy to understand the differences in decisions as to what field is most appropriate or potentially most rewarding. Additionally such hard examples as there being only 3% women in the National Academy of Sciences (Anderson, 1989) might well influence a potential scientist's thoughts for the future. Hubbard (1984) summarizes the issues by stating

> The system by which the structure and content of the scientific and technical professions, has been constructed by one particular, limited social group composed of the economically privileged, university-educated, white men, and it serves their need more than ours.

The present system is wrong. We need a system that serves the society, and not a group.

Solutions

Numerous individuals and organizations have attempted to address some of the problems presented here. The magnitude of the problem points out that we must do more (e.g., Freckman, 1989; Blockstein, 1990; NSF, 1990, Pool, R., 1990), particularly when we are in a political climate that takes away what little support these programs have.

Intervention that might help the pipeline involves spending money, supporting such efforts as historically black colleges and universities, research grants, school programs, and professional opportunities—all areas that in the past have been shown to make a difference (e.g., U.S. House Committee on Education, 1988; Atkinson, 1989). Oakes (1990) suggests less costly but equally essential intervention programs that would address some of the problems: (1) having the classroom situation more informal and less competitive; (2) providing more role models; (3) involving conceptualization instead of memorization, and (4) increasing relevant extracurricular activities that would be nonthreatening and noncompetitive. Additionally, suggestions have been made specifically for the college level, many of which overlap with those just listed (e.g., Cobb, 1984; Widnall, 1988; Brickhouse, 1990; Gold, 1990), as well as some suggestions that are specifically related to geology (Gross, 1990). An interesting point brought up by Gold (1990) was the lack of mentors for women resulting from the fact that graduate support for women tends to be in the form of teaching assistantships rather than research assistantships, as well as general university support being less for women than for men (NSF, 1990). Other research has shown that addressing the problems in the ways listed above indicates that the nontraditional groups tend to stay in the pipeline, while maintaining the same flow of the traditional groups (e.g., Oakes, 1990). Such is the change that we need.

However, other general deep-rooted issues must also be addressed. For example, we must attack poverty and the conditions that create and maintain an urban underclass. The well-known yet little addressed problem of the inexcusably high percentage of minorities below the poverty level needs attention (National Center for Education Statistics, 1990; Fig. 17) as does the fact that the

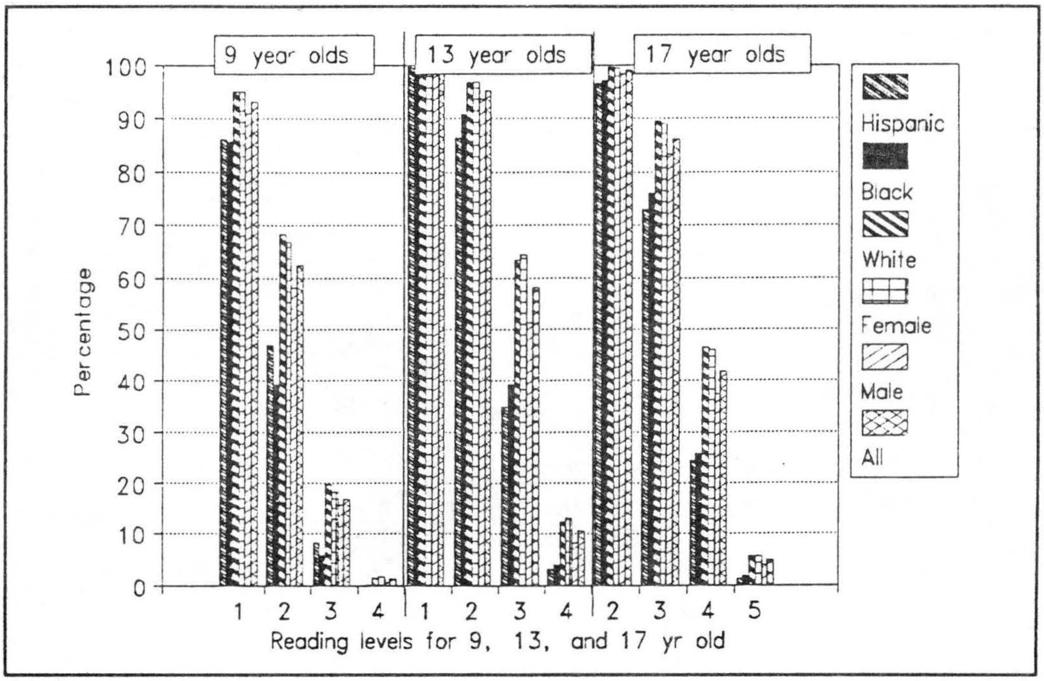

Figure 13. Reading-level attainment of 9-, 13-, and 17-year-olds. (Data from National Center for Education Statistics, 1990, p. 115.)

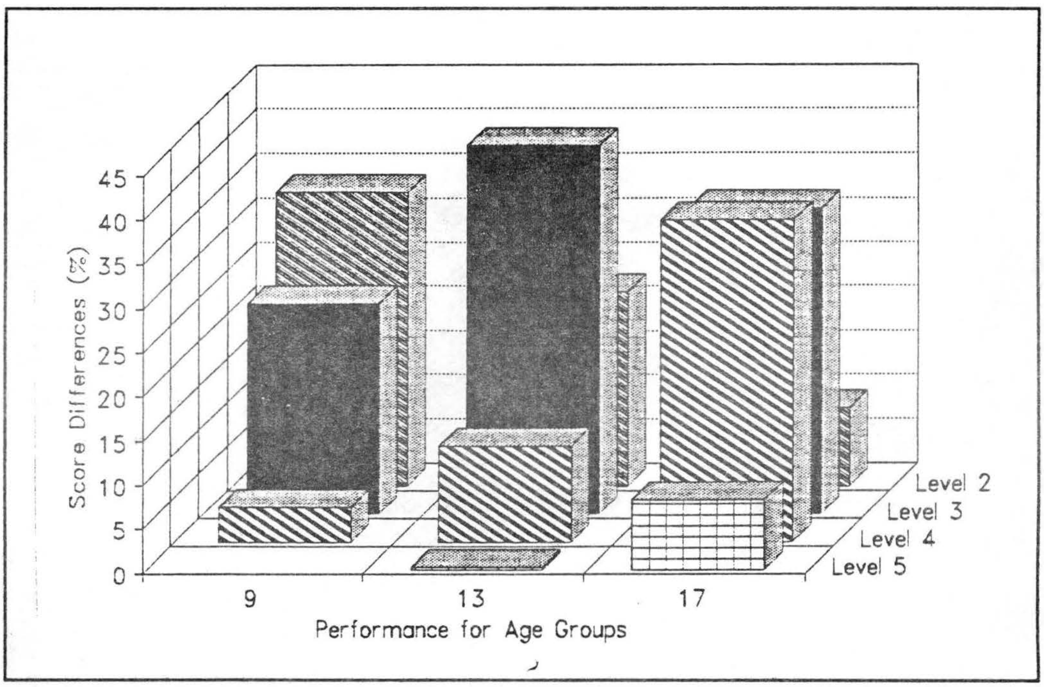

Figure 14. Differences in science test performance of whites vs. blacks, 1985–1986. (Data from National Center for Education Statistics, 1990, p. 121.)

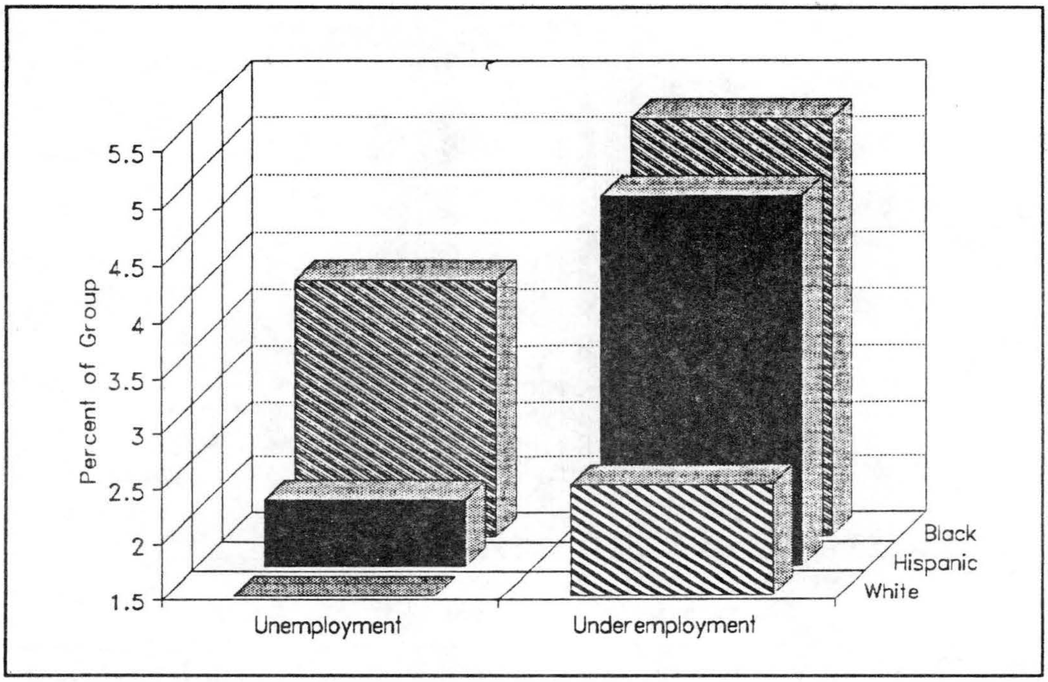

Figure 15. Science/engineering unemployment and underemployment by racial/ethnic group, 1986. (Data from NSF, 1990, p. 28.)

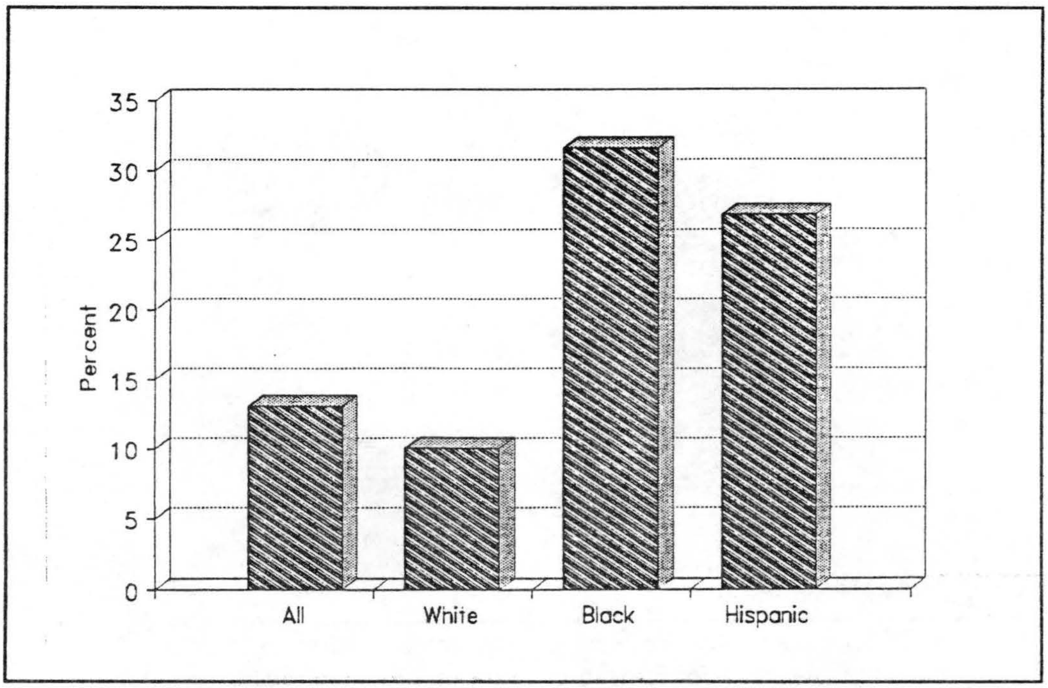

Figure 16. Women and men in R&D management in all scientific fields and in environmental sciences, 1986. (Data from NSF, 1990, p. 7.)

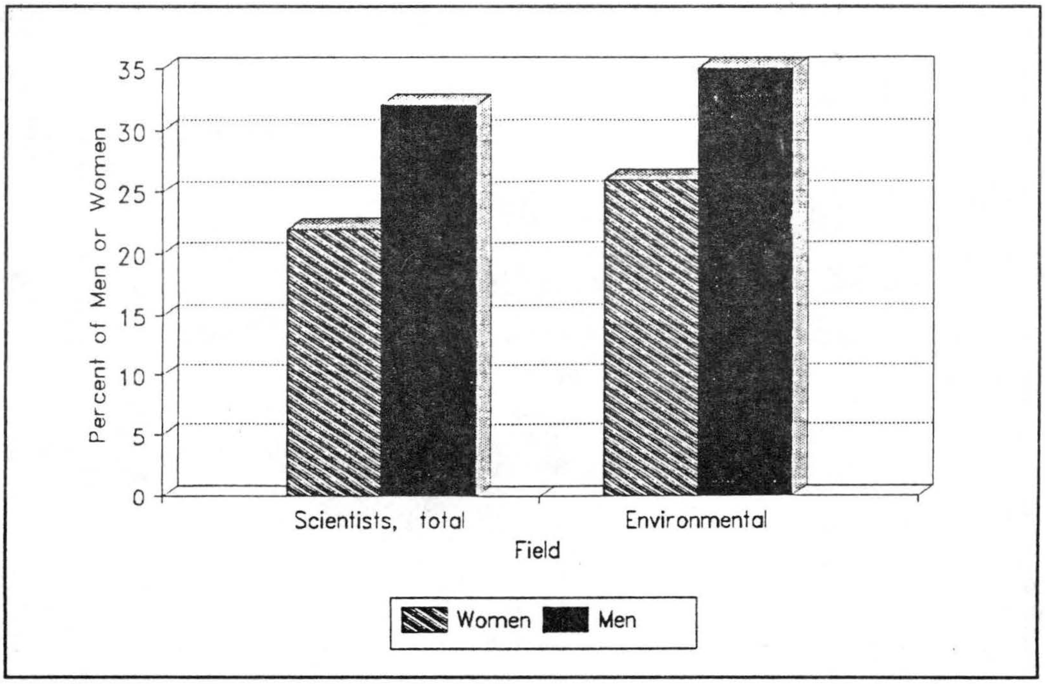

Figure 17. Percent of people in different racial/ethnic groups who live below the poverty level in the U.S., 1988. (Data from National Center for Education Statistics, 1990, p. 27).

percentage of blacks below the poverty level has stayed virtually the same since 1970 (National Center for Education Statistics, 1990; Fig. 18).

One example of the negative impact of poverty is the correlation between socioeconomic status (SES) and performance in eighth-grade science (National Center for Education Statistics, 1990; Fig. 19). Another telling case of the associated effects of poverty on the science education pipeline is demonstrated by computer use. When we look at computer usage by blacks in this computer age, we see what seems to be a race-related discrepancy. Yet, when we control for family income, then the effect of poverty stands out (National Center for Education Statistics, 1990; Figs. 20 and 21). Finally, when we look further down the pipeline at the percentage of students enrolling in post-secondary schools, it is highly correlated with high SES. The pipeline is blocked for those without a college education. We have ensured that escape from the cycle of being denied access is exceedingly difficult. Yet, we can and must address it.

Summary

We have talked about two issues in information transfer within national boundaries. The first we referred to as technology transfer either between businesses or between government and others. Free-flowing information can or should provide the mechanism for cross-fertilization, which will allow us to remain competitive.

The other issue is the number of individuals in our society available to create and interpret science information, a number determined by the flow through the science education pipeline. Problems in this pipeline could well impact projected shortages in the work force. Of course, we are all aware of the issues of equity of access, a matter of principle. We are making decisions of access by neglect, ensuring that science information will never even reach a significant portion of the population, much less that they will be trained to be sophisticated users.

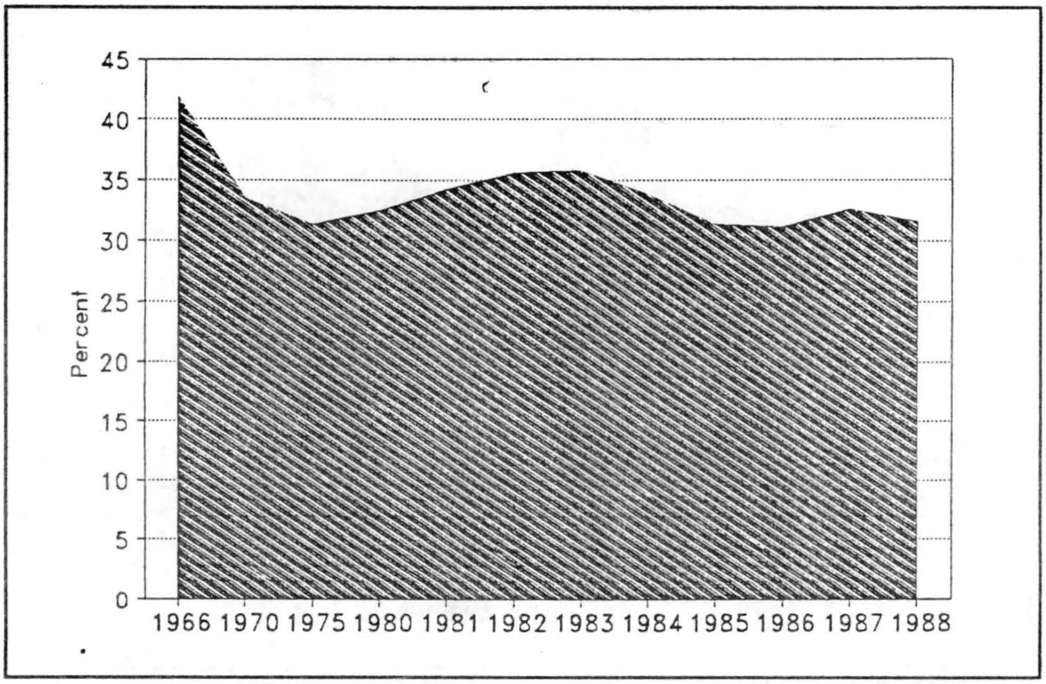

Figure 18. Percent of blacks living below the poverty line, selected years, 1966–1988, in the U.S. (Data from National Center for Education Statistics, 1990, p. 27.)

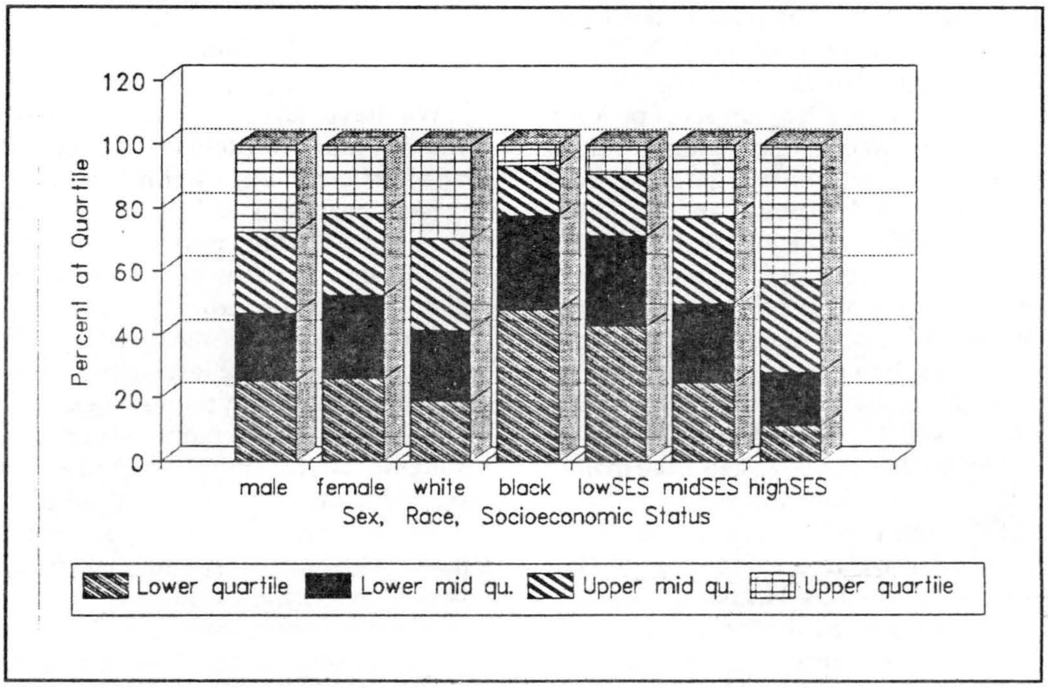

Figure 19. Ranking of eighth-grade students on standardized science tests, 1988. SES = socioeconomic status. (Data from National Center for Education Statistics, 1990, p. 122.)

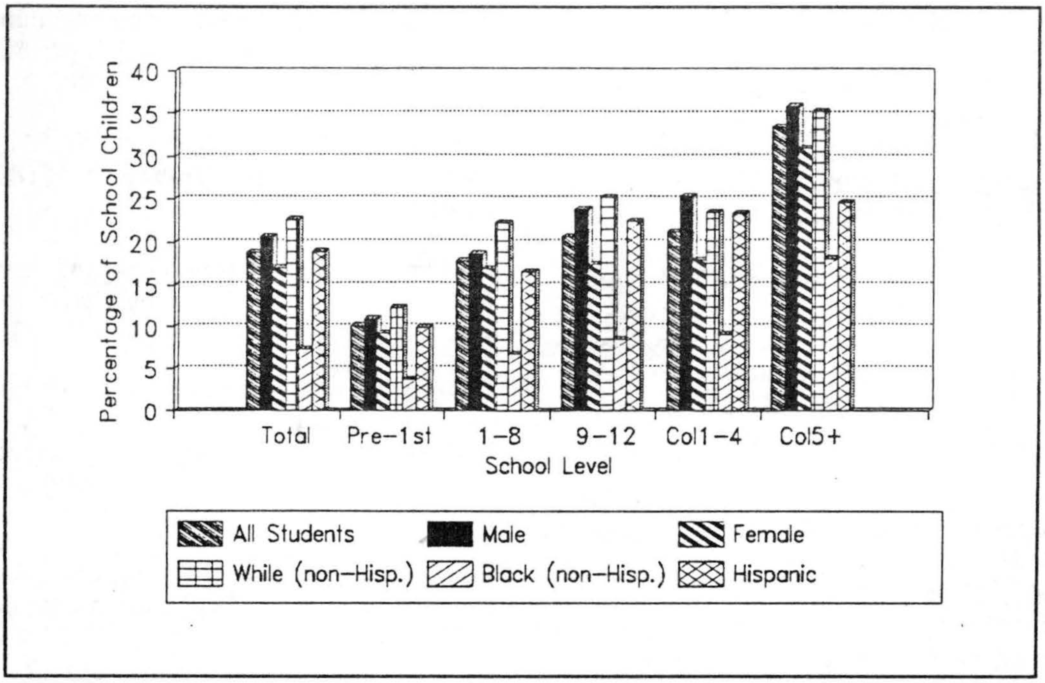

Figure 20. Student home use of computers, U.S., 1989. (Data from National Center for Education Statistics, 1990, p. 397.)

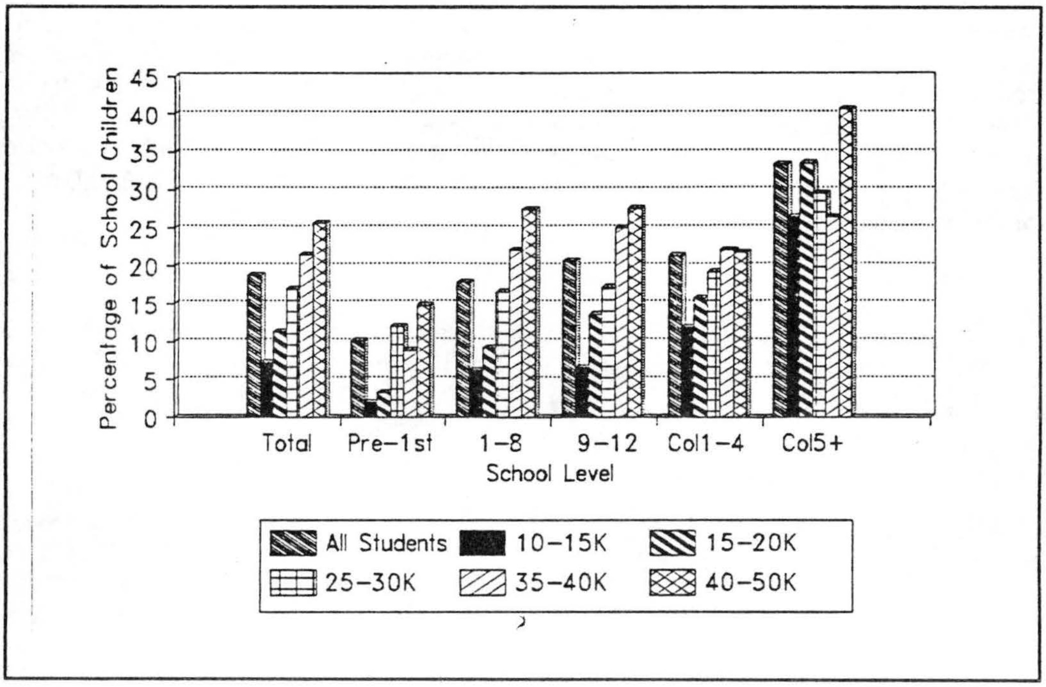

Figure 21. Student home use of computers, U.S., by family income, 1989. (Data from National Center for Education Statistics, 1990, p. 397.)

CONCLUSION

The world changes dramatically, as even we in the United States continually become less caring in spite of rhetoric to the contrary. Aid is shrinking, producing many negative effects. We have lost our sense of justice, and thereby, our national sense of direction.

Information transfer across political boundaries hits numerous filters, be they international or local in scope. I want to argue that the issues are identifiable, and with political commitment and personal action, we can make a difference. If we wait for someone else to care or to act, then information and its inherent power will be more and more concentrated in the hands of the haves, and our web—the fabric of the planet—with its multitude of interconnecting systems will become rigid and lifeless.

I would like to end by asking a few questions that address the importance of each one of us making a difference, focused particularly on the pipeline issue, though similar questions could be written for all the issues discussed today. We are all aware of the problems. Each one of us can look at the pipeline and see where the loss is, and each one of us can help correct the problems.

What are you doing? Have your representatives heard from you? How many minorities and women are in your classes, and what sort of support are you giving to the underrepresented groups? Are you a mentor for anyone? How many times have you been to a city elementary school to give a talk about your work or to help a colleague? Or, to sum up, do we care about each other and our future?

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PART II

TECHNICAL SESSION:

CURRENT ISSUES IN GEOSCIENCE INFORMATION

CAREER EXPECTATIONS OF GEOSCIENCE AND ENGINEERING BRANCH LIBRARIANS

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Abstract—Are future academic library administrators being trained in branch libraries or in more mainstream library departments? Theoretically, because of their broad and varied responsibilities, branch librarians should be very well qualified for promotion to the upper echelons of library administration. In the real world of affirmative action and national searches, however, branch librarians are possibly being overlooked in the recruitment of future library leaders.

A survey aimed at measuring the career expectations of two groups of academic branch librarians was conducted. Some of the questions asked were: (1) How do branch librarians perceive their opportunities for promotion to higher levels of library administration? (2) Are most branch librarians so content with their positions that they do not seek promotion to higher levels of management? (3) Have the responding branch librarians ever applied for higher level administrative positions, and if so, what was the outcome? (4) What are realistic career goals for branch librarians? (5) How can branch librarians enhance their promotional opportunities? The survey results indicate that as a group, geoscience and engineering branch librarians are fairly content in their careers and feel relatively optimistic with regard to their promotional opportunities.

METHODOLOGY AND DATA COLLECTION

This paper presents data from 61 respondents to a survey, consisting of 12 questions, on the career expectations of geoscience and engineering branch librarians. Copies of the questionnaires are available from the investigators upon request. The survey was mailed to 161 academic librarians who as of 1990 were members of two professional groups, the Geoscience Information Society (GIS) and the Engineering Library Division (ELD) of the American Society for Engineering Education. A total of 118 responses was received, for a 73% return rate. Of the 118 respondents, 61 (52%) identified themselves as being or having been a branch librarian. These 61 current or former branch library administrators make up the sample for this study.

DATA REVIEW

Of the 61 respondents who make up the sample, 33 (54%) administered geoscience branch libraries and 28 (46%) administered engineering branch libraries (Fig. 1). Twenty-one (34%) of the respondents were male and 40 (66%) were female. Of the total, 25 (41%) reported that they had administered a science branch library for 1–5 years, 16 (26%) for 6–10 years, 12 (20%) for 11–15 years, and 8 (13%) for 16–20 years. Twenty-four (39%) indicated that they report to the head of branch or science libraries; 18 (30%) report to the head of public services; 9 (15%) report to the head of a general or divisional science library; 5 (8%) report to the library dean or director; and 5 (8%) to other positions. These other positions were: director of research branch libraries; assistant

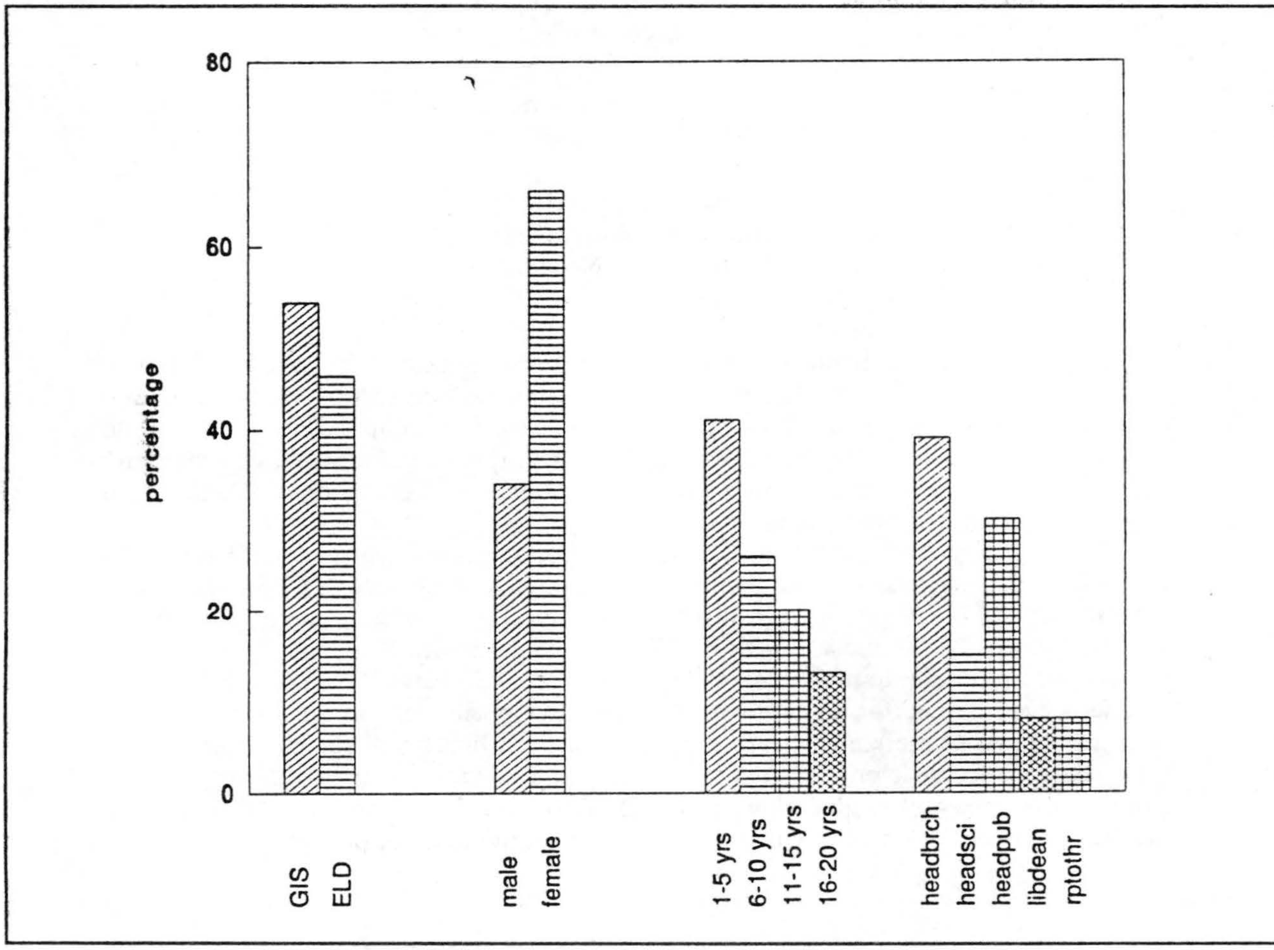

Figure 1. Composition of the sample. Number of respondents = 61.

director for branches and the undergraduate library; administrative director for science and technology; director of the Geophysical Institute with a joint appointment with the main library for teaching; and associate librarian of a specific College for the Sciences (Fig. 1).

A pivotal question was how the respondents perceived opportunities for branch librarians to be promoted to higher levels of library administration. One respondent (2% of the sample) had no opinion; 7 (11%) perceived opportunities to be almost nonexistent; 15 (25%) perceived them to be limited; 31 (51%) thought them to be good; and 7 (11%) perceived them to be excellent (Fig. 2).

The 38 respondents who indicated that they thought opportunities were good or excellent were asked to indicate realistic career goals for a science branch librarian. They were given several choices and could mark more than one. Twenty-eight marked head of branch libraries as a realistic career goal; 27 indicated head of a general science library; 24 indicated head of public services; 23 indicated library dean or director; 17 indicated head of reference; and 8 indicated other positions, including academic deans in other areas and library school faculty (Fig. 2).

The 22 respondents who said that they thought opportunities for advancement were almost nonexistent or limited were asked why they felt this way. They were given four choices and could mark more than one. Six marked that they felt that branch librarian positions were restricted on the career ladder; 15 felt that they are perceived as being too specialized to qualify and compete through national searches for higher level administrative positions; 11 responded that

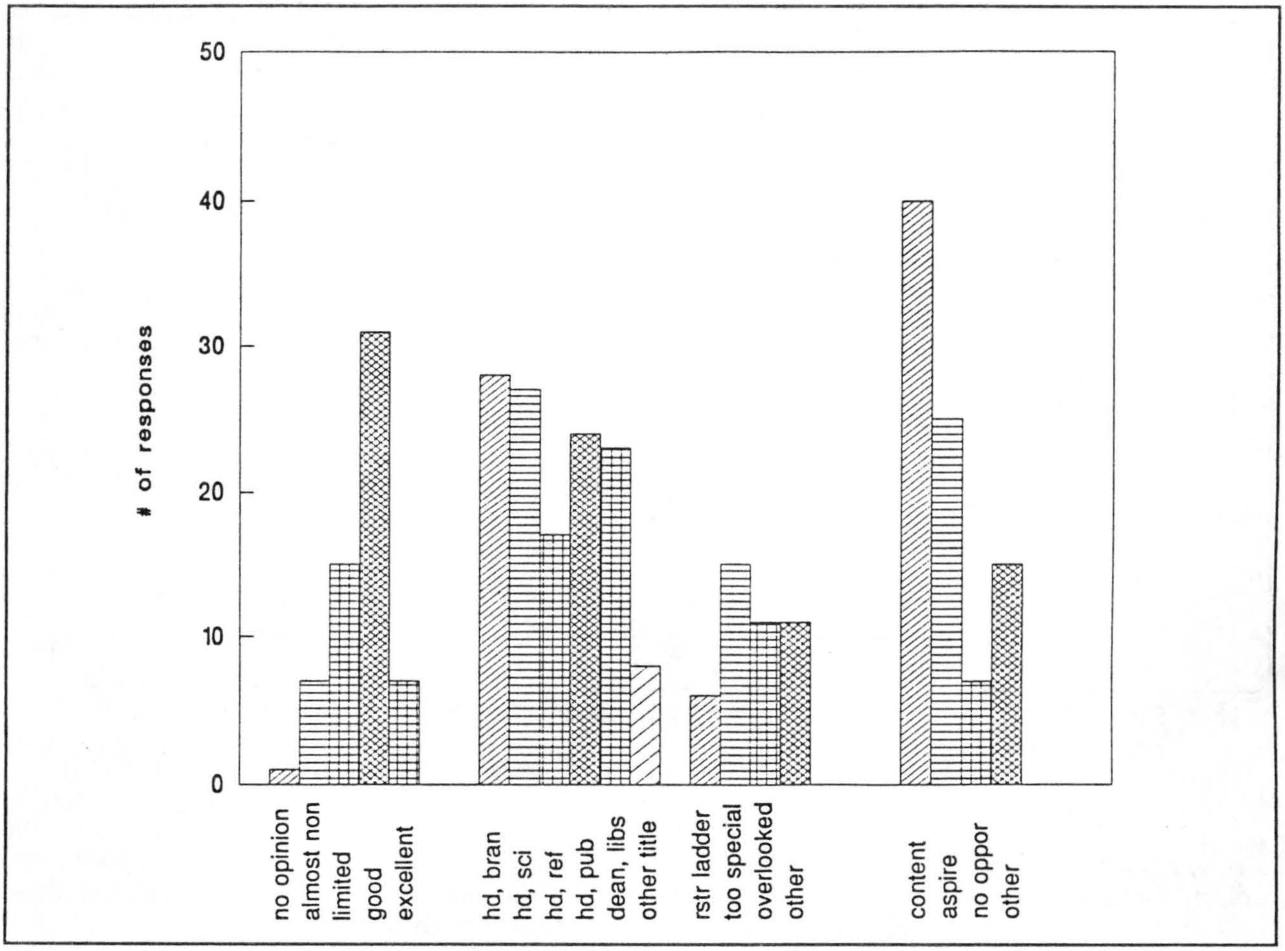

Figure 2. Promotional opportunities, goals, obstacles, and aspirations.

branch librarians are out of the mainstream and overlooked for promotion, and 11 indicated having other feelings (Fig. 2).

All but 2 of 61 answered the question inquiring if they were content being responsible for a branch library/if they aspired to go on to a higher level administrative position/if they felt they had no opportunities for advancement/if they had other feelings. Again, more than one answer could be marked. Forty (68%) reported being content; 25 (42%) aspired to move up the ladder; 7 (12%) felt they had no opportunities for advancement; and 15 (25%) had other feelings (Fig. 2).

Twenty-one respondents answered "yes" to the question on whether they had applied for a higher level administrative position within their library or elsewhere. Of the 21 applicants, 13 were geoscience branch librarians and 8 were engineering branch librarians. They were asked several questions about their assessment of the outcome of their application efforts. Sixteen answered the first question concerning whether they felt they were given serious consideration; 13 felt they were. All 16 who answered the question on whether they felt they met the qualifications for the position answered affirmatively. Sixteen indicated that they had been invited to interview, while only 1 had not. Of the 16 who answered the question on whether they had been offered the position, 7 answered affirmatively. The 5 respondents who reported other outcomes included 4 who went through the whole process, then did *not* accept the position and 1 who was not offered the position because it was never filled (Fig. 3).

In the next question, respondents were asked their reactions to two statements. The first was "as

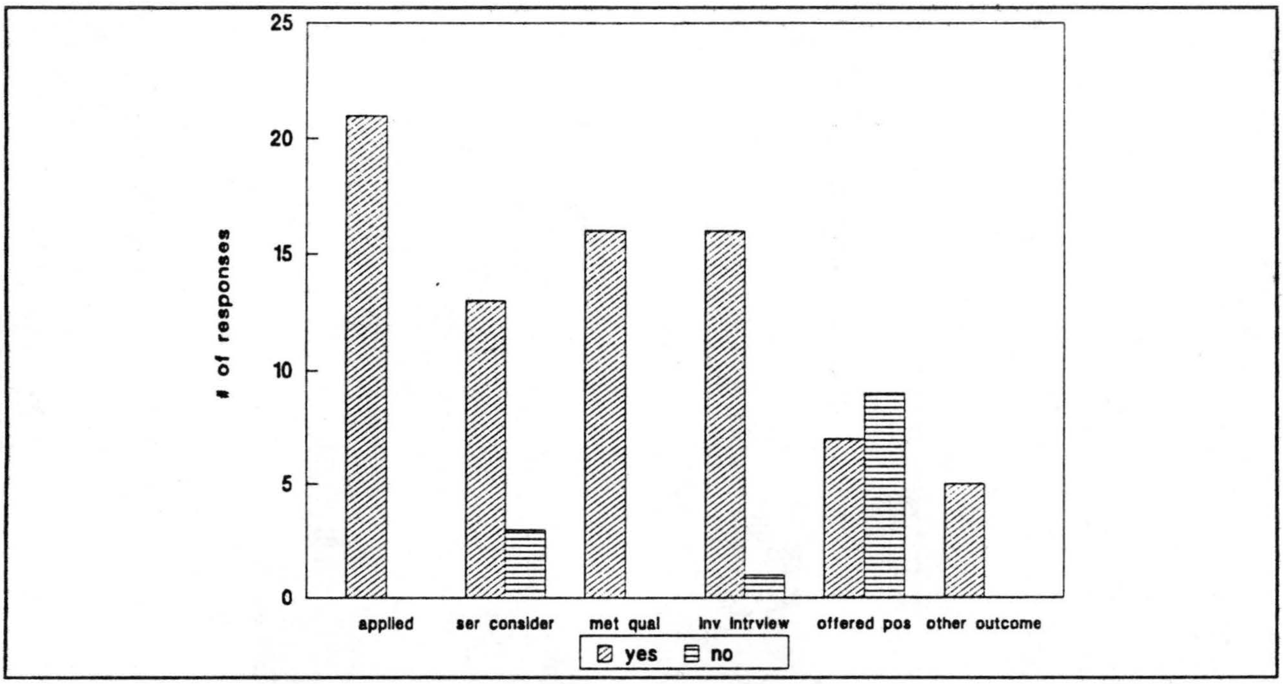

Figure 3. Outcome of applications for higher level administrative positions. Number of respondents = 21.

a rule, branch librarians are so dedicated to their branch responsibilities and clientele that they do not seek promotions." Of the 61 responding, 19 (31%) agreed; 20 (33%) disagreed; and 22 (36%) had no opinion. The second statement was "as a rule, by virtue of their varied responsibilities, branch librarians are better equipped to seek promotion." Forty-nine (80%) indicated agreement; 2 (3%) disagreed; and 10 (17%) had no opinion (Fig. 4).

All but 1 person responded to a question on what branch librarians can do to enhance their promotional opportunities. Again, more than one response could be given. Twenty-two recommended seeking a degree in business administration, public administration, or library administration; 17 recommended transfer to a more mainstream department; 35 recommended exploring promotional opportunities during periodic evaluations; 32 suggested requesting temporary placements in other library areas to broaden one's base of experience; and 31 suggested other actions (Fig. 4).

The last question asked for comments or observations concerning the upward career mobility of science branch librarians. Many of these comments reflected a higher degree of pessimism regarding promotional opportunities than did the numeric data. A selection of these comments is given later in this paper.

DATA ANALYSIS

Statistical analysis was done using SPSS-X Release 3.0 for Sun 3/fpa for cross-tabulations by gender, librarian type, and length of experience, to highlight noticeable differences in opinion.

Whereas the gender split among the 28 engineering branch librarians, coincidentally, was 50–50, the gender split among the 33 geoscience branch librarians was 21% males to 79% females (Fig. 5). There are twice as many engineering males as geoscience males and almost twice as many geoscience females as engineering females. Although the overall 34% male–66% female split may seem a bit lopsided, we feel that it is still possible to make some interesting comparisons.

Were the male/female ratios normalized (meaning halving the number of female responses, so that there would be the same number of responses from both genders), there would be a notable difference in the length of experience as a function of gender. There would be more females with 1–5

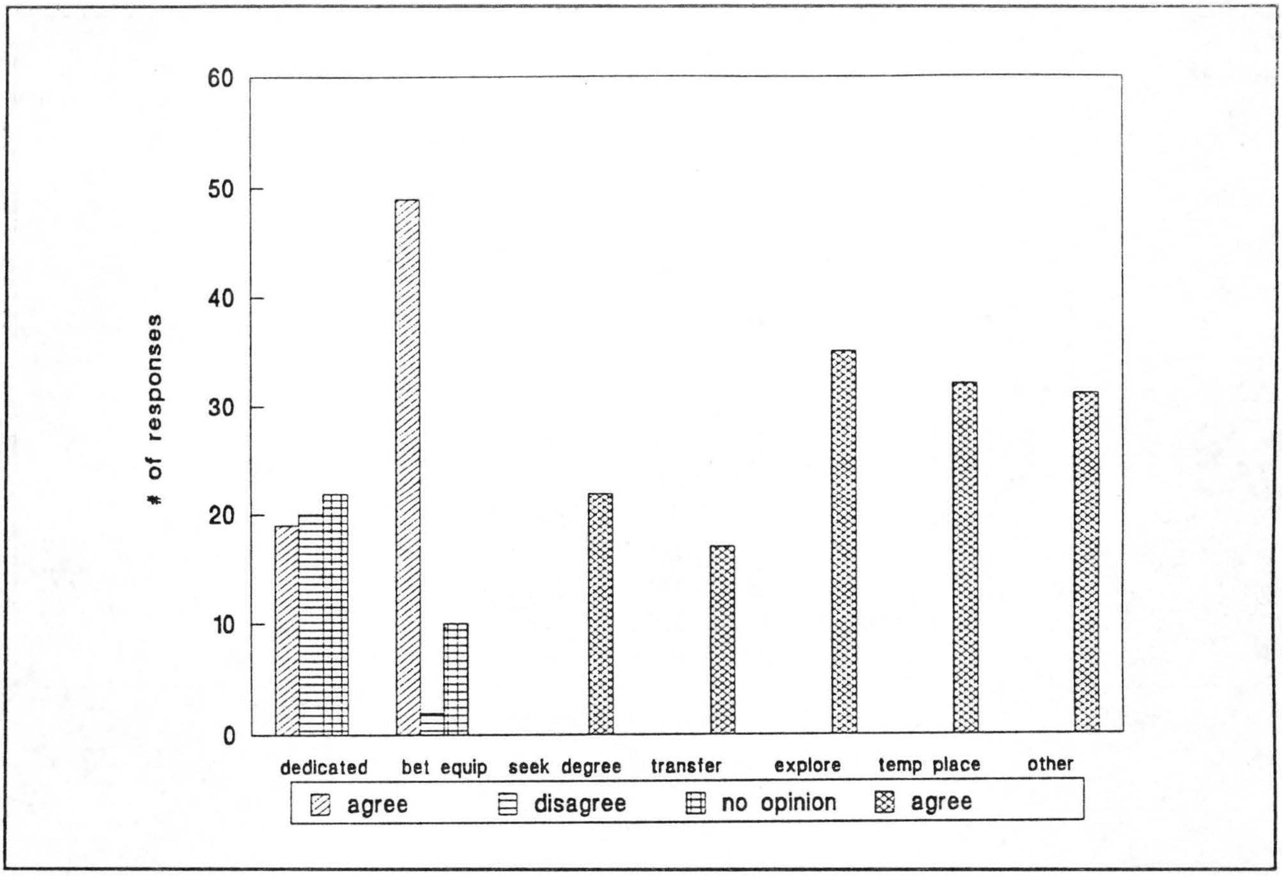

Figure 4. Promotional opportunities and enhancement thereof.

and 11–15 years of experience; more males with 6–10 years of experience; and almost two-thirds more males with 16–20 years of experience (Fig. 6).

The only major difference in the sample in terms of length of experience as a function of librarian type, is that there are two-thirds more geoscience branch librarians with 11–15 years of experience than engineering branch librarians (Fig. 7).

Were the male/female ratios normalized, there would be little difference, in an overall comparison, in perceived opportunities as a function of gender. Of the 21 males, 11 (52%) indicated that they felt that their advancement opportunities were good or excellent. Hence, there was an almost even optimistic/pessimistic split between the male respondents. Of the 40 female respondents, 27 (68%) perceived good or excellent promotional opportunities (Fig. 8).

As a group, GIS and ELD librarians feel relatively optimistic about their opportunities for promotion to higher administrative level positions (Fig. 9). ELD librarians are somewhat more optimistic than GIS librarians. Nineteen (68%) of the ELD members indicated that they felt that their opportunities for advancement were good or excellent, whereas 19 (58%) of GIS members were optimistic (Fig. 9).

Of the 25 who had administered a branch 1–5 years, 18 (72%) perceived their promotional opportunities to be good or excellent; of the 16 who had administered a branch 6–10 years, 10 (63%) thought opportunities to be good or excellent; of the 12 who had administered for 11–15 years, 8 (67%) thought opportunities good or excellent; and of the 8 who had administered 16–20 years, only 2 (25%) perceived opportunities as good or excellent (Fig. 10).

Those who have been branch librarians 10 years or less are the most optimistic. A high percentage (71%) of these "rookies" feel that promotional

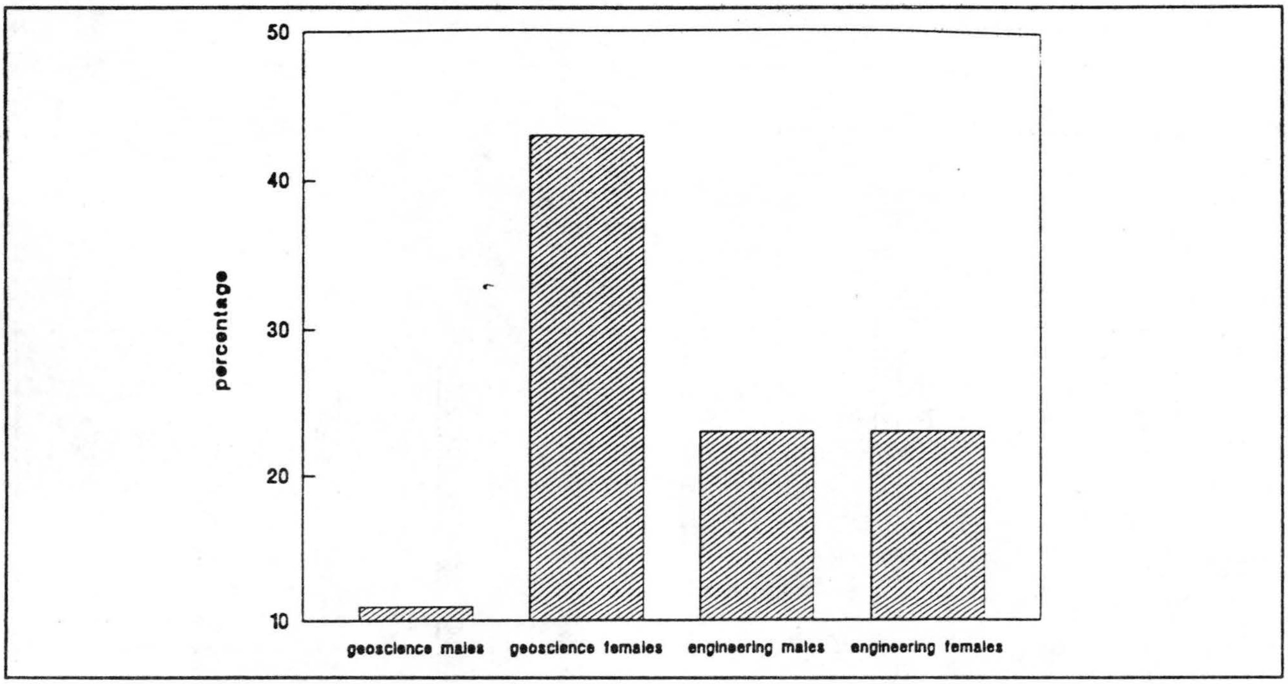

Figure 5. Librarian type as a function of gender.

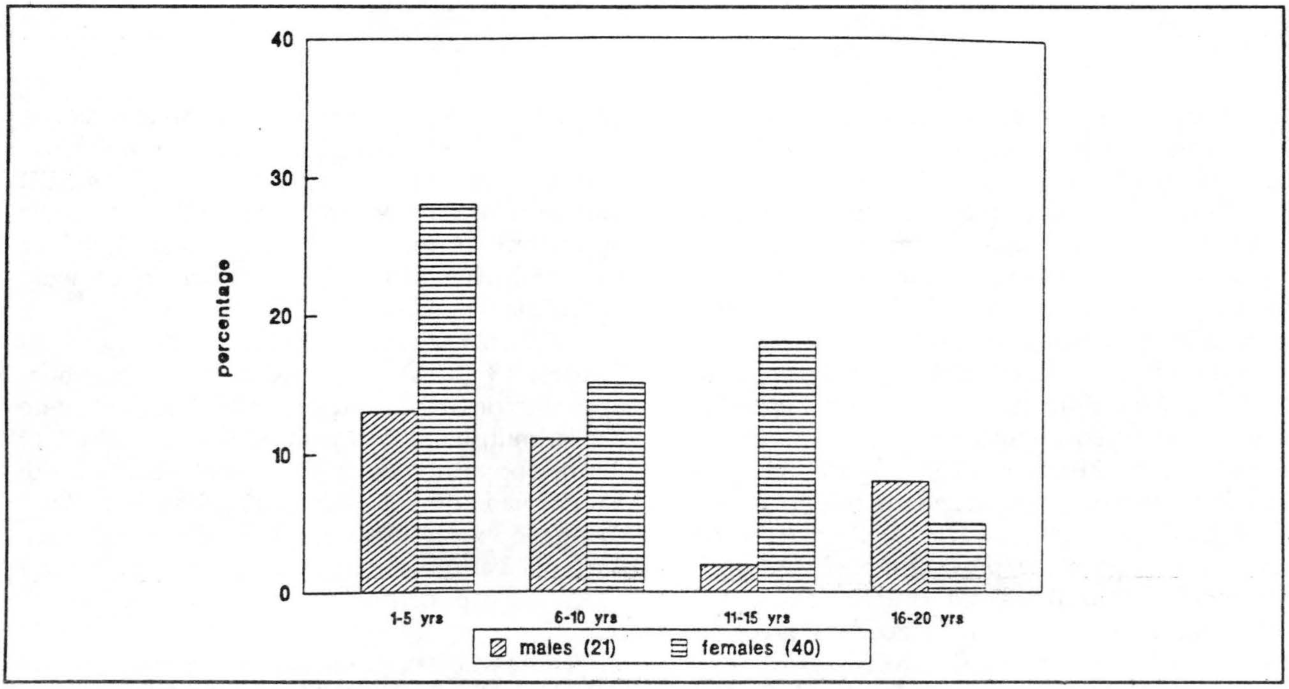

Figure 6. Length of experience as a function of gender. Number of respondents = 61.

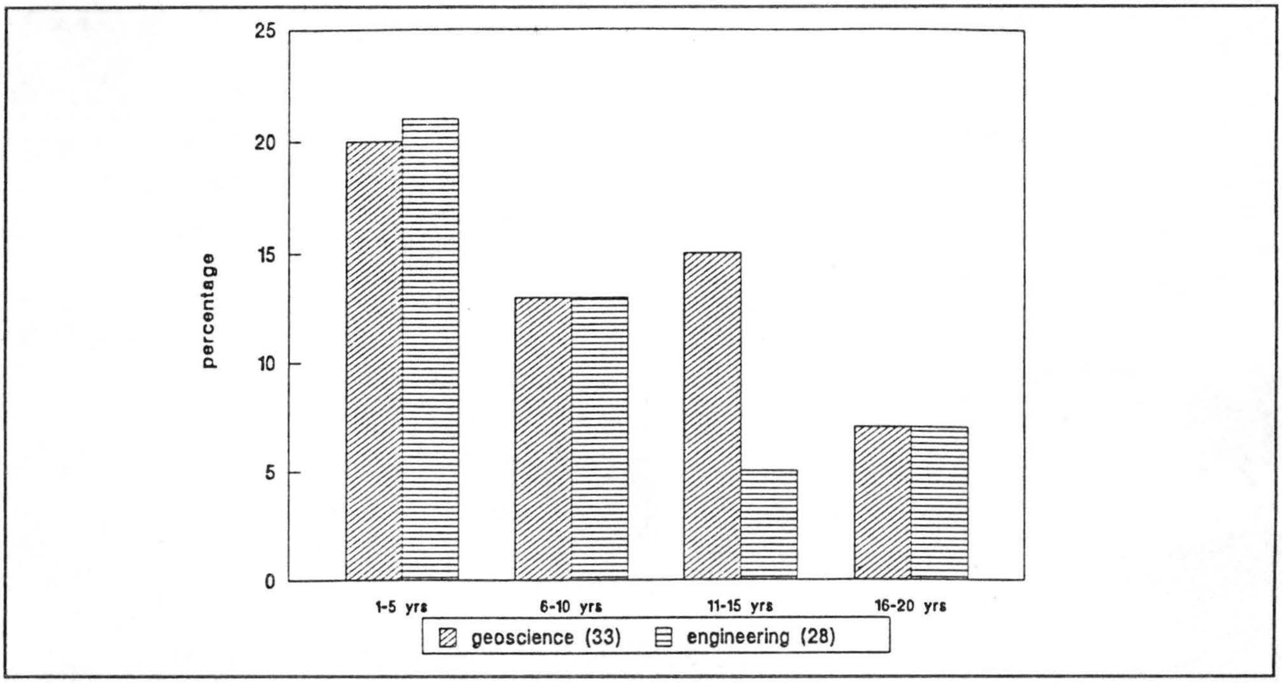

Figure 7. Length of experience as a function of librarian type. Number of respondents = 61.

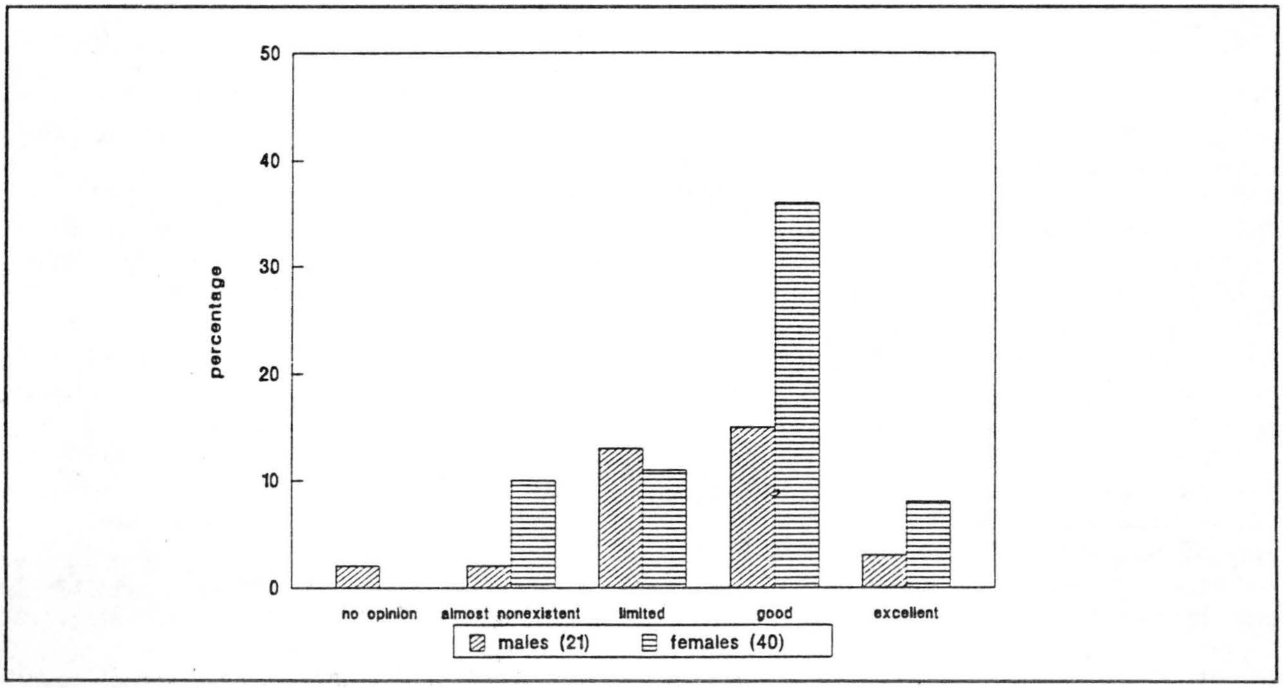

Figure 8. Perceived opportunities as a function of gender. Number of respondents = 61.

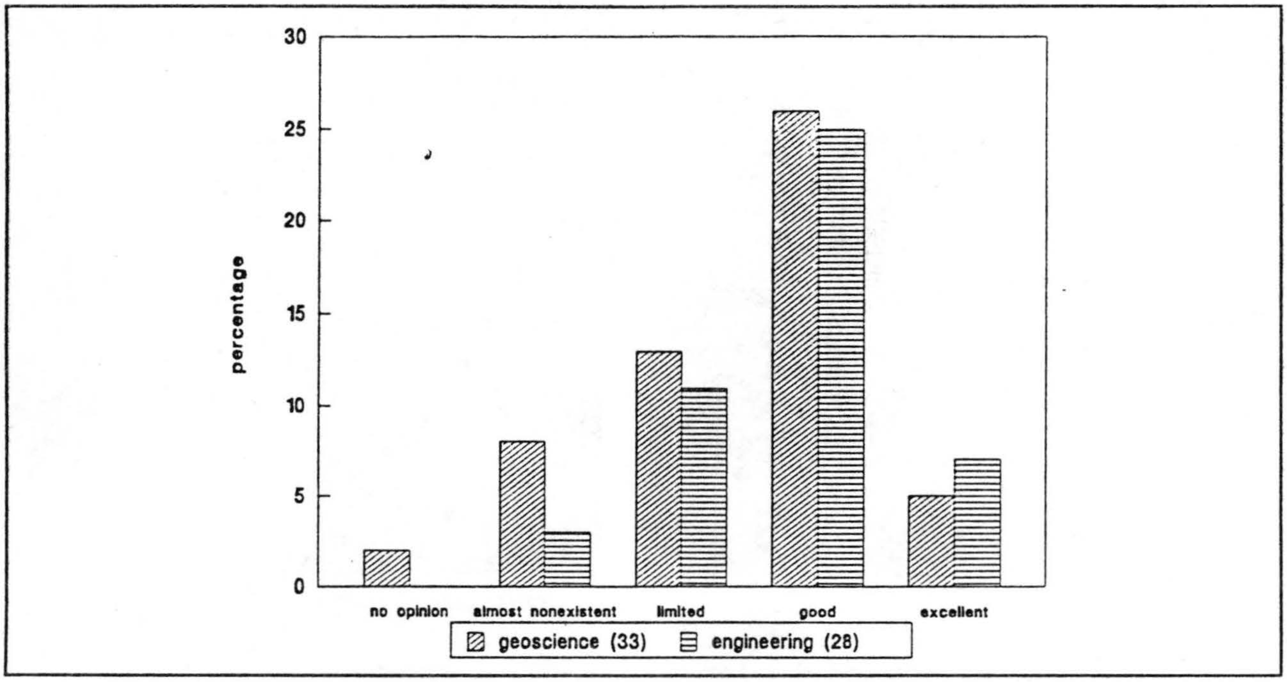

Figure 9. Perceived opportunities as a function of librarian type. Number of respondents = 61.

perceived opportunities as good or excellent (Fig. 10).

Those who have been branch librarians 10 years or less are the most optimistic. A high percentage (71%) of these "rookies" feel that promotional opportunities are good or excellent, whereas an even higher percentage (75%) of the "old-timers" feel they are almost nonexistent or limited, and the other 25% feel that they are good. No one with 16–20 years of branch experience feels that promotional opportunities are excellent. The "rookies" do the most applying and are the most successful in securing higher level administrative positions.

Four of the respondents who perceived promotional opportunities to be either good or excellent had more general comments on "other goals." All agreed that, because it depends on the individual, branch librarians should aspire to anywhere they want to go and anything they want to do. One of the four voiced this sentiment best by stating: "Any of the above: it will depend on individual's character, additional experience, intellectual breadth, analytical capacity, commitment to the profession, managerial style, leadership ability, and capacity to cope with complex issues." Another said, "I've seen people reach all these levels from branch librarian."

Half the respondents who perceived promotional opportunities to be either almost nonexistent or limited marked that they had "other reasons" for being pessimistic, although some of the "other" reasons fit within the three choices already offered on the survey. These included the following perceptions:

- that the biggest problem is that branch librarians don't often get to supervise other librarians and are misperceived to lack general administrative experience necessary for promotions;
- that their library generally does not "promote" its own people to administrative positions but imports from the outside;
- that because it is difficult to replace good branch librarians, administrators are reluctant to consider them for promotion;
- that library administrators do not understand or recognize the diverse talents and assets a branch librarian would bring to an administrative

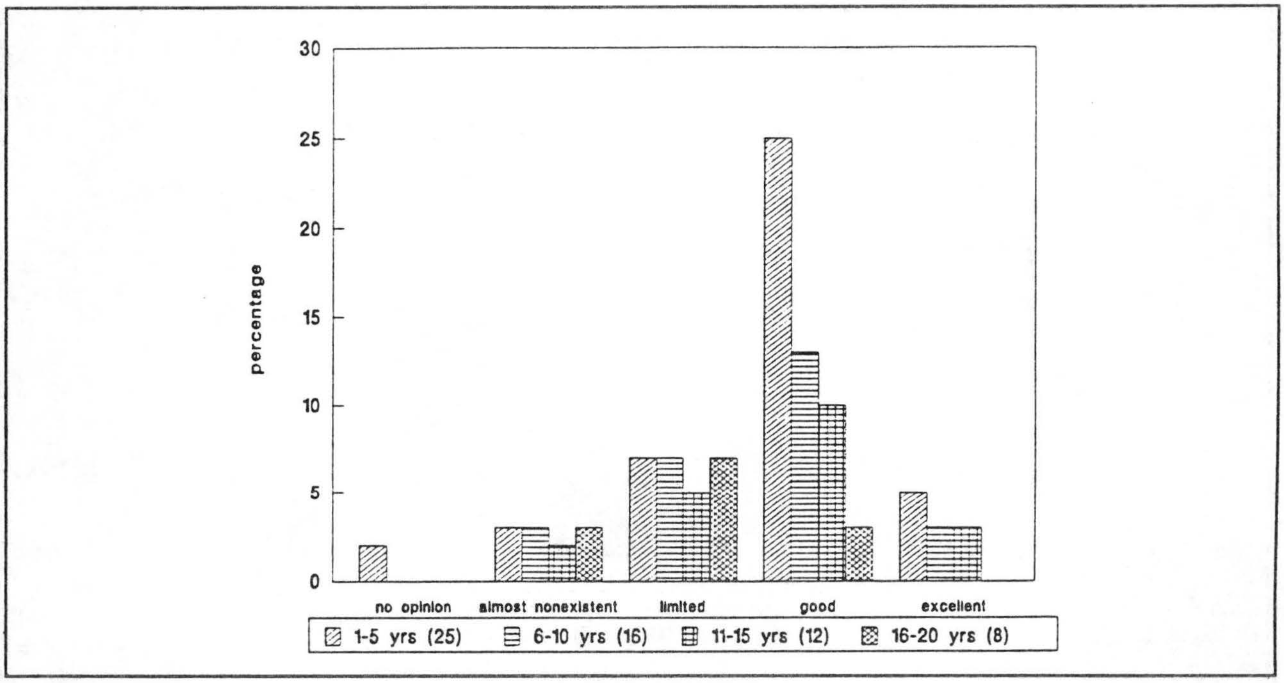

Figure 10. Perceived opportunities as a function of length of experience. Number of respondents = 61.

position because they have generally not worked in a branch and know little about what it takes to run one;

• that branch librarians are not noticed until something goes wrong, and are perceived to ally themselves with their academic departments, rather with the main library;

• that branch librarians have less contact on an ongoing basis with the library administrators who play the "gatekeeper" role in one's career moves.

Considering that they make up only one-third of the females in the sample, the female engineering branch librarians appear the most optimistic of the group, since they leaned most heavily toward perceiving promotional opportunities as good or excellent (Fig. 11). The male geoscience branch librarians are the most pessimistic; they were split between perceiving promotional opportunities as limited or good, and one expressed no opinion.

Most of the respondents (39 or 66%), even those who aspired for promotion (24 or 41%), reported being content with their branch positions (Fig. 12). The rookies appear to be content, but the vast majority of them also aspire. Only 6 (11%) of the total felt that there is no opportunity for advancement. The one respondent who had no opinion on whether or not there are opportunities for branch librarians to be promoted to higher levels of library administration indicated aspiring to go on to a higher management position. Of the 15 respondents who said that there are only limited opportunities for advancement, only 1 perceived no personal opportunities for advancement. Of the seven respondents who said that there are excellent opportunities for advancement, only 1 perceived no personal opportunities for advancement. Of the 25 respondents who had 1–5 years of experience, only 2 said that they felt they had no opportunities for advancement. And of the 16 respondents who had 6–10 years of experience, only 1 perceived no personal opportunities for advancement. Those who voiced "other" feelings included 3 respondents who were approaching retirement, 2 of whom pointed out that when they were younger, they "aspired." Three respondents stated that they felt that there is potential for growth and development in the branch position, and that it is

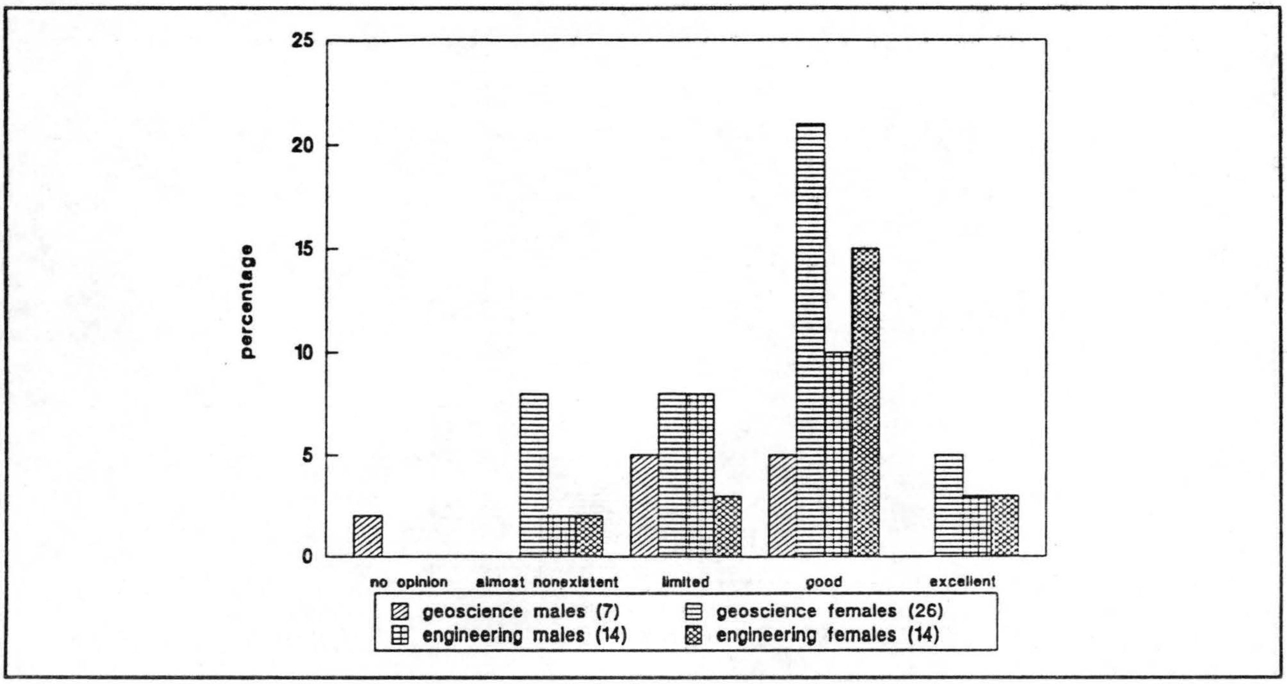

Figure 11. Perceived opportunities as a function of librarian type and gender. Number of respondents = 61.

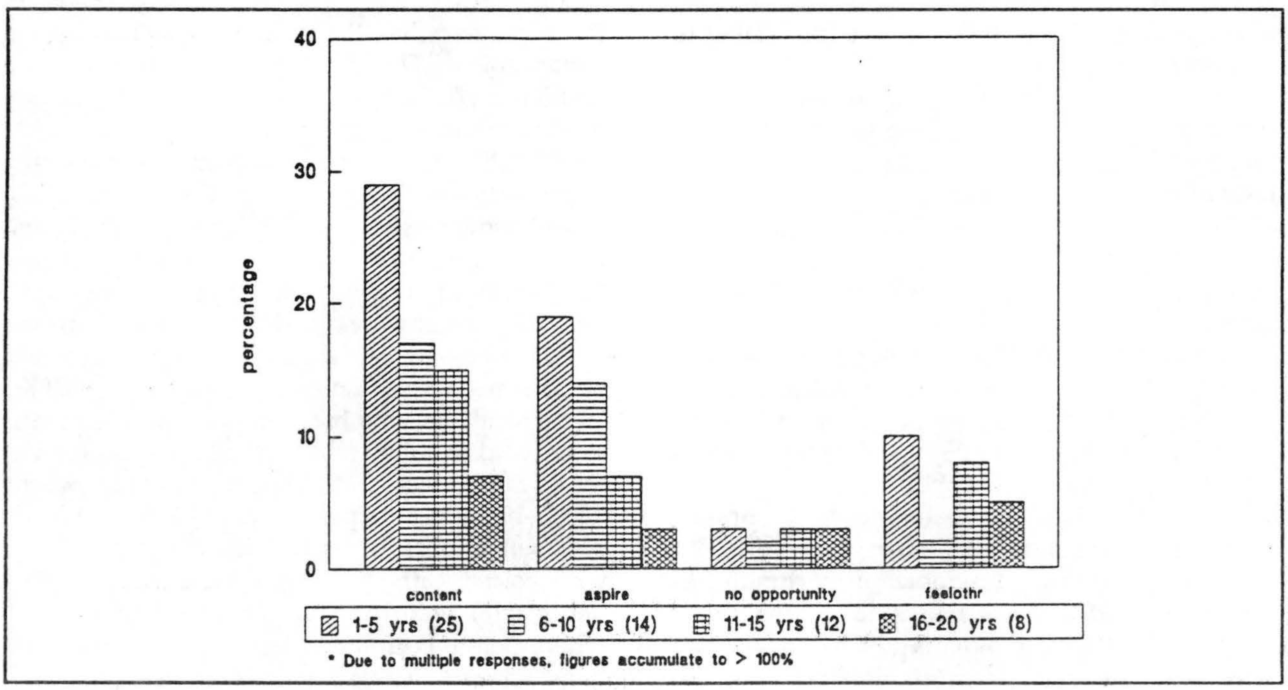

Figure 12. Aspirations as a function of length of experience. Number of respondents = 59.

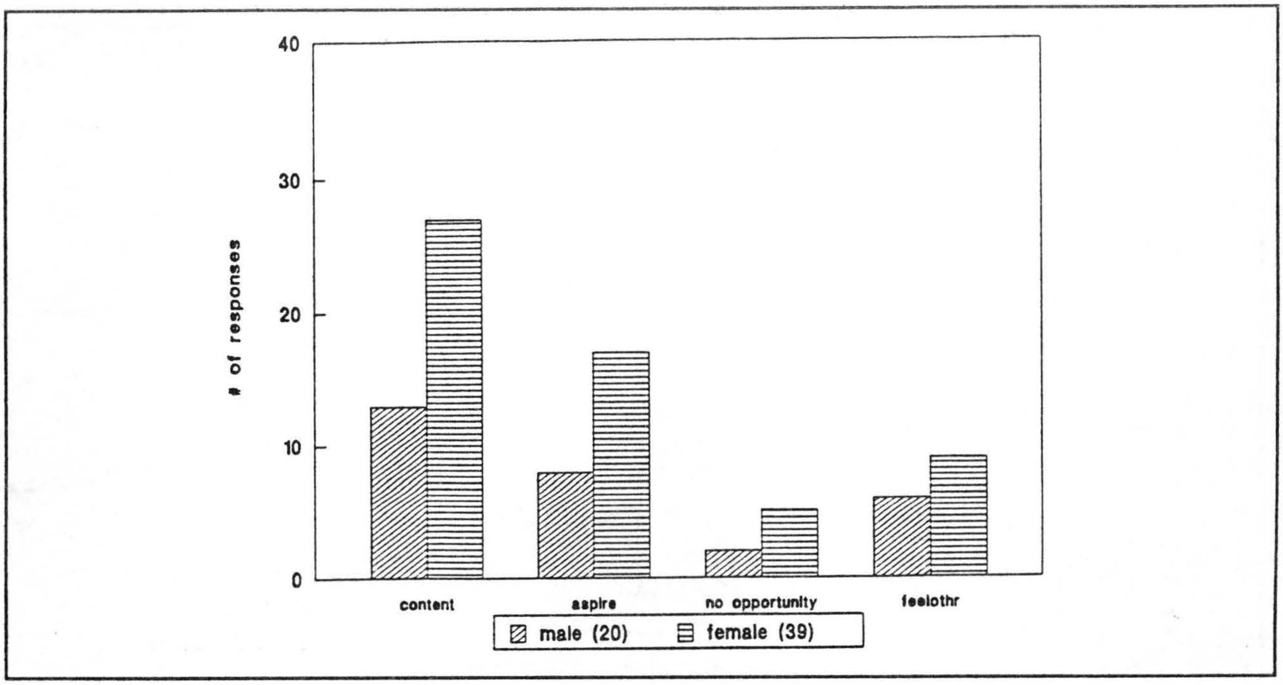

Figure 13. Aspirations as a function of gender. Number of respondents = 59.

the subject that is holding them, not the level of responsibility; that they wanted to continue to work with the disciplinary literature and weren't interested in pure management. One of these respondents stated that it is the close contact with their clientele that is the plus for a branch manager and this contact is not a part of a higher level administrative position. One respondent indicated not being *dis*contented, but wanting only to move to a position of considerably more responsibility. Another said, "We have a promotion system, so it is possible to advance through the ranks in that way." And yet another said, "I have opportunities for advancement, but they are not here."

The level of optimism does not appear to be significantly influenced by reporting lines. Of the 24 respondents who reported to a head of branch libraries, 16 (67%) indicated optimism (marked good or excellent); of the 9 who reported to a head of a general science library, 5 (56%) expressed optimism; of the 18 who reported to the head of public services, 10 (56%) were optimistic; of the 5 who reported directly to the dean/director of libraries, 3 (60%) were optimistic; and of the 5 who reported to other (mostly variations on the title "head of branch libraries"), 4 (80%) were optimistic.

Were the male/female ratios normalized, there really would not be much difference, in an overall comparison, in the respondents' characterization of their feelings about their careers (Fig. 13).

As a group, geoscience and engineering branch librarians feel good about their careers (Fig. 14). The geoscience branch librarians are somewhat more content than the engineering branch librarians. The two groups compare quite favorably in terms of the numbers of their respondents who aspire or who feel that there is no opportunity for advancement, and also in who feels otherwise.

Of the 21 respondents who had applied for higher level administrative positions, 5 were male and 16 were female (Fig. 15). Three respondents who felt they had been given serious consideration/met the qualifications/were invited to interview neglected to also mark whether or not they were offered the position. All 7 of the respondents who were offered the position

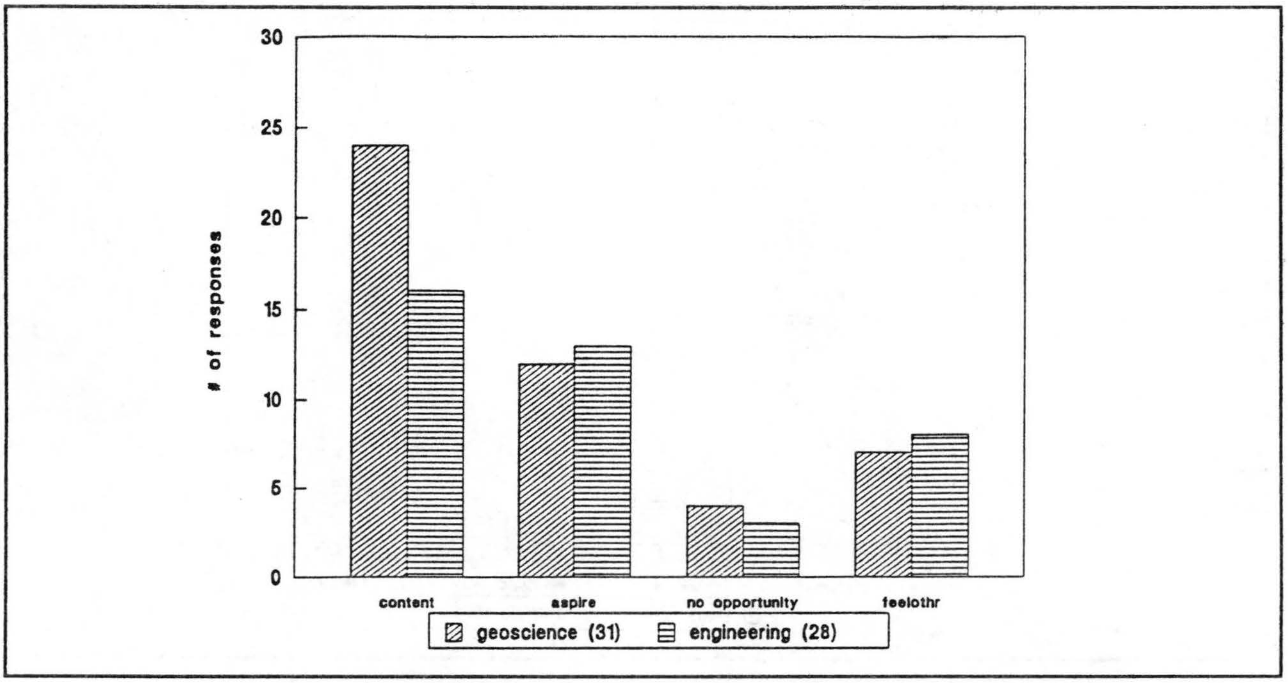

Figure 14. Aspirations as a function of librarian type. Number of respondents = 59.

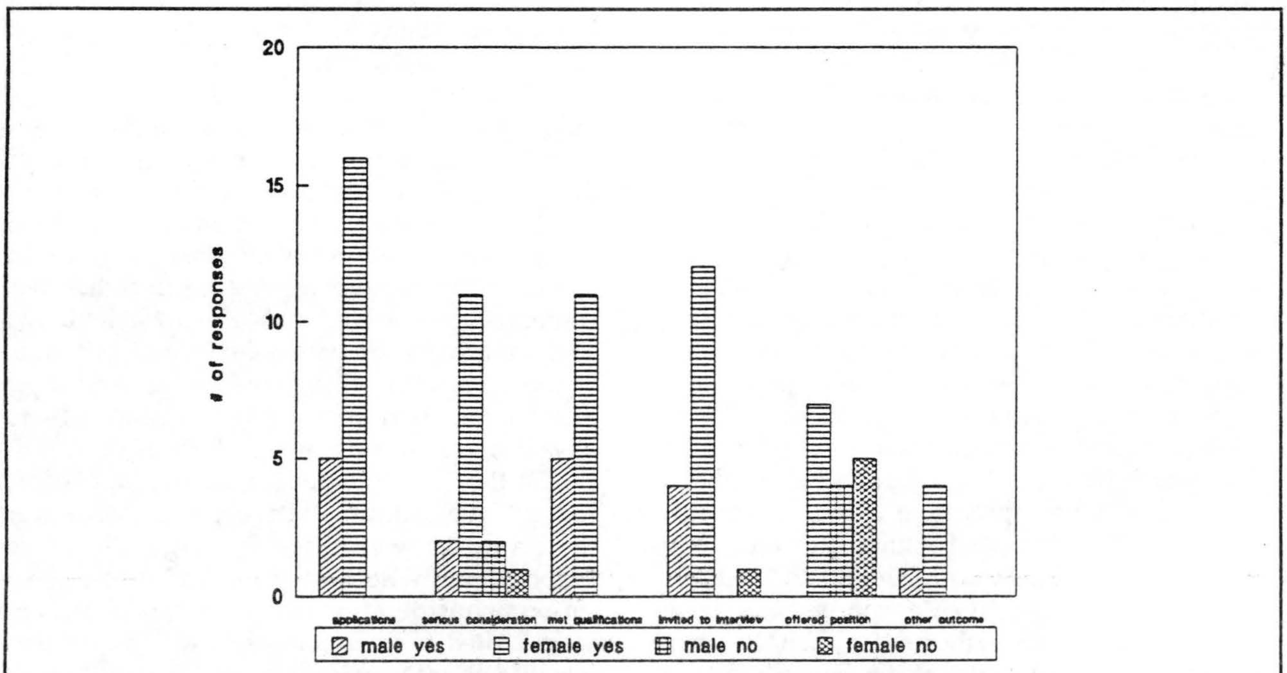

Figure 15. Outcome of applications for higher level positions as a function of gender. Number of respondents = 21.

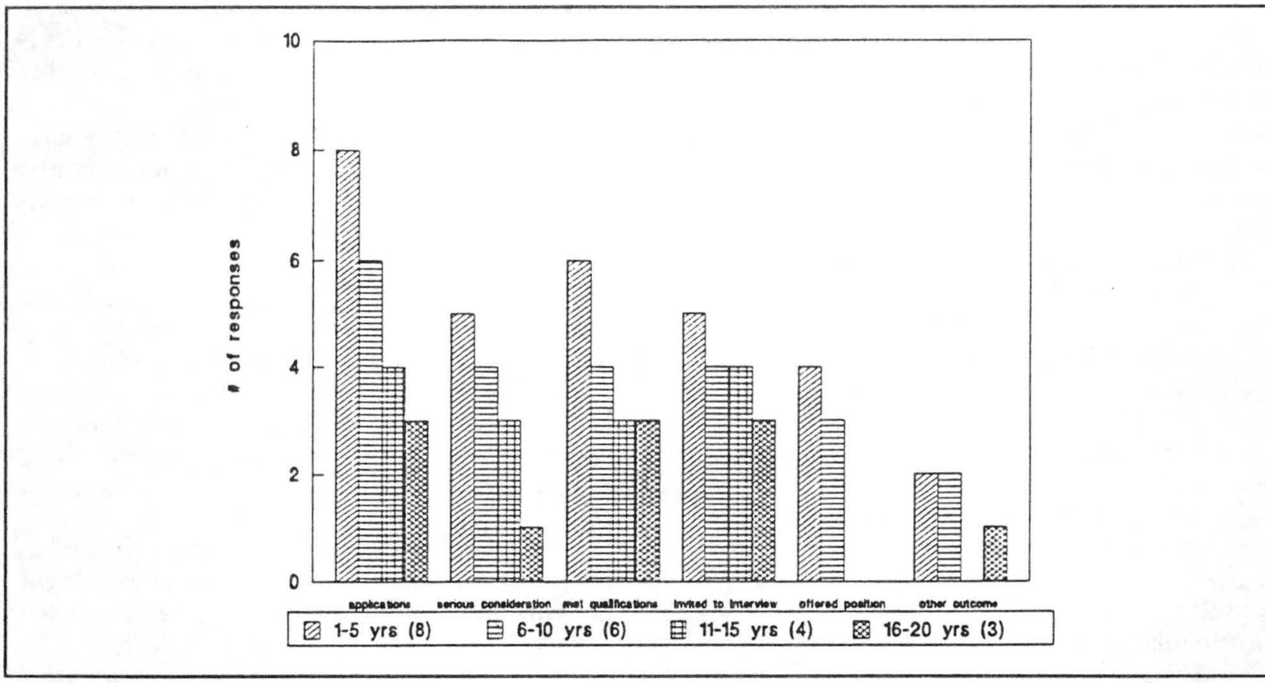

Figure 16. Outcome of applications as a function of length of experience. Number of respondents = 21.

in question were female. Of the males, only 2 felt that they had received serious consideration, while all 5 felt that they had met the qualifications for the position. Although 4 males received invitations to interview, none reported being offered the position. A fifth male reported not being invited to interview because the position in question was never filled. Four females did not accept the positions they were offered.

While 16 respondents felt their applications for higher level administration positions had been given serious consideration, it seems worth noting that of the 3 who felt that they hadn't been, all had been branch librarians for over 10 years (Fig. 16). Of the 7 respondents who had been offered higher level positions, *all* had been branch librarians for 10 years or less. It appears that the longer one is a branch librarian, the fewer reasons there are for optimism regarding promotional opportunities.

There was an almost even split between those who agreed, disagreed, and had no opinion on the statement that branch librarians are too dedicated to their branches to want to seek higher administrative level positions while, of all of the survey questions, that which garnered the highest level of agreement was the generalization that because of their varied responsibilities, branch librarians are well equipped to seek promotion.

Favored approaches to enhancing promotional avenues were exploring opportunities during periodic evaluations, requesting temporary placements in other areas to broaden experience, making oneself visible on librarywide and campus committees, being willing to relocate, and persisting in applying for higher level administrative positions. Specifically:

- 7 respondents suggested that the key is to keep applying for higher level positions, including changing focus and/or career: "either go bureaucratic or jump out of the bureaucracy."
- 7 suggested that "visibility," both in the "Main" library and outside the library, through service on committees (and community service) is crucial, since it is important to stay involved in overall library issues and systemwide planning.

Other elements to this are developing a positive relationship with higher level administration and demonstrating the ability to see the "big picture" — making it clear to the library system that there is broader interest than merely the discipline, including in library social activities because "when we're out of sight, we're out of mind."

• 5 suggested seeking training and experience in management, budgeting, systems, technical services, and other subject departments and libraries and taking on temporary assignments/ positions where one can learn, and demonstrate, leadership capabilities.

• 5 suggested that the key is a willingness to relocate.

• 3 suggested the need to obtain a Ph.D.— seemingly regardless of subject matter—and 3 suggested publishing/networking/research and consulting. One specifically suggested publishing on administrative matters.

• 2 suggested being outstanding in the job and being organized to be so competent that the "rest of the system" has to pay attention.

• 1 suggested that there is a natural alliance with the disciplinary faculty that should be capitalized upon when applying for higher level administrative positions.

And the last, rather ambitious, point mentioned by one respondent, "Try to broaden the traditional view of the 'gatekeepers' so that they have a better understanding of our talents and achievements."

The respondents' degree of optimism had an impact on their responses to the question on how to enhance their opportunities for being promoted to higher administrative positions. Of the 22 who recommended seeking another degree, 17 (77%) were optimistic (had marked good or excellent) about promotional opportunities; of the 17 who recommended transfer to a more mainstream department, only 6 (35%) were optimistic (the investigators interpret this finding to mean that the pessimists feel that a permanent change, in the form of a transfer out of the branches, is necessary); of the 35 who suggested exploring promotional opportunities during periodic evaluations, 24 (69%) were optimistic; of the 32 who recommended temporary placement to broaden experience, 21 (66%) were optimistic (the investigators interpret this finding to mean that the optimists feel that a temporary change of venues is a good idea); and of the 31 who indicated other approaches, 21 (68%) were optimistic.

On the other hand, many of the general comments, in response to the investigators' request for such, were more pessimistic than the results reflected by numerical tabulations. A selection of these comments/observations follows:

• "I moved to a higher level only by getting a temporary management position and applying elsewhere for other jobs while in that position."

• "Sometimes when applying for management positions, you encounter main library librarians who feel that you cannot "switch" allegiance to the system and therefore will be partial to your discipline and departmental libraries in general."

• "Library administration often is viewed as the province of librarians with backgrounds in the humanities. Science librarians may be considered too specialized to administer the whole library."

• "Preference seems to be given to those from large, centralized departments, e.g., reference, cataloging, or to those on fast-track administrative ladders. Having a science or technical background and largely branch experience is definitely a drawback to serious consideration for assistant/ associate director positions (or higher). This is exacerbated by the collegial environment, where the large, centralized departments constitute power blocks."

• "I was surprised to find what a limited view other librarians have of branch librarians' responsibilities when I applied for an administrative position. I was totally identified with my branch and considered unable to fulfill broader scope duties."

• "I served on a search committee recruiting for a new Assistant/Associate University Librarian for Public Services. A branch librarian within the system applied for the position. I thought he was well-qualified, well thought of, and a good candidate. He was not seriously considered by either the library administration or the rest of the search committee (from main library departments)."

• "'Visibility' also comes with proximity. Even in informal circumstances (coffee breaks), 'main' library staff are more visible to those who might potentially hire or promote them to administrative jobs."

SUMMARY AND FUTURE DIRECTIONS

This paper reports the results of a survey of two professional groups of science branch librarians. To broaden the sample, we next plan to survey agriculture and chemistry librarians. It is hoped that the additional samples will include more male librarians and more librarians with lengthy experience in branch librarianship. We plan to publish the final results in *Science and Technology Libraries*.

ACKNOWLEDGMENTS

We thank all those who responded to our survey, as well as Tori Nigro, Sandra Neese, and Young Koh for their assistance in preparing and analyzing the results of the survey.

A STUDY OF THE CHARACTERISTICS OF THE INTERNATIONAL CONFERENCES OF GEOSCIENCE INFORMATION

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Abstract—The first three international conferences of geoscience/geological information, held in London, England, Golden, Colorado, and Adelaide, South Australia, constitute a unique and emerging corpus of literature. The fourth conference, known as GeoInfo IV, has yet to publish its proceedings.

This analysis consists of a series of individual analyses, authors, their place of employment, subjects treated and the kinds of papers or studies given. Comparisons between the conferences and trends are noted and described as a guide to organizing committees for future conferences and their sponsors. Areas not covered are also noted.

INTRODUCTION

There is at once the fact that each of the printed proceedings of the conferences is bibliographically different; they surely present a cataloger or bibliographer with a challenge, to put it kindly. The London conference, held at the Royal Institute for Science and Technology in 1978, was under the sponsorship of the Geological Information Group (GIG) of the Geological Society of London, the Geoscience Information Society (GIS), the Australian Geoscience Information Association, Editerra, (European Association of Earth Science Editors) and Association of Earth Science Editors (AESE). It was published as *Geoscience Information; A State-of-the-Art Review*, edited by A. P. (Tony) Harvey and Judith A. Diment, by the Broad Oak Press Ltd., Heathfield, Sussex, England. The second conference, which had the same name as the first, was held in 1982 on the campus of the Colorado School of Mines, Golden, Colorado. Its proceedings were published by the Oklahoma Geological Survey in 1982 as Special Publication 82-4, titled *Second International Conference on Geological Information*, in two volumes edited by Claren M. Kidd. This second conference was sponsored by the GIS and GIG, but this time joined by the International Union of Geological Sciences, the Association of Chief Librarians of National Geological Surveys and the Association of Geoscientists for International Development.

The third conference had a subtle change in name; the printed proceedings was titled *Proceedings of the 3rd International Conference on Geoscience Information*. The two volumes of proceedings were edited by E. P. (Paul) Shelley and published by the Australian Mineral Foundation (AMF), Adelaide, South Australia (that being the venue for the conference). The AMF was also one of the sponsors, being identified among a "special category" of sponsors, together with the Australian Geoscience Information Association and the Bureau of Mineral Resources, Geology and Geophysics of Australia. There were 16 additional sponsors, including both GIS and GIG of the Geological Society of London.

As in any conference or series of conferences, there is a wide range of quality among the papers presented. Many have dated quickly, others are as fresh as when they were given. Some are of great import, many of only passing provincial interest. It is of interest to observe how the leadership of the sponsoring societies has evolved. A few of us have been to all three (or for that matter all four) conferences and plan to attend the fifth in Prague in 1994.

GENERAL DESCRIPTION OF THE PAPERS

There were 31 papers presented at the first, 43 at the second, and 36 at the third, plus 5 poster summaries. This analysis will be based on 102 formal presentations and poster papers for which there are full reports. The total 108 papers include 6 papers represented by abstracts only. No attempt will be made here to compare quality differences among the three conferences, only to analyze the corpus of literature as a whole and to identify differences in subject treatment and coverage of topics, formats, and authorship.

As the series has grown in stature, involved more organizations, been attended by a broader range of geoscience professionals, attained a broader geographical spread, and built on previous conferences, it has become an important part of the geoscience literature. The London conference was a solid first contribution and served as a sound foundation upon which subsequent conference organizers built. As a way of exchanging ideas and information, these conferences have proven their worth. As more and more information professionals become acquainted and as friendships are formed among conference attenders, their value has increased. From the pleasant surprise of a group of eight geologists (including their interpreter) from the People's Republic of China at the London Meeting, just as that country was beginning to open its doors to the rest of the world, to the special funds available to support the attendance of our colleagues from third-world countries at the Ottawa meeting, there has been a healthy exchange of information.

Conference papers make up an important corpus of literature of any discipline. They serve as an index of critical issues and as a measure of the profession's sophistication and maturity. International conferences are a special indicator of the maturity of a field. The first three international conferences on geoscience literature make up an important corpus of literature upon which future conferences can build and serve as a strong foundation for future work.

GENERAL ANALYSIS

Extensive studies of the publishing and communication aspects of individual disciplines have been made. Dedy Ward and I did a content analysis of 20 years of the papers presented at GIS annual meetings at the third conference in which brief references to international conferences were made:

> These sessions reflect the diverse interests of delegates in several ways. The interdisciplinary and international aspects of geoscience itself are directly reflected in the content of the programs.

And again,

> [the conferences contained a number of papers] related directly to information issues in international geoscience...basic issues and the language problems and need for translation (Ward and Walker, 1986).

The first and most obvious characteristic of the papers presented is the lack of research reported. In the first conference there were 2 papers out of 30 that reported anything remotely related to research—these two being descriptive studies of data gathered on questionnaires of limited sophistication and rigor. Of 38 papers presented at the second conference, only 1 was a careful descriptive case study. At the third conference there was a case study, the reporting of the results of a questionnaire sent to a random sample of participants, followed by detailed descriptive statistics, and one content and subject analysis reported, being the only paper that attempted an interpretation of the data gathered—and even there no hypothesis was tested.

The commonly occurring type of paper was the state-of-the-art report. The first conference was planned to be just that and was so titled. The individual papers have a variety of titles, but each could have easily been entitled, "The State-of-the-Art of Geoscience Information in _______." The blanks were eight countries and one dealing with international aspects of geoscience documentation. Another group was made up of special aspects and problems or media treatment, e.g., indexing and abstracting, maps, and society publications. Geoscience literature users of various descriptions were also represented by five papers.

At the second conference in Golden there was more of the same: state-of-the-art papers, issues in documentation, special problems and national and international aspects of geoscience literature and data. Individual databases, bibliographic files and services, and special production and distribution problems were also covered in greater or lesser detail.

The third conference showed a greater level of detail of treatment of specific problems and concerns and a broader treatment of specific places and media, patents, for example, as well as a broader interpretation of what is to be covered by the term "geoscience literature."

DETAILS OF THE ANALYSIS

Of the authors of all 108 papers (for this element only were all the papers used, including the 6 abstracts), there were 35 women authors and 113 men authors.

Place of employment of authors was only broadly identified as academic, of which there were 28; commercial, of which there were 24; government, 41; and not-for-profit (societies and organization, national and international), 15. There was almost the identical distribution by gender and place of employment in each of the conferences.

Country of employment was different at each of the three conferences, no doubt the venue having much to do with who was in attendance as well as who gave papers. The United States was most often the country of employment. Forty-six papers had the U.S. identified as the first listed author's employment, 12, 24, and 10, respectively for the 3 conferences. The U.K. was next for the first conference, with 10 speakers, but had only 5 authors at the second and 2 at the third. The Australians dominated the third conference, as one might guess, with a total of 16 authors, and a total of 20 speakers in the 3 conferences. Sixteen countries were represented in the 108 papers, Canada with 7, France and India with 4 each, China with 3, and Germany and Japan with 2 speakers each. New Zealand, Brazil, Mexico, Austria, and South Africa were each represented by a single paper. All papers were given in English, and no provisions were made for translation at the conference venues.

KIND OF STUDY AND SUBJECTS TREATED

As expected, the papers fell broadly within geoscience, a few dealt with science generally and a few with either geology specifically or narrowly with economic geology concerns.

In the first conference, 5 dealt with geology, 2 specifically with economic geology and 23 were state-of-the-art presentations, as noted earlier. In the second conference 30 papers dealt with some aspect of geoscience broadly, 4 treated problems of science information in general, 3 presented aspects of geology as it affected information, and 1 covered economic geology and documentation.

Of the 40 papers presented at the third conference, only 10 covered topics that cannot be identified as geoscience. Only 2 of these 10 were on broad science matters, 1 was in economic geology, and the remaining 7 were on specific geology concerns.

Information systems or documentation was the topic of 28 of the 102 papers presented at the 3 conferences, 21 dealt with bibliographic structure, 17 with international aspects of geoscience communication or the distribution of information, and 7 with aspects of publishing. Geodata manipulation was the subject of 12 papers, communication or information transfer in general was treated by 4 authors, and 2 authors each wrote about users of information and brokering of information through private agencies or organizations. There was one paper each on history of geoscience information, education of information professionals, bibliographies, costs and funding of online services, and a description of a government agency involved in the distribution of geoscience information.

FORMS TREATED

The most popular format described, discussed, evaluated, or criticized was the database. Reference databases, source databases, and mixed databases were the subject of 33 papers. In addition, computer use in information systems, services and their creation was the subject of 12 papers. Maps were covered by six authors, and the archival journal was the subject of three papers. Library reference materials, books, and patents were each covered by one speaker. The majority of the papers did not deal with a specific format or specific formats but treated the literature in general. These accounted for the remainder of the papers, being 45 of the 102.

GENERAL OBSERVATIONS

There were no surprises for me, but I attended all three conferences. As expected there has been a tendency toward more specific subject treatment, more universal application and a narrowing of focus as we progress through the three conferences. This analysis did not include the content of the papers presented at the fourth conference in Ottawa in 1990, but more specific topics were treated there, with more research reported than at the first three conferences reported upon here. One would expect that from the general direction of the first three conferences, and one can expect even a greater concentration of research papers at the fifth conference in Prague.

The first three conferences served the international geoscience information community quite well and have created a solid corpus of information upon which future conferences can build and from which expanded research and discovery can be shaped. We can be proud of the vehicle we built and shaped from 1978 through 1990 and can be confident that conferences to follow will serve us well. I am quite confident that the fifth conference in Prague will benefit from these earlier contributions.

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THE GEOLOGIC REMOTE SENSING FIELD EXPERIMENT: THE ARCHIVE AND ITS USE

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Abstract—The Geologic Remote Sensing Field Experiment (GRSFE) was performed in July, September, and October of 1989. It included both airborne and ground-based components and involved a total of 16 experiments. The Version 1.0 Archive Release occupies a set of nine CD-ROMs. Data are organized by experiment and are accompanied by object-oriented labels and tabular information suitable for loading into database management systems. There is also an extensive text file stored on the first CD-ROM that details each instrument involved in GRSFE and describes the overall objectives and implementation of GRSFE. The GRSFE data set collection is described in the Planetary Data System Catalog. The collection may be ordered through the catalog or through the National Space Science Data Center (NSSDC).

The objective of having simultaneous airborne and ground-based components was to acquire an information base to test theories for the extraction of surface properties using remote-sensing data. For example, in the Visible/Near Infrared region, airborne data were acquired using AVIRIS and ASAS, whereas ground-based data were acquired using a Daedalus handheld spectrometer and the Single beam visible/InfraRed Intelligent Spectroradiometer (SIRIS). In addition to the Visible/Near Infrared, the Thermal Infrared (using TIMS) and Radar wavelengths (using AIRSAR) are covered by this data set. The airborne instruments were flown over ground-based field sites in the Lunar Crater Volcanic Field, allowing data from the two airborne instruments to be compared to one another and to data from the ground instruments. This method also permits evaluation of calibration, atmospheric models, and models used to extract surface properties. Comparison of the data collected from different ground-based instruments allows assessment of instrument strengths and weaknesses.

INTRODUCTION

The Geologic Remote Sensing Field Experiment (GRSFE) consisted of coordinated airborne remote sensing and field observations over geological targets in the Mojave Desert, California, and the Lunar Crater Volcanic Field, Nevada, in July, September, and October 1989. GRSFE was funded by NASA's Planetary Geology and Geophysics Program, the Geology Program, the Planetary Data System (PDS), the Pilot Land Data System, the Mars Observer Project, and the Magellan Project. The GRSFE archive is maintained and updated by the Planetary Data System Geosciences Node at Washington University, in collaboration with the Pilot Land Data System. Version 1.0 of the GRSFE archive was released in the spring of 1991 on a set of nine CD-ROMs. This collection is meant to provide a well-documented data set for research and teaching remote sensing and geology. Release on CD-ROMs also provides concrete examples of archived data using Planetary Data System and Pilot Land Data System standards (e.g., Planetary Data System Data Preparation Workbook).

This paper describes GRSFE and how the various observations can be used synergistically to address geological remote-sensing problems. We will explain the organization of the CD-ROM archive and discuss the documentation of this very diverse data archive. Users should understand that the GRSFE archive is dynamic, and release of Version 1.0 on CD-ROMs was a convenient way to ensure wide distribution.

THE GEOLOGIC REMOTE SENSING FIELD EXPERIMENT

The GRSFE Sites

GRSFE sites for data collection were selected by the Science Steering Group (SSG), which imposed several requirements, including relevance to local geologic processes and planetary surfaces. No sites on Earth simulate surface properties of Mars or Venus in detail. The surface of Mars, for example, is highly desiccated and probably has been for millions, if not billions, of years. The 750°K, 90 bar carbon dioxide conditions at the Venusian surface probably lead to unique surface properties. Rather, the approach was to select sites that are roughly analogous to what we expect on planetary surfaces and to use GRSFE data to test models for extraction of surface property information.

Two site types were defined for GRSFE: (1) modeling sites were designated for concentrated airborne and field observations and resultant detailed modeling of GRSFE data, and (2) calibration sites were regions where ground measurements were obtained in order to calibrate the airborne data independently of any instrument-specific procedures, e.g., pre-flight and post-flight AVIRIS instrument radiometric calibrations. Modeling sites were characterized on the ground in enough detail to provide quantitative information on how electromagnetic radiation interacts with geological surfaces and materials in the visible and reflected infrared, thermal infrared, and microwave wavelengths. Both surface and atmosphere measurements were made while the airborne campaign was underway. The modeling sites are located in the Lunar Crater Volcanic Field. Logistical and financial constraints limited both the number of calibration sites and the ground measurements that could be acquired at each site. The main focus was on field spectrometer measurements that were used to characterize the reflectance and emittance of various surfaces. Corner reflectors were also deployed to calibrate AIRSAR. Table 1 gives an overview of all GRSFE sites.

The Airborne Experiment

The airborne component of the GRSFE campaign was conducted on July 17, 1989, for ASAS; September 28-29 and October 4, 1989, for AVIRIS; July 17, September 27-29, 1989, for TIMS; and September 13-14, 1989, for AIRSAR. AVIRIS flew on the NASA ER-2; ASAS and TIMS both flew on the C-130 on July 17. TIMS flew alone on the C-130 during September. AIRSAR was on board the NASA DC-8 aircraft. Table 2 contains brief descriptions of these instruments.

The original plan for the airborne campaign was to fly all four instruments at the same time over the modeling sites and within a day or so of one another for the calibration sites. In fact, ASAS and TIMS collected data throughout the day of July 17 until engine trouble on the C-130 forced cessation of operations. The ER-2 flew on July 17 with AVIRIS, but operational difficulties with the instrument precluded data collection. The DC-8 was unable to fly on July 17 because of scheduling problems, so it was not possible to get AVIRIS and AIRSAR coverage until September. It was decided to refly TIMS during September, but prior commitments for ASAS precluded its use during that month. Thus, though the field campaign was focused on the July 17 date, instrumental difficulties forced the full airborne campaign to be spread out over 3 months.

The Field Experiment

The GRSFE field campaign supported the July and September airborne observations. A base camp was set up at Lunar Lake for the July campaign focused on the modeling sites. Personnel were also deployed at the various calibration sites. Activities were divided into five functions: (1) atmospheric measurements at Lunar Lake; (2) detailed ground observations at the modeling sites; (3) thermal emission experiments at the Lunar Crater Volcanic Field in July by researchers from the University of Colorado; (4) calibration site measurements in the visible, reflected infrared, and thermal infrared wavelengths; and (5) deployment of corner

Table 1. Overview of GRSFE field sites.

Lunar Crater Volcanic Field, Nevada

Location: 250 km northwest of Las Vegas, Nevada (38°15'N, 116°W).

Age: Middle to late Pliocene and Pleistocene (0.015 to 4.2 m.y.).

Features: The field contains about 95 vents and at least 35 associated lava flows within a northeast-trending zone, up to 10 km wide and about 40 km long. Vents include cinder cones, elongate fissures, and at least two maar craters. Lava flows range up to 1.9 km wide and 6.1 km long with thicknesses of less than 3 to as much as 25 m. Progressive degradation of the cones and flows is very similar to that displayed by other basaltic volcanic fields in the southwest Basin and Range (including the Cima, Crater Flat, and Coso fields). Many of the flows in the northeast and central parts of the field are veneered with various thicknesses of air-fall tephra. In other areas, all but the youngest flows are mantled with extensive deposits of aeolian silt and fine sand. Full range of igneous (volcanic) rocks present.

Sites of interest: Lunar Lake (a playa) was used as a modeling site because it has an alluvial fan on one side, transition to cobble-strewn playa, then to playa, and on the other side are volcanic materials, including lava flows and cones of various ages and compositions.

Death Valley, California

Location: 300 km northeast of Los Angeles, CA (36°31'N, 16°50'W).

Age: Alluvial fan units are as old as 800,000 years.

Features: A variety of rock types (metamorphosed Precambrian–Paleozoic limestones, quartzites, and shales and Miocene volcanic rocks) are present.

Sites of interest: Basaltic lava flows and fanglomerates have been exhumed to form a bouldery surface appearing much like the surface of Mars as observed by Viking Lander 2. Informally called "Mars Hill." Sand dunes, about 3 km across, rise to 50 m and are located to the northwest and east of Stovepipe Wells. Ubehebe crater, approximately 700 m in diameter and 150 m deep, is located in the northern end of Death Valley. A small amount of basaltic tephra that erupted during the explosion that created Ubehebe blankets the area. Alluvial fans occur in this area. Salt deposits exist at this site.

Southern Mojave Desert, California

Location: Southeast of Baker, California (35°15'N, 116°45'W).

Age: Variable.

Features: Sand dunes, alluvial fans, basaltic volcanic flows.

Sites of interest: Kelso dune field: an extensive, complex dune field. Cima volcanic field: basaltic flows and tephra cones ranging from recent to several million years in age. Providence Mountains: alluvial fans of granitic and carbonate provenances.

Table 2. GRSFE airborne remote sensing instruments.

Instrument	Description
AIRSAR	Flew on DC-8. C, L, P-band (68 cm) polarimetric SAR. Multiple incidence angle coverage is possible by acquiring data on multiple passes. 10 m pixels with 10 to 20 km swath width.
ASAS (Advanced Solid-state Array Spectroradiometer)	Flew on C-130. 29 channel (0.47 to 0.87 micrometer) imaging system. Acquires multi-emission angle data of surface 45 ° from nadir along round track. Footprint about 2 by 3 km and pixel width of about 4 m.
AVIRIS (Airborne Visible Infrared Imaging Spectrometer)	Flew on ER-2. Covers 0.4 to 2.45 micrometer wavelength region with and 224 channels, 20 m pixels (20 km altitude), with 11 km cross track swath width.
TIMS (Thermal Infrared Multi-spectral Spectrometer)	Flew on C-130. Six broad bands in 8 to 12 micrometer region. 2.5 mrad instantaneous field of view; total field of view of 76 °.

reflectors at the microwave calibration sites. The calibration team focused on acquiring measurements for bright and dark surfaces, in the visible/near-infrared wavelengths, at each calibration site.

Advantage of Combining Airborne and Field Experiments

A synergistic relationship results from the combination of airborne and field measurements taken at the same place and time. A number of models have been conceived that predict surface characteristics from airborne or spacecraft data. The GRSFE field measurements provide ground truth, so that the surfaces viewed from the air can be very well understood. Field data can then be used to test models of how electromagnetic radiation interacts with surfaces. Better models might even be developed with continued study of the GRSFE data. Improved models mean improved confidence in using these instruments to interpret surfaces where ground measurements are extremely difficult to obtain (Antarctica, for example) or places where ground measurements are currently impossible (Mars or Venus, for example). The extensive ground measurements also permit evaluation of instruments used in GRSFE. Table 2 is a list of the GRSFE airborne instruments. Some are precursors or prototypes for instruments planned to fly on upcoming NASA missions. Widespread use of the GRSFE data will provide a great deal of experience in the community that can help guide the evolution of these instruments. Finally, the GRSFE data collection provides an important source of data to study the geology of this unique arid region.

THE ARCHIVE

The volume and directory structures of this CD-ROM conform to the standard specified by the International Organization for Standardization

(ISO, 1987). These CD-ROM disks conform to the first level of interchange, level-1.

Given the nature of GRSFE, the data are most logically organized by instrument. The archive is arranged by instrument as much as possible, but since some data sets, e.g., AVIRIS, are larger than a single CD-ROM, placing data on CD-ROMs became more complicated. The total number of CD-ROMs in the GRSFE set needed to be kept to a minimum due to cost considerations. To accomplish this the more voluminous data sets are spread among a number of CD-ROMs. For instance, parts of the AVIRIS data set are contained on seven of the nine CD-ROMs, while parts of ASAS are on two discs. A table of contents for the entire archive is printed on each CD-ROM case and is also contained in the VOLINFO.TXT document described below.

Documentation of the GRSFE data sets also proved to be a complex issue. Data formats range from tables of time and temperature to band interleaved imaging spectrometer data sets. Even similar instruments, like SIRIS and Daedalus (which are both handheld spectrometers), have different data formats. Also, GRSFE was a coordinated experiment in which a number of different experiments were taking place at the same time for specific reasons. It was decided that the primary documentation for the experiment would be a peer-reviewed document that could explain the overall GRSFE experiment and each instrument and data set for which data were submitted to the archive. This document is about 100 pages in length, and resides as an ASCII text file, named VOLINFO.TXT, on CD-ROM volume 1.

Early in the project it was decided to retain the original formats for the data sets rather than reformat all of the data to make a more uniform archive. This choice permits scientists to use any software that may have been developed by the instrument team for the data set. It also permits those scientists who are already familiar with an instrument, and who may have already written software to process the data, to use what they have already developed. Lastly, reformatting can introduce error into the data files and should be avoided if possible.

PDS labels were also used to document the data files. Figure 1 is a label for a PARABOLA data file, which is in a tabular format. The labels follow a "keyword = value" structure where the portion to the left of the equals sign is a keyword, which has a standard meaning that is defined in the PDS Data Dictionary (Cribbs and Wagner, 1991). The portion to the right of the equals sign is the value for the keyword for the data set being described. This label format allows description of all aspects of a file. The first portion of the label in Figure 1 describes the physical file, its size and structure. Next is a section that gives information about the data file including where and when the data were taken. Next the file header, which contains the column headings in the PARABOLA file, is described. Then the format of the table itself is described. Finally, each individual column is described in detail.

Index files are also provided for most of the GRSFE data sets. Figure 2 is the ASAS index file. This file contains human- and machine-readable information that is useful in locating specific data files of interest to a user. The files are suitable for populating data tables in nearly any Data Base Management System (DBMS). The index files are ASCII, comma delimited files that are padded with spaces in order to provide fixed format access. The data residing in each column varies somewhat from one data set to another due to differences between instruments and data sets. Each index file is described with a PDS label, so there is no doubt as to which elements are in which columns. The ASAS index table in Figure 2 contains the instrument identifier, the volume number of the GRSFE CD-ROM the data file resides upon, the file name, the location where the data were acquired, the date/time the data were acquired, the flight line number, the flight run number, the center latitude of the image, the center longitude of the image, the incidence angle, the emission angle, the look direction, the number of lines in the image, the number of samples in the image, and the number of records in the file.

SUMMARY

GRSFE was a coordinated experiment including airborne remote sensing experiments and extensive field experiments at carefully selected sites in the southwestern United States. The GRSFE approach allows the evaluation of new instruments and evaluation and improvement of current methods of scientific modeling of remote sensing data. Thus, the archive should be useful as

```
CCSD3ZF0000100000001NJPL3IF0PDS20000000001 = SFDU_LABEL
/* PDS label for a PARABOLA filtered
 radiometry file */
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 76
FILE_RECORDS                    = 283
/* Pointers to objects */
^TABLE_HEADER                   = ("PRBLL04F.DAT",1)
^TABLE                          = ("PRBLL04F.DAT",2)
/* Data description */
DATA_SET_ID                     = 'FEXP-E-PARB-3-RDR-SPECTRUM-V1.0'
PRODUCT_ID                      = "PRBLL04F"
INSTRUMENT_NAME                 = PARABOLA
FEATURE_NAME                    = "LUNAR LAKE"
SITE_NAME                       = "COBBLE SITE"
START_TIME                      = 1989-07-18T18:05:00Z
DESCRIPTION                     = "SKY READING"

/* Description of objects */
OBJECT                          = TABLE_HEADER
 BYTES                          = 76
 RECORDS                        = 1
 INTERCHANGE_FORMAT             = ASCII
 ^DESCRIPTION                   = "PARABOLA.TXT"
END_OBJECT                      = TABLE_HEADER

OBJECT                          = TABLE
 INTERCHANGE_FORMAT             = ASCII
 ROWS                           = 282
 COLUMNS                        = 10
 ROW_BYTES                      = 76
 OBJECT                         = COLUMN
  NAME                          = HEMISPHERE_ID
  DATA_TYPE                     = CHARACTER
  START_BYTE                    = 2
  BYTES                         = 2
  UNIT                          = 'N/A'
  FORMAT                        = 'A2'
  DESCRIPTION                   = "POSSIBLE VALUES ARE GR FOR GROUND AND SK
                                  FOR SKY"
 END_OBJECT                     = COLUMN

 OBJECT                         = COLUMN
  NAME                          = SEQUENCE_NUMBER
  DATA_TYPE                     = INTEGER
  START_BYTE                    = 5
  BYTES                         = 3
  UNIT                          = 'N/A'
  FORMAT                        = 'I3'
```

Figure 1. PARABOLA label.

```
DESCRIPTION                      = "SEQUENCE NUMBER OF DATA RECORD"
 END_OBJECT                      = COLUMN

 OBJECT                          = COLUMN
  NAME                           = OFF_NADIR_1
  DATA_TYPE                      = REAL
  START_BYTE                     = 10
  BYTES                          = 5
  UNIT                           = DEGREE
  FORMAT                         = 'F5.1'
  DESCRIPTION                    = "OFF-NADIR (VIEW ZENITH ANGLE) VALUE OF THE
                                    CENTER OF A BIN ASSIGNED TO THE PIXEL"

 END_OBJECT                      = COLUMN

 OBJECT                          = COLUMN
  NAME                           = AZIMUTH_1
  DATA_TYPE                      = REAL
  START_BYTE                     = 16
  BYTES                          = 5
  UNIT                           = DEGREE
  FORMAT                         = 'F5.1'
  DESCRIPTION                    = "AZIMUTH (VIEW AZIMUTH ANGLE) VALUE OF
                                    THE CENTER OF A BIN ASSIGNED TO THE PIXEL"

 END_OBJECT                      = COLUMN

 OBJECT                          = COLUMN
  NAME                           = OFF_NADIR_2
  DATA_TYPE                      = REAL
  START_BYTE                     = 22
  BYTES                          = 5
  UNIT                           = DEGREE
  FORMAT                         = 'F5.1'
  DESCRIPTION                    = "ACTUAL OFF-NADIR VIEW ZENITH ANGLE
                                   (RELATIVE TO LOCAL NORMAL) OF THE PIXEL"

END_OBJECT                       = COLUMN

 OBJECT                          = COLUMN
  NAME                           = AZIMUTH_2
  DATA_TYPE                      = REAL
  START_BYTE                     = 28
  BYTES                          = 5
  UNIT                           = DEGREE
  FORMAT                         = 'F5.1'
  DESCRIPTION                    = "ACTUAL VIEW AZIMUTH ANGLE IN THE 0 TO 360
                                   DEGREE COORDINATE SYSTEM, WHERE THE SUN
                                   IS AT ZERO AND BACKSCATTER
                                   DIRECTION IS AT 180"
```

Figure 1. cont.

```
  END_OBJECT                          = COLUMN

  OBJECT                              = COLUMN
   NAME                               = AZIMUTH_3
   DATA_TYPE                          = REAL
   START_BYTE                         = 34
   BYTES                              = 6
   UNIT                               = DEGREE
   FORMAT                             = 'F6.1'
   DESCRIPTION                        = "ACTUAL VIEW AZIMUTH ANGLE IN -180 TO 180
 DEGREE                                 COORDINATE SYSTEM, NEGATIVE
                                        AZIMUTH REFERS TO BOOMSIDE WHERE
                                         EQUIPMENT OR SHADOW OF THE
                                        INSTRUMENTS OBSTRUCTS THE SCAN"
  END_OBJECT                          = COLUMN

  OBJECT                              = COLUMN
   NAME                               = RADIANCE_1
   DATA_TYPE                          = REAL
   START_BYTE                         = 41
   BYTES                              = 5
   UNIT                               = 'W/M**2/STER/µ'
   FORMAT                             = 'F5.1'
   DESCRIPTION                        = "RADIANCE VALUE FOR CHANNEL 1"
  END_OBJECT                          = COLUMN

  OBJECT                              = COLUMN
   NAME                               = RADIANCE_2
   DATA_TYPE                          = REAL
   START_BYTE                         = 47
   BYTES                              = 5
   UNIT                               = 'W/M**2/STER/µ'
   FORMAT                             = 'F5.1'
   DESCRIPTION                         = "RADIANCE VALUE FOR CHANNEL 2"
  END_OBJECT                          = COLUMN

  OBJECT                              = COLUMN
   NAME                               = RADIANCE_3
   DATA_TYPE                          = REAL
   START_BYTE                         = 53
   BYTES                              = 22
   UNIT                               = 'W/M**2/STER/µ'
   FORMAT                             = 'F22.18'
   DESCRIPTION                        = "RADIANCE VALUE FOR CHANNEL 3"
  END_OBJECT                          = COLUMN

 END_OBJECT                           = TABLE
 END
```

Figure 1. cont.

"ASAS"	"GR_0009"	"[ASAS.ASALL01]ASALL01A.IMG"	"LUNAR LAKE"	"1989-07-17T20:58:20Z"	" 2"	4	38.39	116.02	22.6	23	"FORWARD "	5000	512	150001
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02A.IMG"	"LUNAR LAKE"	"1989-07-17T19:21:26Z"	" 2"	3	38.39	116.02	18.3	45	"FORWARD "	890	512	26701
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02B.IMG"	"LUNAR LAKE"	"1989-07-17T19:21:51Z"	" 2"	3	38.39	116.02	18.3	29	"FORWARD "	1030	512	30901
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02C.IMG"	"LUNAR LAKE"	"1989-07-17T19:22:09Z"	" 2"	3	38.39	116.02	18.3	14	"FORWARD "	860	512	25801
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02D.IMG"	"LUNAR LAKE"	"1989-07-17T19:22:23Z"	" 2"	3	38.39	116.02	18.3	0	"NADIR "	820	512	24601
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02E.IMG"	"LUNAR LAKE"	"1989-07-17T19:22:38Z"	" 2"	3	38.39	116.02	18.3	15	"BACKWARD"	630	512	18901
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02F.IMG"	"LUNAR LAKE"	"1989-07-17T19:22:52Z"	" 2"	3	38.39	116.02	18.3	30	"BACKWARD"	530	512	15901
"ASAS"	"GR_0009"	"[ASAS.ASALL02]ASALL02G.IMG"	"LUNAR LAKE"	"1989-07-17T19:23:06Z"	" 2"	3	38.39	116.02	18.3	45	"BACKWARD"	740	512	22201
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03A.IMG"	"LUNAR LAKE"	"1989-07-17T19:31:37Z"	"16"	1	38.39	116.02	17.7	45	"FORWARD "	1050	512	31501
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03B.IMG"	"LUNAR LAKE"	"1989-07-17T19:31:59Z"	"16"	1	38.39	116.02	17.7	29	"FORWARD "	1120	512	33601
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03C.IMG"	"LUNAR LAKE"	"1989-07-17T19:32:18Z"	"16"	1	38.39	116.02	17.7	15	"FORWARD "	880	512	26401
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03D.IMG"	"LUNAR LAKE"	"1989-07-17T19:32:34Z"	"16"	1	38.39	116.02	17.7	0	"NADIR "	770	512	23101
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03E.IMG"	"LUNAR LAKE"	"1989-07-17T19:32:48Z"	"16"	1	38.39	116.02	17.7	15	"BACKWARD"	700	512	21001
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03F.IMG"	"LUNAR LAKE"	"1989-07-17T19:33:03Z"	"16"	1	38.39	116.02	17.7	30	"BACKWARD"	670	512	20101
"ASAS"	"GR_0009"	"[ASAS.ASALL03]ASALL03G.IMG"	"LUNAR LAKE"	"1989-07-17T19:33:17Z"	"16"	1	38.39	116.02	17.7	45	"BACKWARD"	1080	512	32401
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04A.IMG"	"LUNAR LAKE"	"1989-07-17T14:50:30Z"	"15"	1	38.39	116.02	65.4	45	"FORWARD "	550	512	16501
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04B.IMG"	"LUNAR LAKE"	"1989-07-17T14:50:57Z"	"15"	1	38.39	116.02	65.4	29	"FORWARD "	700	512	21001
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04C.IMG"	"LUNAR LAKE"	"1989-07-17T14:51:16Z"	"15"	1	38.39	116.02	65.4	14	"FORWARD "	700	512	21001
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04D.IMG"	"LUNAR LAKE"	"1989-07-17T14:51:33Z"	"15"	1	38.39	116.02	65.4	0	"NADIR "	470	512	14101
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04E.IMG"	"LUNAR LAKE"	"1989-07-17T14:51:44Z"	"15"	1	38.39	116.02	65.4	15	"BACKWARD"	690	512	20701
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04F.IMG"	"LUNAR LAKE"	"1989-07-17T14:52:00Z"	"15"	1	38.39	116.02	65.4	30	"BACKWARD"	670	512	20101
"ASAS"	"GR_0001"	"[ASAS.ASALL04]ASALL04G.IMG"	"LUNAR LAKE"	"1989-07-17T14:52:18Z"	"15"	1	38.39	116.02	65.4	45	"BACKWARD"	640	512	19201
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05A.IMG"	"LUNAR LAKE"	"1989-07-17T15:10:20Z"	" 2"	2	38.39	116.02	61.6	45	"FORWARD "	400	512	12001
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05B.IMG"	"LUNAR LAKE"	"1989-07-17T15:10:38Z"	" 2"	2	38.39	116.02	61.6	29	"FORWARD "	680	512	20401
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05C.IMG"	"LUNAR LAKE"	"1989-07-17T15:10:55Z"	" 2"	2	38.39	116.02	61.6	14	"FORWAR "	690	512	20701
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05D.IMG"	"LUNAR LAKE"	"1989-07-17T15:11:11Z"	" 2"	2	38.39	116.02	61.6	0	"NADIR "	540	512	16201
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05E.IMG"	"LUNAR LAKE"	"1989-07-17T15:11:24Z"	" 2"	2	38.39	116.02	61.6	15	"BACKWARD"	520	512	15601
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05F.IMG"	"LUNAR LAKE"	"1989-07-17T15:11:36Z"	" 2"	2	38.39	116.02	61.6	30	"BACKWARD"	560	512	16801
"ASAS"	"GR_0001"	"[ASAS.ASALL05]ASALL05G.IMG"	"LUNAR LAKE"	"1989-07-17T15:11:53Z"	" 2"	2	38.39	116.02	61.6	45	"BACKWARD"	750	512	22501
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01A.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:14:32Z"	" 1"	3	38.49	116.02	25.2	45	"FORWARD "	830	512	24901
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01B.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:14:55Z"	" 1"	3	38.49	116.02	25.2	29	"FORWARD "	800	512	24001
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01C.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:15:10Z"	" 1"	3	38.49	116.02	25.2	14	"FORWARD "	790	512	23701
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01D.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:15:24Z"	" 1"	3	38.49	116.02	25.2	0	"NADIR "	740	512	22201
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01E.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:15:38Z"	" 1"	3	38.49	116.02	25.2	15	"BACKWARD"	660	512	19801
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01F.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:15:53Z"	" 1"	3	38.49	116.02	25.2	30	"BACKWARD"	470	512	14101
"ASAS"	"GR_0009"	"[ASAS.ASALV01]ASALV01G.IMG"	"LUNAR CRATER VOLCANIC FIELD"	"1989-07-17T21:16:07Z"	" 1"	3	38.49	116.02	25.2	45	"BACKWARD"	730	512	21901
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01A.IMG"	"UBEHEBE"	"1989-07-17T20:25:38Z"	" 5"	2	37.00	117.40	17.3	45	"FORWARD "	800	512	24001
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01B.IMG"	"UBEHEBE"	"1989-07-17T20:26:07Z"	" 5"	2	37.00	117.40	17.3	29	"FORWARD "	910	512	27301
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01C.IMG"	"UBEHEBE"	"1989-07-17T20:26:27Z"	" 5"	2	37.00	117.40	17.3	14	"FORWARD "	1100	512	33001
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01D.IMG"	"UBEHEBE"	"1989-07-17T20:26:46Z"	" 5"	2	37.00	117.40	17.3	0	"NADIR "	720	512	21601
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01E.IMG"	"UBEHEBE"	"1989-07-17T20:27:01Z"	" 5"	2	37.00	117.40	17.3	15	"BACKWARD"	750	512	22501
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01F.IMG"	"UBEHEBE"	"1989-07-17T20:27:15Z"	" 5"	2	37.00	117.40	17.3	30	"BACKWARD"	830	512	24901
"ASAS"	"GR_0001"	"[ASAS.ASAUB01]ASAUB01G.IMG"	"UBEHEBE"	"1989-07-17T20:27:37Z"	" 5"	2	37.00	117.40	17.3	45	"BACKWARD"	760	512	22801

Figure 2. ASAS index table.

a tool for teaching remote sensing at a number of levels.

The data are published on a set of nine peer-reviewed CD-ROMs, organized by instrument. The archive is documented using an extensive, peer-reviewed document that describes the general and specific details of the overall experiment, as well as each instrument and its data sets. PDS labels are used to describe the data file structures, and index tables are to locate specific data files.

NASA-sponsored researchers can order the CD-ROMs mentioned in this article through the PDS catalog. Orders for data can also be placed by researchers or individuals through the National Space Science Data Center's Coordinated Request and User Support Office (301-286-6695).

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Table 3. GRSFE participants.

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USA_NASA_PDS_GR_0003,
USA_NASA_PDS_GR_0004,
USA_NASA_PDS_GR_0005,
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ARCTIC DATA INTERACTIVE: AN ELECTRONIC SCIENCE JOURNAL

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Abstract—Multimedia computer technology offers exciting new possibilities for communicating complex scientific processes. Through the use of computer graphics, satellite imagery, and animation, data and information can be visually depicted in ways to enhance analysis of earth science phenomena such as seafloor spreading, plate tectonics, and sea ice concentrations.

In 1990, the U.S. Geological Survey and several other federal agencies agreed to use multimedia technology to promote access to data and information on global environmental change. Effective data management is one of the goals of the global change research community. To meet this goal, a project was established to design and implement prototype as an electronic science journal. The objective of the project, known as the Arctic Data InterActive (ADI), was to integrate a variety of scientific information, including complete texts of scientific papers, numeric and spatial data sets, and related software for data analysis. The Arctic was selected because it is one of the first geographic regions to respond to changing climate.

The design of ADI is based on hypertext technology. Hypertext, also known as hypermedia, is defined in the computer and information science literature as a software environment for developing nonsequential data base management systems. Hypertext techniques provide the capability to create associative links between structured and unstructured information that may include data, text, graphics, imagery, and sound. A hypertext link, which is conceptually similar to a footnote or a parenthetical phrase, directs the reader to related points or topics for further research.

Hypertext technology allows easy access to a mix of information through the use of a graphical user interface. The use of icons for representing different system functions allows readers to browse through information by following associative links between bibliographies, numeric data, textural information, and spatial imagery.

[Editor's Note: No paper was submittted; for further information, please see Wiltshire, D. A., 1991, Arctic Data InterActive–a hyper-media system, *in* U.S. Geological Survey Yearbook Fiscal Year 1990, p. 85–87.]

PATENTS AS A GEOSCIENCE INFORMATION SOURCE AND THEIR RETRIEVAL USING THE CASSIS CD-ROM SYSTEM

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Abstract—Patents are important sources of scientific and technical information that are used in a variety of contexts. Approximately 80% of the scientific information contained in patent documents does not appear in other forms of literature. Ironically, patents are an underused source of information in most fields of science and technology.

Although few authors have written about patents as geoscience document types, a sizable number of patents contain information pertinent to geoscience fields. Realistically, patents will always be a relatively minor form of geoscience literature. The high cost of searching patent databases or the labor of a manual search is further discouragement.

A procedural problem also exists in accessing patents. Patents are usually classified by each national patent office according to either the International Patent Classification or their unique national code. Subject-oriented indexes using the vocabulary and indexing structure most common in their fields may miss closely related patents. Studies have shown that even full-text searching may fail to retrieve all relevant items. Therefore it is often advantageous to search a base devoted exclusively to patents that allows access by the originally assigned classification structure. Most of these bases are expensive, however.

There are several patent CD-ROM products on the market. One such product is CASSIS, produced by the U.S. Patent and Trademark Office and available to the public free of charge at Patent and Trademark Depository Libraries (PTDLs). CASSIS permits access to U.S. patents by the classification codes and also permits limited access by keyword title, author, and assignee.

The PTDLs have also been issued discs with Japanese patents for 1980–1981 and 1985–1988. Patents may be searched by the English keyword for titles and abstracts, International Patent Code, and the English transliteration of the author's name.

A prototype disc with the published Patent Cooperation Treaty (PCT) international applications from 1983 through 1986 has also been issued to the PTDLs. Access is possible by keywords for English and French titles and abstracts and by International Patent Codes.

The use of the CASSIS system, with geoscience examples for U.S. and Japanese patents and international applications, is presented. Knowledge of these resources and free availability of the indexing systems may encourage greater use of patents by geoscience researchers.

Patents are an important component of scientific literature that are used in a large number of contexts. They can be used not only as an indication of state-of-the-art technical knowledge in a given area but also to see if a solution to a technical problem already exists, to pinpoint key research or researchers, and to monitor activities of competitors. They are also instrumental in forecasting future technological trends and industrial applications, and they play a key role in the transfer of technology from industrial nations to developing countries. Patents are also important primary resource material for the study of the history of science and technology.

Most authors estimate that roughly 80% of the scientific and technical information contained in the patent documents is not duplicated in journals, proceedings, or other forms of scientific literature (Terragno, 1979; Tertell, 1986; Hill, 1989). A few authors have placed this estimate as high as 90–95%

(Rimmer, 1988; Evers, 1989). One study disputes these high estimates, stating that the journal literature rarely cites patents directly but nonetheless often contains similar information (Eisenschitz et al., 1986). In either case, writers are unanimous in stating that patents contain unique information but are underused, treated superficially, or even ignored by the scientific community. Chemistry and pharmacy are the two subject fields that use patent literature the most and appear to be exceptions to the general tendency.

The reasons for this underuse are subject to speculation. First, patents are stylized legal documents written in a prescribed manner using legal jargon and terminology that may differ from common or technical usage. Second, patents are not as available as other forms of scientific literature and are not always well integrated into the subject indexing systems. Third, many researchers, particularly academicians, are trained to rely primarily on journals and associated types of literature. Finally, there is often an inaccurate perception that patents are an unreliable source of technical information (Kumar, 1984).

Few authors have written specifically about patents as a form of geoscience literature, and there is no readily available estimate of the number of geoscience patents. Even so it seems reasonable to assume that there are a large number of patents containing geoscience information and that patents are an important albeit relatively minor geoscience document type.

The intellectual and legal foundations of patent law and documents can be traced to the trading monopolies of 13th-century Europe. Venice is recognized as the first state to have developed a system of granting patents in 1474. The first North American patent was granted by the Massachusetts General Court in 1641 for a method of making salt. The first patent granted in the independent United States was in 1790 for a method of "making pot and Pearl Ashes" (Kumar, 1984). For practical purposes patents have always been relevant geoscience documents.

There are two methods of extracting patent information by subject. One is to use an index or database devoted to a particular subject that selectively includes patent materials. The second is to use an index or base devoted exclusively to patents.

The subject-oriented indexes and databases will of course use the indexing structure and vocabulary most common in those fields. *Chemical Abstracts* is widely recognized as the subject index that best systematically integrates patent information. A large number of other indexes selectively include patents. Major database vendors such as DIALOG and STN include numerous patent files; these indexes and bases were reviewed by several authors (Rimmer and Green, 1985; Raduazo, 1986; Thieme and Smith, 1986; Davis Smith, 1988).

Patents are classified by each national patent office at the time of registration. Most countries now use the International Patent Classification code (IPC). The IPC was first published in 1968 and is now revised and updated at 5-year intervals by the World Intellectual Property Organization (Rimmer and Green, 1985; Evers, 1989).

The U.S. Patent and Trademark Office uses its own classification code rather than the IPC. This code was actually designed to facilitate the examination procedure and hence follows three basic industrial divisions: chemical, electrical, and mechanical. Both utility and design classes are subdivided hierarchically. The industrial process, structure, or proximate function (similar operations resolving similar problems) rather than the intended use of the item are the primary criteria for grouping patents together in the 400 or so classes. Thus, dissimilar items often appear in the same class. Patents may be cross-referenced from their original classification to additional classifications, providing better access to patentably similar items. The system is further complicated (or in another sense simplified) by digest and cross-reference art collections that cut across the hierarchy to bring related subclasses together in a more topical manner.

Searches in the more traditional indexes may miss closely related patents that have been assigned the same or similar class numbers. A comprehensive search often requires retrieval and comparison of apparently unrelated patents. Studies have shown that even full-text searching may miss this connection and fail to retrieve all relevant items (Thieme and Smith, 1986). Thus, there is often considerable advantage in searching bases devoted exclusively to patents that can be searched by their assigned patent codes. Several such bases are available, each with slightly different characteristics and search capabilities. Regardless of the approach used, the databases involved are expensive.

Interestingly, few authors, if any, link the cost of online database searching or the labor of a manual search to the underuse of patents. If researchers are highly oriented to seeking patents then cost is not a deterrent. If a document or information type is of relatively minor importance in a field, many researchers will be reluctant to spend much time or money tracking them down. A cheaper searching method, even if it uses less powerful software, might increase the visibility and use of patents. There are a number of CD-ROM products on the market that could presumably address this point.

One such CD-ROM product is CASSIS, produced by the U.S. Patent and Trademark Office (PTO) and distributed to Patent and Trademark Depository Libraries (PTDLs). Since the depository libraries have some of the most complete patent collections available, it is appropriate to highlight the structure and use of this system. CASSIS is described in a journal article (Lawson, 1989) and in pamphlets and the user's manual produced by the PTO.

In the early 1980's the Patent and Trademark Office developed the Classification and Search Support Information System (CASSIS) to provide the patent depository libraries online access to U.S. patents via their unique classification system. In 1988, a CD-ROM version with enhanced search capabilities was distributed to all PTDLs. Although this provides a limited keyword title, author and assignee access, searching by the U.S patent classification codes is usually the best approach.

Searching for patents in a depository collection usually involves three indexes, all of which are now included on the CASSIS discs: the Index to the U.S. Patent Classification (an alphabetic listing of the classes and major subclasses), the *Manual of Classification* (the complete listing of the classification structure), and the *Manual of Definitions*, which indicates the scope of the codes.

Japanese patents have always presented problems for foreign researchers beyond the obvious language barriers. A lesser degree of inventive justification is required for patent applications in Japan; hence, many of them would be considered trivial in other countries. Japanese patent documents are not issued individually but are bound into four series of volumes representing different stages of the application and granting process (unexamined patents; examined patents; unexamined utility models; and examined utility models). The numbering sequence is renewed each year. In any given year as many as four patent documents may have the same number (Rimmer and Green, 1985). Even carefully constructed indexes such as *Chemical Abstracts* cannot always cope with Japanese patents. Direct assistance from the U.S. Patent and Trademark Office is sometimes necessary to solve the problems.

The PTDLs have been issued discs of Japanese patents covering 1980–1981 and 1985–1988. The discs contain English abstracts from the Japanese "Published unexamined patent application (Kokai Tokkyo Koho)." Access is possible by English keyword for titles or abstracts, by International Patent Code, and by English transliteration of the author's name.

The PTDLs have also been issued a prototype disc of published Patent Cooperation Treaty applications, 1983–1989. This disc is primarily used to access Canadian and European patents by author, English or French keywords, and IPC classification codes.

Walker (1986, p. 133) roughly defines geoscience patents as those pertaining "...to the discovery, exploitation, and distribution of natural resources such as water, minerals, and petroleum." He lists the classes of utility patents falling broadly into this category. Table 1 is his list, slightly modified to include recent changes and additions.

Figure 1 shows the menu screen for the CASSIS system. Geochemical exploration patents can be easily searched by class number. Figure 2 lists the screens for this search. The classification file shows Geochemical Exploration as a subheading under Geophysical Prospecting with the designation of Class 436 (Analytical and Immunological Testing), subclass 25. The Bibliographic/Assignee file (1969–) indicates 25 patents under this particular subclass. Figure 2 shows a full record of one of these patents with the classification codes and abstract.

The Classification Information file shows that a total of 38 patents is classed in 436/25. This file includes all patents from 1790 but lists no information other than an indication of original (i.e., primary) classification (O) vs. a cross-referenced classification (X).

The next example shown in Figure 3 represents a search for patents for mining waste treatment. The appropriate class number(s) cannot be readily determined from the index schedules.

Table 1. Classes of utility patents (modified from Walker, 1986).

- Geophysical Prospecting
  - Acoustic means
  - Digital computer with system
  - Exploration in situ
  - Geochemical exploration
  - Nuclear
  - Underwater seismometer spreads
  - Vibration transducers
- Geothermal power plant
- Prospecting
  - Chemical analysis with
    - Apparatus
    - Methods
  - Earth boring combined
  - Electrical
    - Radar
  - Neutron using
  - Radiant energy
  - Radioactive using
  - Sound using
  - X ray using
- Seismology
  - Computer controlled, monitored
  - Computer combined apparatus
  - Earth boring combined
  - Instruments
  - Seismology or seismometers
    - Electro-acoustic
    - Mechanical
      - Recording
    - Submarine signaling
    - Vibration testing
- Gas separation
- Mines and mining
- Chemistry, Carbon compounds
- Chemistry, Hydrocarbons
- Gas and liquid contact apparatus

Therefore it is appropriate to start with a keyword title/abstract search in the Bibliographic File. Such searches must be made with caution since the most recent patents do not show assigned titles, and abstracts are only included for the most recent 2 years. However, this particular keyword search is successful and yields six patents. Expansion of one of the records indicates four relevant class/subclass combinations. Expansion of other records could reveal additional combinations. For a comprehensive search, these should be examined as in the above example for geochemical exploration.

Figure 4 lists the screens for a keyword title/abstract search for Japanese patents pertaining to seismographs for 1988. Figure 5 lists the screens for a PCT International Applications search for geothermal patents.

Figure 6 shows a map identifying the patent depository libraries in the U.S. The CASSIS system is available for the public to use free of charge at these locations. Other libraries may have CASSIS as it can be purchased from the PTO. However, the foreign discs are not available for purchase and may be used only at the depository locations. In addition, the PTDLs have copies of the *Official Gazette* listing patent abstracts and a sizable percentage of the complete texts of patents on microfilm.

Finally, a recent book (Ardis, 1991) describes patent organization and searching with clarity and detail. It is hoped that the knowledge of these resources and the free availability of the indexing system will encourage greater use of patents by the geoscience community.

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Thieme, Bill, and Smith, Harold, 1986, Automating search and retrieval of patents in the U.S. Patent and Trademark Office: Government Publications Review, v. 13 (July/Aug.), p. 431–449.

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Figure 1. CASSIS menu screen.

U.S. PTO Classification and Search Support Information System

HARD DISK MENU - PAGE 1	PAGE INDEX
1 Bibliographic / Assignee Files	F1 CASSIS/CD-ROM
2	F2
3 Classification Information File - By Subclass	F3 ASIST
4	F4 TRADEMARKS
5 Classification Information File - By Patent No.	F5 PraCTis
6	F6 JAPANESE ABSTRACTS
7 Manual of Classification File - Page	F7 IMAGE/TEXT
8	F8
9 Manual of Classification File - Title	F9
0	F10

Figure 2. CASSIS search by classification.

Index to U.S. Patent Classification

GEOPHYSICAL PROSPECTING	
SEE PROSPECTING	
ACOUSTIC MEANS	181/101
DIGITAL COMPUTER WITH SYSTEM	367/60+
EXPLORATION IN SITU	324/323+
GEOCHEMICAL EXPLORATION	436/25
NUCLEAR	250/253+
UNDERWATER SEISMOMETER SPREADS	367/15+
VIBRATION TRANSDUCERS	367/140+

U.S. Department of Commerce/Patent and Trademark Office
PATENT BIBLIOGRAPHIC FILE/ASSIGNEE FILE

Assignee Name:		
Assignee Code:		
Patent Count:		
Patent Number:		
Issue Year:		
State or Country:		
Status:		
Classification:	436/25	
Title or Abstract:		25

Patent Title List: 1 of 25

Patent Number	Patent Title Some titles may be truncated, see Full Record
4992379	FIELD TEST FOR AROMATICS IN GROUNDWATER
4904603	MONITORING DRILLING MUD
4805708	CONTROLLING SULFIDE SCAVENGER CONTENT OF OIL-BASED DRILLING FLUID
4661459	CONTINUOUS GAS/STEAM MONITOR
4658914	CONTROLLING SULFIDE SCAVENGER CONTENT OF DRILLING FLUID
4587847	METHOD FOR INDICATING CONCEALED DEPOSITS
4573354	APPARATUS AND METHOD FOR GEOCHEMICAL PROSPECTING
4565786	METHOD FOR DETECTING MERCURY GAS
4560663	WELL LOGGING METHOD USING ELECTRON SPIN RESONANCE SIGNALS FROM
4495292	DETERMINATION OF EXPANDABLE CLAY MINERALS AT WELL SITES
4402910	GAS SAMPLING SYSTEM
4378055	ANALYZING FOR HELIUM IN DRILLING MUDS TO LOCATE GEOTHERMAL RESERVOIRS
4355997	METHOD FOR MEASURING THE LEVEL OF HYDROGEN SULFIDE IN GEOTHERMAL STEA
4328001	METHOD OF DETERMINING WEATHERING CHARACTERISTICS OF ROCK FORMATIONS I
4166721	DETERMINING THE LOCUS OF A PROCESSING ZONE IN AN OIL SHALE RETORT BY
4136951	SEPARATION AND ANALYSIS OF PARTICLE COATINGS
4116632	COUNTERCURRENT COMBUSTION SYSTEM FOR PREPARING RADIOACTIVE SAMPLES AN

Figure 2. (cont.)

Full Record: 1 of 25

Patent Number	4992379
Issue Year	91
Assignee Code	0
State/Country	TX
Classification	436/29 210/747 436/25 210/691 436/30 436/31 436/140
Title	FIELD TEST FOR AROMATICS IN GROUNDWATER
Abstract	A simple, on-site, field test method and kit for aromatic contamination in a water sample is provided. In the field test, the water sample is first extracted using an alkyl halide extractant, with a Friedel-Crafts Lewis acid catalyst being added to the resulting extractant phase. A reaction product is thereby produced having a characteristic color indicative of the amount and type of aromatic contamination

Classification Information File

SUB CLASS LIST: 1 of 1

Classification: 436/25

5036699 X	4992379 X	4904603 O	4805708 X	4661459 O	4658914 X	4587847X
4573354 X	4565786 X	4560663 O	4495292 O	4402910 X	4378055 X	4355997O
4328001 O	4166721 O	4136951 X	4116632 X	4056969 X	3934455 X	3768302X
3681028 X	3653837 O	3628131 X	3508875 O	3246428 X	3232712 X	3143648X
2662401 X	2623097 X	2604382 O	2576718 O	2551449 X	2387513 X	2117365X
1994761 X	1843878 O	RE33349 X				

Figure 3. CASSIS search by keyword.

SEARCH

U.S. Department of Commerce / Patent and Trademark Office
PATENT BIBLIOGRAPHIC FILE / ASSIGNEE FILE

Assignee Name:		
Assignee Code:		
Patent Count:		
Patent Number:		
Issue Year:		
State or Country:		
Status:		
Classification:		
Title or Abstract:	mining waste*	6

Full Record: 5 of 6

Patent Number	4219416
Issue Year	80
Assignee Code	149415
State / Country	IL
Classification	210/707 210/725 423/58 423/87
Title	PROCESS FOR RECOVERING MOLYBDENUM AND TUNGSTEN FROM MINING WASTEWATER

Figure 4. CASSIS search for Japanese patent.

SEARCH

U.S. Department of Commerce
Patent and Trademark Office
PATENT ABSTRACT OF JAPAN

Publication No.:		
Publication Date:		
Application No.:		
Appl. Filing Date:		
Name of Applicant:		
Name of Inventor:		
IPC:		
Abstract Group Code:		
Abstract Pub. Date:		
Abstract Volume:		
Title or Abstract:	seismograph*	2

display: 1 of 2

Publication No.:	63025581
Publication Date:	880203
Application No.:	61168061
Application Date:	860718
Name of Applicant:	OKI ELECTRIC IND CO LTD
Other Applicants:	00
Name of Inventor:	NAMIKI, HIROYUKI
Other Inventors:	00
IPC:	GO1V1/28
Invention Title:	SEISMOGRAPH FOR DISASTER PREVENTION
Group Code:	P724
Publishing Date:	880705
Volume Number:	012233
Abstract:	PURPOSE: To reduce wrong information, by combining an acceleration amplitude discriminator circuit and a speed amplitude discriminator circuit to transmit an alarm output from an AND circuit. CONSTITUTION: When an earthquake occurs, vibration of the ground is converted with an accelerometer 1 into an electrical signal proportional to acceleration to be outputted to an amplification circuit. 2. An output of the circuit 2 is branched in two and one system thereof is in putted into an acceleration amplitude discriminator circuit 3 as acceleration signal while the other is inputted into an integration circuit 4. The circuit 4 converts the acceleration signal into a speed signal to be inputted into a speed amplitude discriminator circuit 5. Both the acceleration and speed preset with the circuits 3 and 5 and when they are above a set value, an output is provided to an AND circuit 6. When outputs of the circuits 3 and 5 are produced to the circuit 6 simultaneously, an alarm output is transmitted thereby reducing wrong information.

Figure 5. CASSIS search for PCT applications.

WIPO-PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION/U.S. PATENT & TRADEMARK OFFICE
Bibliographic File of Published PCT International Applications
January 1983 to December 1989
Dates format is DDMMYYYY

I.P.C.		
Eng.Title & Abs	geothermal	3
Fr. Title & Abs		
Appl/Inv Name		
Priority Country		
Priority Date		
Priority Appl. No.		
Designated States		
Int. Filing Date		
Int. Pub Date		
Int. App. Number		
Int. Pub. Number		

WIPO-PCT: 3 of 3

WORLD INTELLECTUAL PROPERTY ORGANIZATION/U.S. PATENT & TRADEMARK OFFICE
Bibliographic File of Published PCT International Applications
January 1983 to December 1989
Prototype June 1990

Int. Pub. No.:	8805172
Int. Pubd. Date:	14071988
I.P.C.:	gO1v003/02
Int. Appl. No.:	ep8600784
English Title:	GEOELECTRICAL PROCESS BASED ON STRUCTURAL GEOLOGY CALIBRATION FOR DETERMINING HYDRAULIC CHARACTERISTIC VALUES
English Abstract	This hydrogeological process makes it possible to determine, in the form of mean values for a measurement range, main permeabilities, mean permeabilities, joint system permeabilities, throughflow effective total space proportions and joint-space proportions of homogeneous layers of anisotropic liquid - or gas-filled solids as mean values for a measurement range. The process can be operated from ground surface and via bore

NOTE: the abstract and other information continues on other screens

PATENT AND TRADEMARK DEPOSITORY LIBRARIES

(1) Albany, NY - New York State Library
(2) Albuquerque, NM - University of New Mexico Library
(3) Amherst, MA - Physical Sciences Library, University of Massachusetts
[4] Anchorage, AK - Anchorage Municipal Libraries
(5) Ann Arbor, MI - Engineering Transportation Library, University of Michigan
(6) Atlanta, GA - Price Gilbert Memorial Library, Georgia Institute of Technology
(7) Auburn University, AL - Auburn University Libraries
(8) Austin, TX - McKinney Engineering Library, University of Texas at Austin
(9) Baton Rouge, LA - Troy H. Middleton Library, Louisiana State University
[10] Birmingham, AL - Birmingham Public Library
[11] Boston, MA - Boston Public Library
[12] Buffalo, NY - Buffalo and Erie County Public Library
(13) Butte, MT - Montana College of Mineral Science and Technology Library
(14) Charleston, SC - Medical University of South Carolina Library
[15] Chicago, IL - Chicago Public Library
[16] Cincinnati, OH - Public Library of Cincinnati and Hamilton County
[17] Cleveland, OH - Cleveland Public Library
(18) College Park, MD - Engineering and Physical Sciences Library, University of Maryland
(19) College Station, TX - Sterling C. Evans Library, Texas A&M University
(20) Columbus, OH - Ohio State University Libraries
[21] Dallas, TX - Dallas Public Library
[22] Denver, CO - Denver Public Library
[23] Detroit, MI - Detroit Public Library
(24) Durham, NH - University of New Hampshire Library
[25] Fort Lauderdale, FL - Broward County Main Library
(26) Houston, TX - The Fondren Library, Rice University
[27] Indianapolis, IN - Indianapolis-Marion County Public Library
(28) Kansas City, MO - Linda Hall Library
(29) Lincoln, NE - Engineering Library, University of Nebraska–Lincoln
(30) Little Rock, AR - Arkansas State Library
[31] Los Angeles, CA - Los Angeles Public Library
[32] Louisville, KY - Louisville Free Public Library
(33) Madison, WI - Kurt F. Wendt Library, University of Wisconsin - Madison
[34] Memphis, TN - Memphis & Shelby County Public Library and Information Center
[35] Miami, FL - Miami-Dade Public Library
[36] Milwaukee, WI - Milwaukee Public Library
[37] Minneapolis, MN - Minneapolis Public Library and Information Center
(38) Moscow, ID - University of Idaho Library
(39) Nashville, TN - Vanderbilt University Library
(40) New Haven, CT - Science Park Library
[41] New York, NY - New York Public Library (The Research Libraries)
(42) Newark, DE - University of Delaware Library
[43] Newark, NJ - Newark Public Library
[44] Philadelphia, PA - The Free Library of Philadelphia
[45] Pittsburgh, PA - Carnegie Library of Pittsburgh
[46] Providence, RI - Providence Public Library
(47) Raleigh, NC - D.H. Hill Library, North Carolina State University
(48) Reno, NV - University of Nevada - Reno Library
(49) Richmond, VA - Virginia Commonwealth University Library
(50) Sacramento, CA - California State Library
[51] St. Louis, MO - St. Louis Public Library
(52) Salem, OR - Oregon State Library
(53) Salt Lake City, UT - Marriott Library, University of Utah
[54] San Diego, CA - San Diego Public Library
(55) Seattle, WA - Engineering Library, University of Washington
(56) Springfield, IL - Illinois State Library
(57) Stillwater, OK - Oklahoma State University Library
(58) Sunnyvale, CA - Patent Information Clearinghouse
(59) Tempe, AZ - Noble Library, Arizona State University
[60] Toledo, OH - Toledo/Lucas County Public Library
(61) University Park, PA - Pattee Library, Pennsylvania State University
(62) Washington, DC - Howard University Libraries
(63) Des Moines, IA - State Library of Iowa
(64) Orlando, FL - University of Central Florida Libraries
(65) Piscataway, NJ - Library of Science and Medicine at Rutgers University
(66) Honolulu, HI - Hawaii State Public Library System
(67) Grand Forks, ND - Chester Fritz Library, University of North Dakota
(68) Tampa, FL - Tampa Campus Library, University of South Florida
(69) Jackson, MS - Mississippi Library Commission
(70) Wichita, KS - Ablah Library, Wichita State University

Key:
- ☐ City or City/County Public Library
- ◯ College or University Library
- ⬡ State Library
- ⌓ Research-Oriented Library

PTDLP
UNITED STATES DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
PATENT AND TRADEMARK DEPOSITORY LIBRARY PROGRAM

Figure 6. Patent and Trademark Depository Libraries.

USE OF THE PROCEEDINGS OF INTERNATIONAL CONFERENCES AND SYMPOSIA IN GEOLOGY AS DETERMINED BY CITATION ANALYSIS: A PRELIMINARY REPORT

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Abstract—It is a truism in the sciences that papers published in proceedings of international conferences and symposia are seldom read and rarely cited. If true, this would argue against library purchases of such proceedings in an era when budget limitations demand that librarians focus on materials that will be used.

To test this assumption, a citation analysis was conducted on the international proceedings of conferences and symposia in the areas of geomathematics, geostatistics, and computer applications in the earth sciences. The field of numerical geology is both compact enough, because of its youth, and and sufficiently international in scope, because of wide interest in these areas, to provide an appropriate sample for citation analysis.

Preliminary results suggest that, at least in the fields studied, such proceedings are, in fact, well cited, and thus presumably widely read. Where such proceedings are not cited, the common denominators seem to be publication in forms that are difficult to access or have a very narrow focus, for example, the use of geostatistics in the mineral industries.

In the sciences it is a truism that papers published in the proceedings of international conferences and symposia are seldom read and rarely cited. If this is correct, then the material covered in these papers is not in the mainstream of geologic thinking and, it could be argued, has little or no influence on the field. Such material would not be worth the time of those involved to produce, nor, in these days of ever-shrinking budgets, worth the money of libraries to purchase.

To test the assumption that such materials are difficult to locate, rarely read, and almost never cited, we decided to do a citation analysis of the proceedings of international conferences and symposia in the areas of geomathematics, geostatistics, and computer applications in the earth sciences. The field of numerical geology was selected because it is compact, relatively young, and sufficiently international in scope and of wide interest. This paper is a preliminary report on that citation analysis.

Our sample consisted of 62 proceedings of conferences and symposia (see appendix 1), published in 1 of 4 formats:

1. as a book, distributed by an established publisher
2. as part of a journal (usually a special issue)
3. as part of a series
4. as self-published conference proceedings.

The publications (Fig. 1) were selected from the collection of the junior author, based on their appropriateness for the topic. The distribution of the sample by format and year is shown in Figure 2.

Citation searching was done on the ISI Scisearch database through DIALOG. Funding for the search was provided by the Wichita State University Geology Research Endowment Fund and the University Libraries. Citations were searched using the cited reference command (cr=. . .), and printed using the format command, set/3,k/number, where format 3 is the biblio-

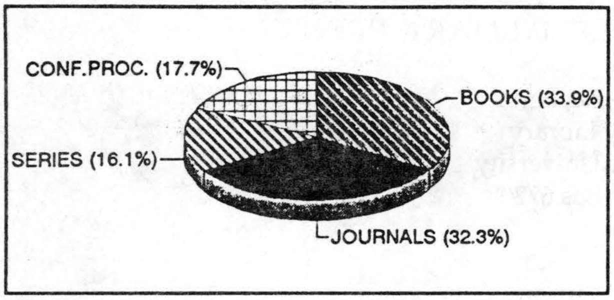

Figure 1. Number of publications surveyed, by format.

graphic citation and k provides the cited reference.

The 62 publications were searched first to determine if any entire proceedings had been cited, as opposed to only the specific papers. As it turned out, a number had been. Of 62 items, 35, or 56.6%, were cited at least once. Of the number of cited works, 16 were books (4 not cited), 9 were journals (14 not cited), 5 were series (5 not cited), and 5 were self-published proceedings (6 not cited). As shown on the piechart (Fig. 3), books received the largest numbers of citations (47.9%), followed by journals (33%), self-published conference proceedings (12.8%), and series (6.4%). Some of the differences in percentages of citations may result from the smaller number of the last two formats in the sample, but it also reflects the fact that books from established publishers and journals are more accessible and therefore more likely to be read and cited.

Although format is an important indicator of the likelihood of citation, the date of publication also plays a role. Figure 4 shows the distributions of citations according to publication year and format. The fact that the greatest number of citations is for one of the older items supports the belief that the trend is for the number of citations to increase with time, although the small number for some of the older works suggests that this is true only for works important enough to be cited continuously through the years.

Although it is interesting to analyze the citation patterns of proceedings as a whole, the

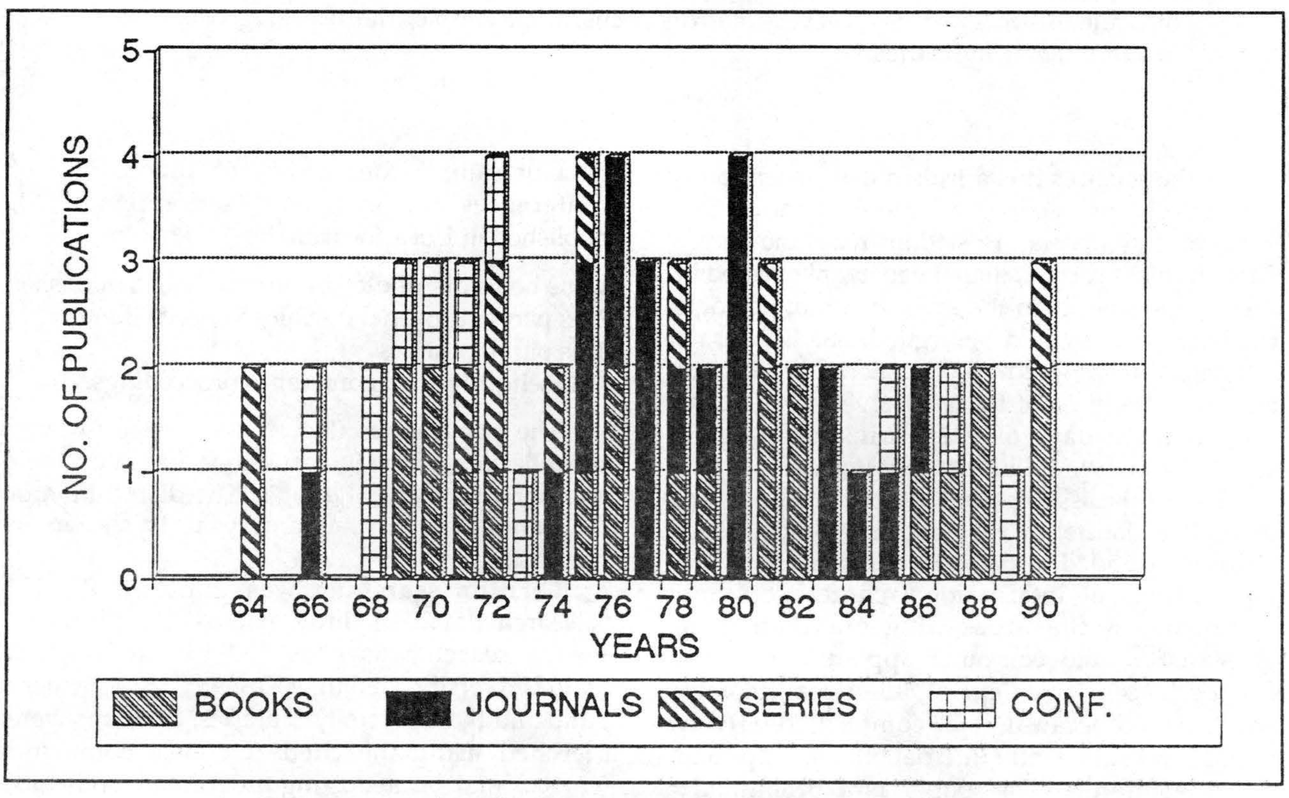

Figure 2. Number of publications surveyed, by year and format.

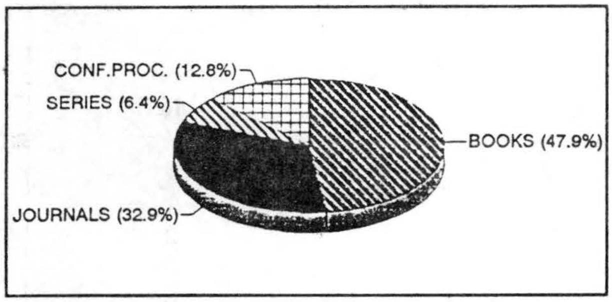

Figure 3. Percentages of citations, by format.

most telling study is that of the individual articles contained in each proceedings, as these are the most widely read and cited.

Fifteen publications were selected from the original 62 for analysis of the individual articles. The small size of the second sample was dictated by financial constraints. The formats studied were books, series, and self-published conference proceedings. Journals were excluded on the theory that articles in journals are better indexed, easier to locate, and therefore more likely to be read and cited than those in other formats. Thus, in a study to determine the impact of supposedly hard-to-locate international proceedings of conferences and symposia, non-journal formats are the most important. An attempt was made to select samples covering the original range of years (1964 to 1990), but otherwise items were selected randomly. The following piechart shows the distribution of publications by format (Fig. 5). Books comprised 60% of the sample, self-published conference proceedings 26.7%, and series 13.3%.

As shown in Table 1, 15 publications spanning the years 1970–1990 were analyzed by the number of articles per source, number of citations per source, number of articles in a source with no citations, and number of articles with self-citations by the first or second author. The 15 publications contained 338 articles, of which 179, or 53%, were cited at least once. This percentage sounds low; however, if the most recent publications dating to 1988 and 1990 are subtracted, that leaves a total of 200 articles of

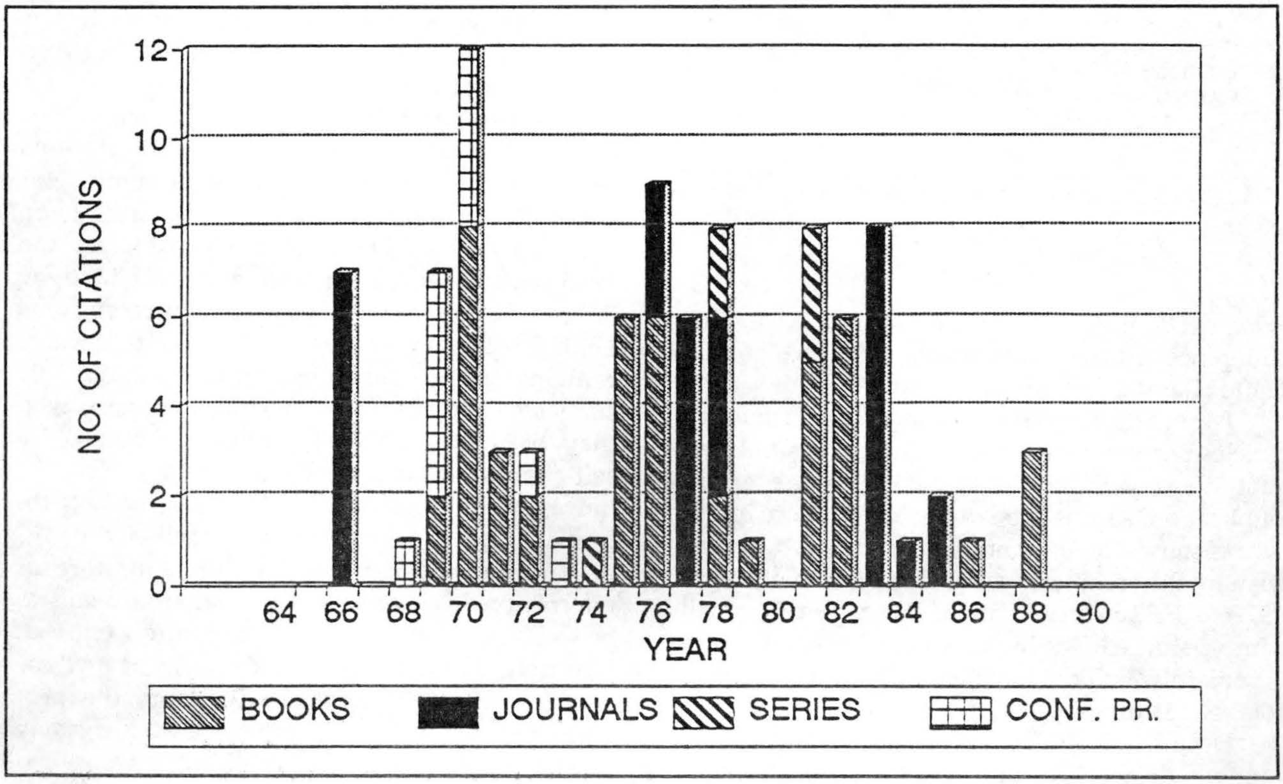

Figure 4. Number of citations, by year and format.

Table 1. Analysis of 15 publications by content, selected years, 1970–1990.

Year	No. sources	No. articles	No. cites	Not cited	Self-cited
1970	1	12	52	0	4
1971	1	13	31	4	1
1975	2	29	174	7	0
1976	1	42	42	2	0
1977	1	8	4	5	0
1980	2	20	18	11	0
1981	1	18	25	10	2
1982	1	15	72	1	9
1984	1	45	19	0	0
1988	2	59	14	46	5
1990	2	77	7	73	4
Total	15	338	458	159	25

Total	Books	Journals	Series	Conference proc.
15	9	0	2	4

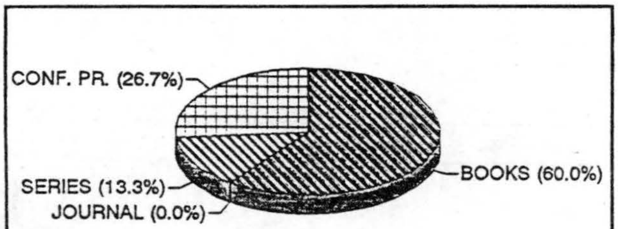

Figure 5. Percentages of citations, by format.

which 160, or 80%, were cited at least once. This difference clearly points out the relevance of time lag to citation.

The pattern of thc number of citations of articles per year, shown in Figure 6, is similar to that displayed by the citations of the entire publication. As might be expected, the more recent works show a higher number of citations by article than by the complete work. The extreme dip from 1977 to 1982 is an artifact of the extremely small sample studied. The high peak in 1975 results from 1 book in which the included articles were cited a total of 143 times.

Figure 7 provides a comparison of the total number of articles, total number of citations of articles, and the total number of self citations of articles. The ribbons representing the number of articles and number of citations are generally compatible, except for the most recent period, in which the number of citations for articles dips dramatically. As mentioned previously, this is most likely an artifact of the time lag between publication of a work and the time necessary for it to be read and cited in a newer paper. The two high peaks in the number of citations probably indicate publication of a seminal or otherwise important work that has been repeatedly cited. The book responsible for the 1975 peak (*Concepts in Geostatistics*, edited by R. B. McCammon) has been cited as recently as 1991. Surprising, the number of self-citations remains fairly constant, averaging 7.8%. This suggests that authors of technical papers, who may be suspected of padding the record by self-citation, in fact rarely do so. It is notable, however, that citations for the most recent publications tend to be predominantly self-citations.

Contrary to expectations, the literature of international conferences and symposia seems to be well-cited and presumably therefore well-read. This trend holds for both proceedings as a whole and for the individual articles from the proceedings, although the latter are more extensively cited. Even the most recent publications were cited several times, at least one of which was not a

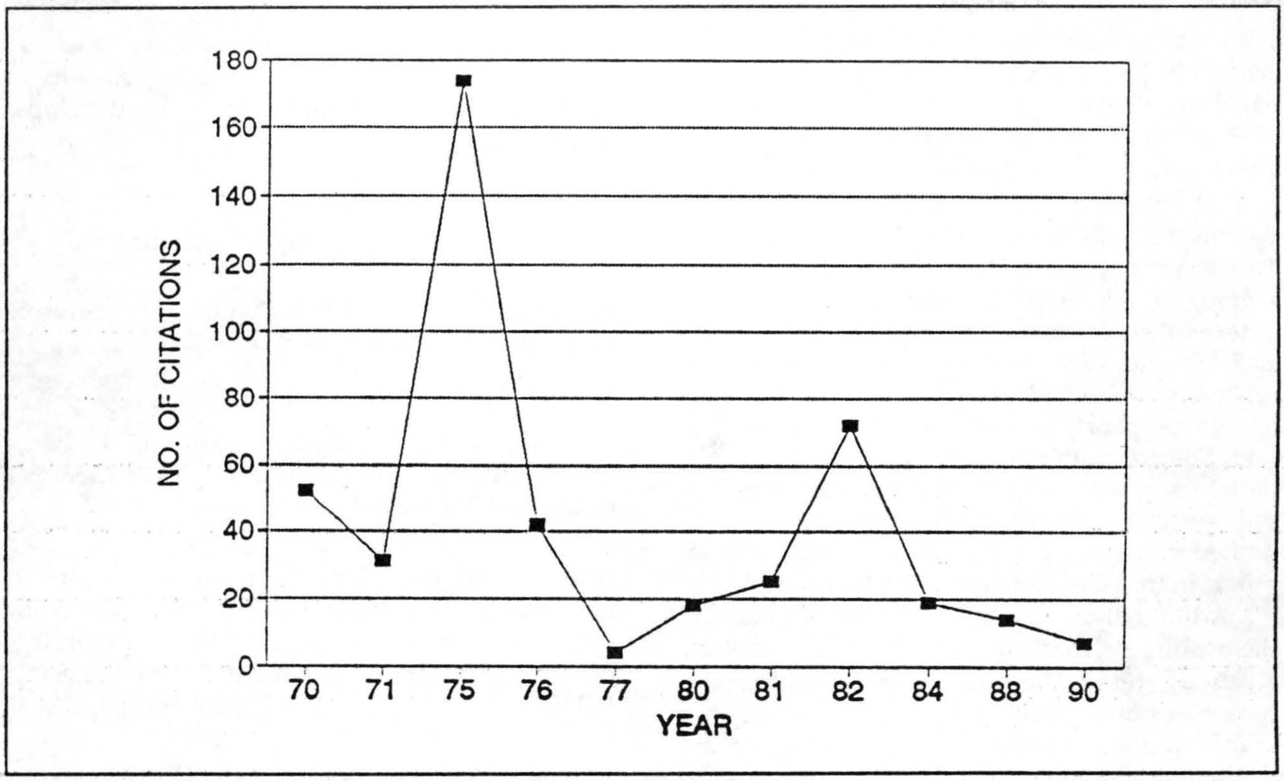

Figure 6. Number of citations per year.

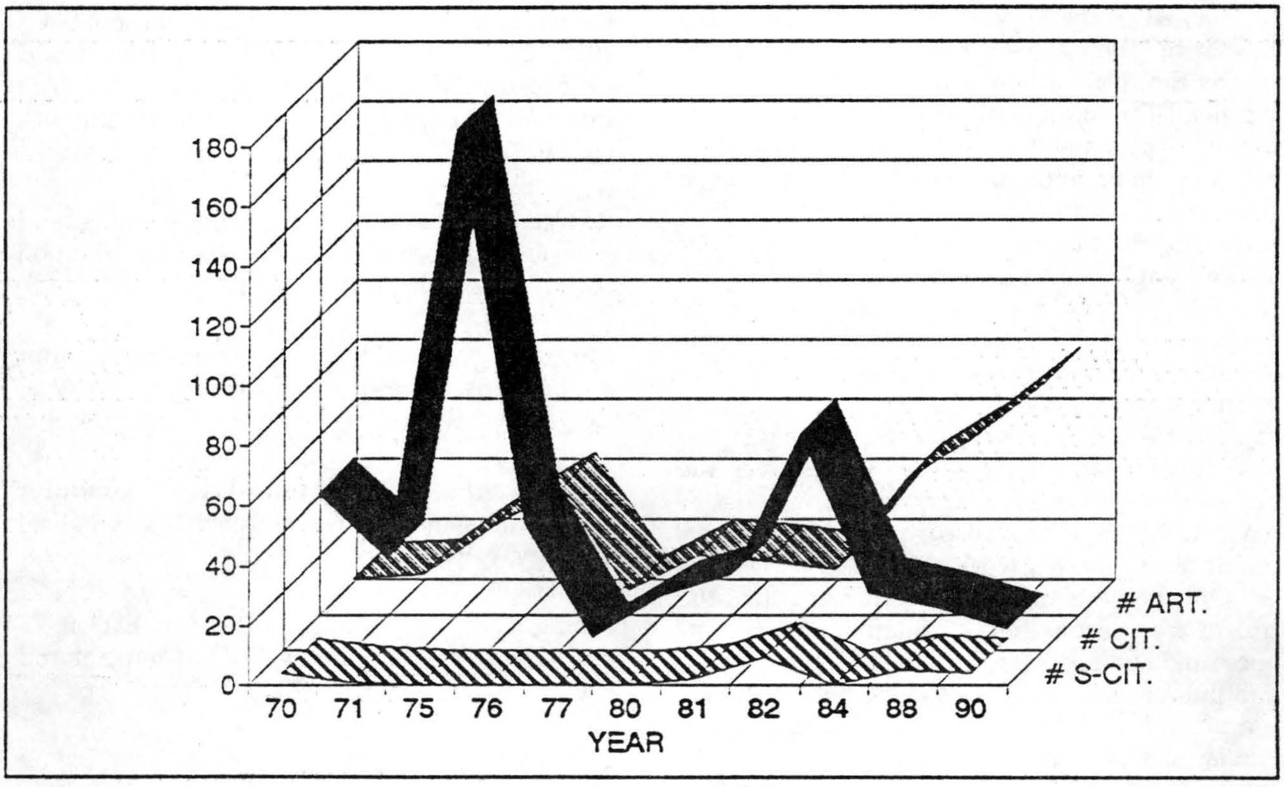

Figure 7. Citation analysis, per year.

self-citation. Although citations of proceedings' articles in journals were not studied, it is anticipated that they would equal or exceed the number of citations for articles published in book format. This is because of the relatively good indexing and ease of access for journals. Books distributed by established publishers were likewise well-cited. This is probably the result of ease of access, although book materials tend to be less well-indexed than journals. Surprisingly, even series and self-published conference proceedings were relatively well-cited, despite the fact that they tend to be poorly indexed and more difficult to find. Subject matter seems to have played a role, particularly with self-published proceedings. The publications with few or no citations were all limited in scope: a proceedings on the use of computers in the petroleum industry, for example.

Admittedly, the study sample was small, yet the results seem clear enough: in the subjects studied, geomathematics, geostatistics and computers in the earth sciences, the proceedings of international conferences and symposia are well-cited and therefore may be supposed to influence (and have influenced) the development of the field of numerical geology. Why should this be true, when the opposite usually is considered the norm? There are several possible reasons. The first is the relative newness and compactness of the field. The number of people who do research in this area is small enough that it is relatively easy to keep up with publications of interest, even those materials that are more difficult to access. Secondly, the majority of the citations were for articles published in book and journal formats, which historically are easier to access. Another possibility is the increasing impact of electronic technologies such as Bitnet and various forms of electronic publishing, as well as online searching capabilities. These technologies expand the individual researcher's ability to discover the existence of proceedings, acquire the material or request the library to do so, read it, and incorporate it into another work.

On the basis of this study, it seems that the truism that proceedings of international conferences and symposia are seldom read, rarely cited, and thus of little importance to the field is, in fact, untrue, at least in the field of numerical geology. Similar analyses need to be done in other subject areas to determine if this holds true for other areas as well. For numerical geology, it is obvious that researchers and librarians need to consider the acquisition of such materials as they obviously have played an important role in the development of the field.

APPENDIX 1. Proceedings used in this study.

Atterberg, F. P., ed., 1983, Quantitative resource evaluation: Mathematical Geology, v. 15, no. 1, p. 1–233.

Atterberg, F. P., and Bonham-Carter, G. F., eds., 1990, Statistical applications in the earth sciences: Geological Survey of Canada Paper 89-9, 587 p.

Anonymous, ed., 1966, Symposium and short course on computers and operations research in mineral industries: Penn State University Mineral Industry Experiment Station Special Publication 2-65, v. 2, and v. 3, variously paged.

_______ 1971, Decision-making IV: Vancouver, University of British Columbia, 335 p.

Bergeron, R., Burk, C. F., Jr., and Robinson, S. C., 1972, Computer-based storage, retrieval and processing of geological information: 24th International Geological Congress (Montreal), sec. 16, 222 p.

Bourgeois, A. E., ed., 1987, Micros, minis, and geoscience information: Geoscience Information Society Proceedings, v. 16, 176 p.

Cargill, S. M., 1978, Standards for computer applications in resource studies: Mathematical Geology, v. 10, no. 5, p. 405–642.

_______ ed., 1977, Standards for computer applications in resource studies: Mathematical Geology, v. 9, no. 3, p. 205–337.

Chung, C. F., Fabbri, A. G., and Sinding-Larsen, R., eds., 1988, Quantitative analysis of mineral and energy resources: Dordrecht, D. Reidel, 738 p.

Craig, R. G., and Labovitz, M. L., eds., 1981, Future trends in geomathematics: London, Pion Ltd., 318 p.

Crouch, L. G. R., and others, eds., 1968, Symposium of decision-making in mineral exploration: Vancouver, British Columbia, 42 p.

Cubitt, J. M., ed., 1977, Quantitative stratigraphic correlation: Computers & Geosciences, v. 4, no. 3, p. 215–318.

_______ 1980, Mathematical models in the earth sciences: Computers & Geosciences, v. 6, no. 2, p. 109–209.

Cubitt, J. M., and Reyment, R. A., eds., 1982, Quantitative stratigraphic correlation: Chichester, John Wiley & Sons, 301 p.

Cutbill, J. L., ed., 1971, Data processing in biology and geology: London, Academic Press, 346 p.

Davis, J. C., ed., 1977, Quantitative strategy for exploration: Mathematical Geology, v. 9, no. 4, p. 341–449.

_______ 1985, Think deep: computer methods and the subsurface: Mathematical Geology, v. 17, no. 4, p. 333–487.

de Marsily, G., and Merriam, D. F., eds., 1982, Predictive geology with emphasis on nuclear-waste disposal: Oxford, Pergamon Press, 206 p.

Fenner, P., ed., 1972, Quantitative geology: Geological Society of America Special Paper, 146, 101 p.

Gaal, G., and Merriam, D. F., eds., 1990, Computer application in resource estimation, prediction and assessment for metals and petroleum: Oxford, Pergamon Press, 453 p.

Gill, D., and Merriam, D. F., eds., 1979, Geomathematical and petrophysical studies in sedimentology: Oxford, Pergamon Press, 267 p.

Hanley, J. T., and Merriam, D. F., eds., 1986, Microcomputer applications in geology: Oxford, Pergamon Press, 258 p.

_______ 1990, Microcomputer applications in geology II: Oxford, Pergamon Press, 303 p.

Hewlett, R. F., ed., 1964, International symposium on applications of statistics, operations research, and computers in the mineral industry, pt. A, Colorado School of Mines, v. 59, no. 4, 503 p.

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APPENDIX 2. Background references.

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TYPES AND USES OF GEOLOGIC LITERATURE: A STATISTICAL ANALYSIS OF 100 YEARS OF CITATIONS ON THE GEOLOGY OF WASHINGTON STATE

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Abstract—About 19,000 items on the geology and mineral resources of Washington State have been issued from 1891 through 1990. An analysis of this data set by date (in 5-year increments) shows the familiar exponential growth of the information explosion. An analysis by type shows that, overall, about 30% of these items are abstracts, 40% are papers published in journals or compiled volumes, and 30% are monographs, including state and federal documents and theses. These percentages have changed over time, indicating publication trends by type. For this data set, the relative percentages of papers published in journals have declined, papers published in compiled volumes have increased, and conference abstracts have had the highest rate of increase.

Citation analysis, while innately biased, provides insights into the use and relative importance of this literature. In the 602 references cited in the Geologic Map of Washington–Southwest Quadrant (1987) and –Northeast Quadrant (1991), some data types were represented differently than in the full data set: abstracts are 5% of the citations but 30% of the data set; theses are 24% of the citations but 8% of the data set; and state agency monographs are 15% of the citations but 5% of the data set.

The older materials (1891–1960) are still being used: 1.8% of all materials 1891–1960 were cited in the quadrant maps, and the oldest citation there is an 1899 paper in the *Geological Society of America Bulletin*. The newer materials (1961–1990) were cited at a relatively constant rate: an average of 4.2% of all materials 1961–1990 was cited, including 4.9% of the items issued 1961–1965 and 4.9% of the items issued 1981–1985.

TYPES OF MATERIALS ON WASHINGTON GEOLOGY

In the geology library we see that site-specific studies are issued from various sources, that they are heavily used, and that their usefulness continues over time. This study was undertaken to quantify these relationships. The database of citations about the geology of Washington State is used as an example.

In the last 100 years, 18,672 items on the geology of Washington State (Fig. 1; Table 1) have been collected at the Washington state survey (the Washington Division of Geology and Earth Resources [WDGER]) for the ongoing bibliographic series (Bennett, 1939; Reichert, 1960, 1969; Manson and Burnetti, 1983; Manson, 1990a, 1990b, 1991). We use various sources to find new items to add to this database:

- Journals: we examine current issues of the major geological journals;
- State and federal agencies: we automatically receive materials from many agencies; we are a depository for all U.S. Geological Survey (USGS) published materials and for the maps and open-file reports about Washington;
- Universities: we receive copies or announcements of new reports and theses
- Authors occasionally send materials;
- A monthly search on the *Bibliography and Index of Geology* is done to identify needed items;
- References cited lists in new reports are checked;
- Staff members bring to our attention items we may otherwise miss.

Table 1. The numbers of citations about Washington geology, 1981–1990, in 5-year increments.

Publication Type	1891	1896	1901	1906	1911	1916	1921	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986	Total
Monographs																					
Theses	0	0	1	9	16	14	38	28	49	75	39	48	54	88	76	114	173	199	228	160	1409
Federal documents	4	7	12	12	33	10	6	4	9	28	78	60	80	169	148	108	172	342	366	228	1876
State documents	3	0	4	2	15	8	14	1	8	37	42	23	29	56	45	43	102	171	105	134	842
PUDs and local government	0	0	0	0	0	0	0	1	0	1	3	0	1	6	3	1	18	35	24	23	116
Professional societies	0	0	0	2	1	0	0	0	6	7	11	18	9	11	10	8	16	12	23	29	163
Research orgs. and univs.	1	0	0	1	1	4	5	3	5	15	10	10	21	36	47	41	84	96	56	60	496
Commerical (trade)	1	4	5	6	0	2	2	1	0	10	9	10	16	20	16	16	23	23	17	16	197
Commercial (compiled)	0	0	0	0	0	0	0	0	0	1	1	3	0	5	2	6	6	3	1	0	28
Commercial (consultant)	0	0	0	0	0	0	0	0	0	0	1	0	1	8	20	19	20	155	201	84	509
Papers																					
In journals	25	57	60	84	53	56	67	75	104	243	206	190	205	316	290	268	314	351	450	653	4067
In Federal documents	7	19	19	16	22	11	10	14	16	24	21	19	35	67	62	77	35	67	139	348	1028
In State documents	0	0	10	0	1	3	1	2	0	4	4	5	5	7	5	64	32	34	29	225	431
In Public utilities	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	30	7	0	40
In Professional societies	1	0	0	3	5	1	1	2	10	3	7	14	20	40	28	48	44	89	114	153	583
In Research orgs. and univs.	0	1	0	0	1	4	2	1	2	8	10	2	10	10	18	31	64	50	79	44	337
In Commercial (compiled)	1	1	1	2	4	2	0	0	0	3	3	2	4	4	3	11	16	32	51	34	174
In Commercial (consultant)	0	0	0	0	0	0	0	0	0	0	0	3	1	0	7	9	0	7	22	4	53
In International orgs.	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	4	1	3	3	1	17
Abstracts																					
Services	1	16	7	1	9	4	15	28	40	39	46	76	42	127	121	1	0	0	1	0	574
Work in progress	0	0	0	0	0	0	0	1	0	0	0	0	0	0	17	7	52	128	32	12	249
Doctoral/masters	0	0	0	0	0	0	0	0	0	0	0	0	5	18	25	41	60	48	40	30	267
Conferences	1	1	1	0	14	6	6	12	24	76	28	67	31	67	119	279	317	511	744	983	3287
Total	45	106	120	138	175	125	167	173	273	574	521	550	569	1060	1062	1196	1550	2386	2732	3221	16743
MSH total	0	0	0	0	0	0	0	1	0	5	4	0	6	5	12	13	23	374	1081	405	1929
Grand total	45	106	120	138	175	125	167	174	273	579	525	550	575	1065	1074	1209	1573	2760	3813	3626	18672

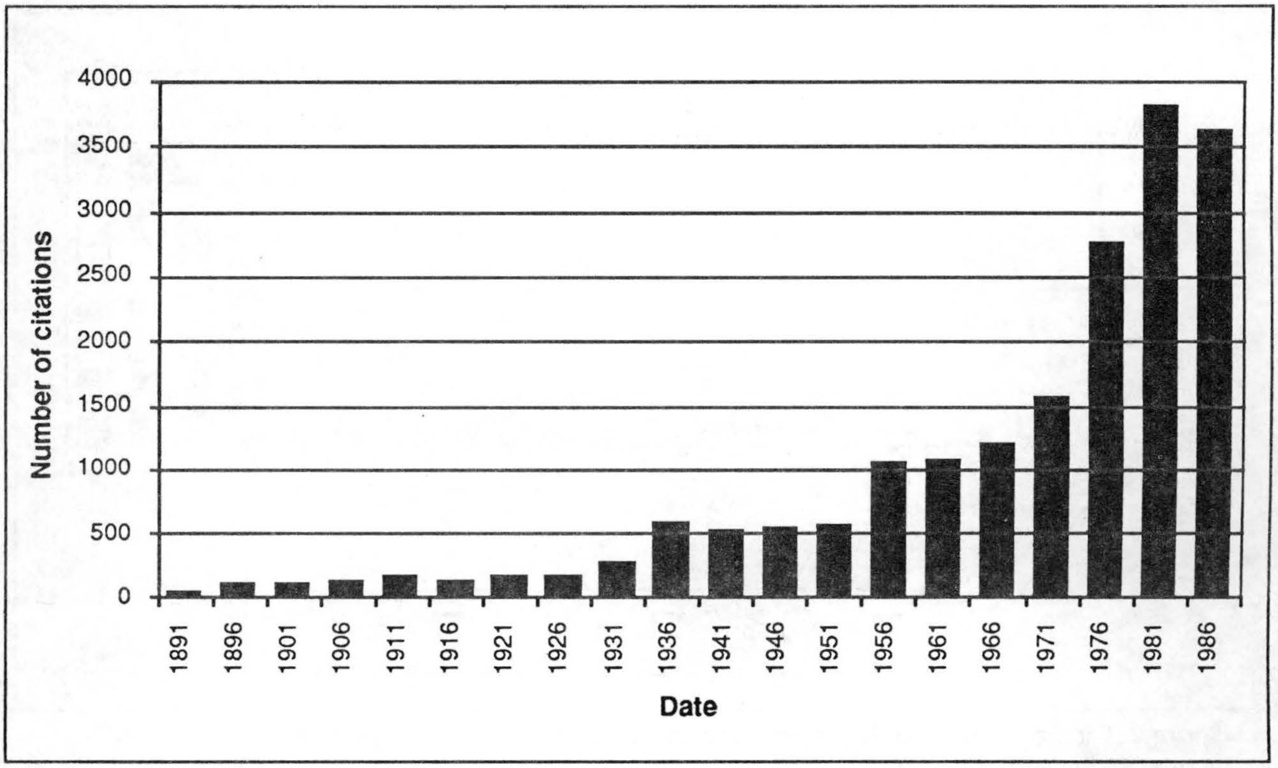

Figure 1. Citations on Washington geology, 1891–1990, in 5-year increments. Total = 18,672.

Because of the cross-checks in this system, we are confident that this is as complete and valid a data set as humanly possible. However, it takes years to find out about some categories of materials, particularly theses and international symposia papers. Therefore, it probably will be another 5 years before we have more than 95 percent of the 1986–1990 citations.

Mount St. Helens (MSH), which erupted in 1980, has been intensively studied: we have collected 1,929 items on the geology of MSH. Because those items could skew the statistics, they are considered only briefly in this analysis.

There are 16,743 non-MSH citations on Washington geology from 1891 through 1990. If we separate these by type into monographs, papers, and abstracts (Fig. 2), we see that whereas the totals in all categories have increased, not all have increased at the same rate. The earliest materials (1891–1930) present a special problem. The data set is so small—only a few hundred items for each 5-year period—that we cannot draw meaningful statistical conclusions about them.

Monographs

A monograph, a whole work that stands alone, is a category that include theses, state and federal documents (often issued in series), consultant reports, or books published by research organizations or commercial publishers. The data set includes 5,636 monographs on Washington geology. The numbers, by subtype, are shown in Figure 3.

Since 1931, monographs have increased as a percentage of all Washington citations (Fig. 4) from about 28 percent in 1931–1935 to about 43 percent in 1976–1980. Declines for the periods 1981–1985 and 1986–1990 (seen in various degrees in all types of monographs) could mean that there has indeed been a decrease in the number of monographs. Or, it could, more likely, reflect

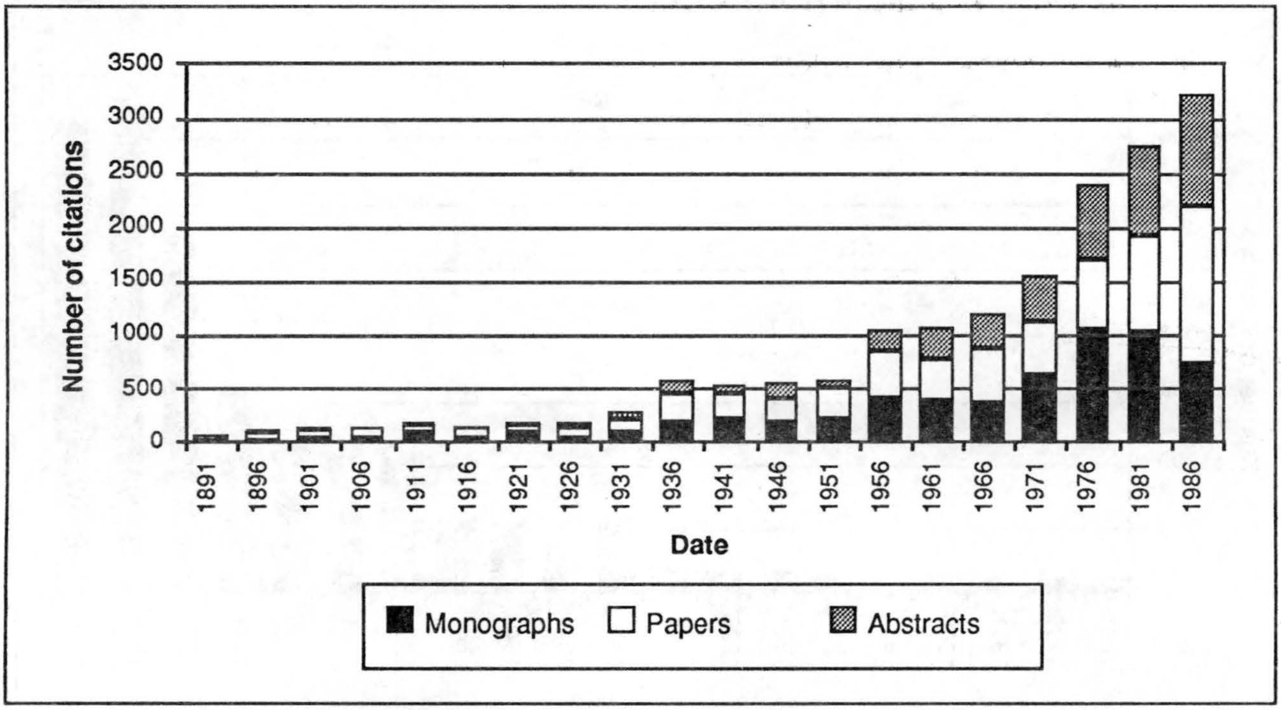

Figure 2. Citations on Washington geology, exclusive of Mount St. Helens citations, 1891–1990, by type, in 5-year increments.

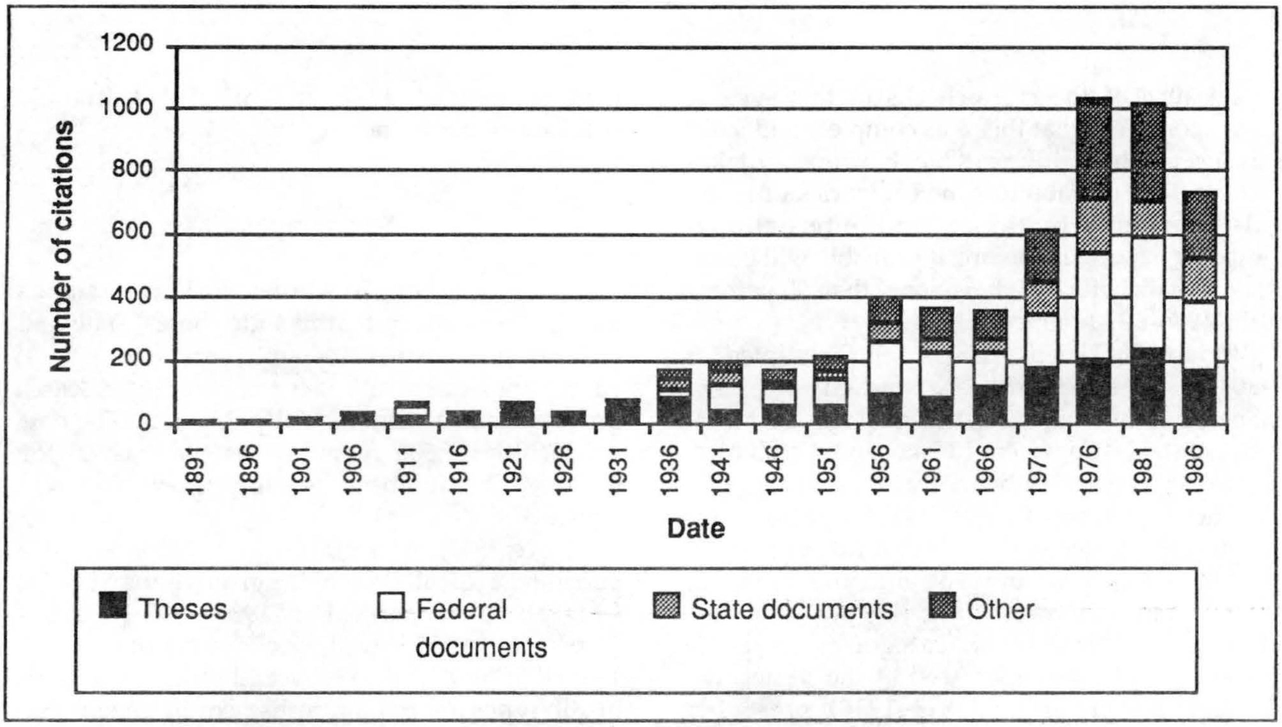

Figure 3. Monographs on Washington geology, 1891–1990, by sub-type, in 5-year increments. Total = 5,636.

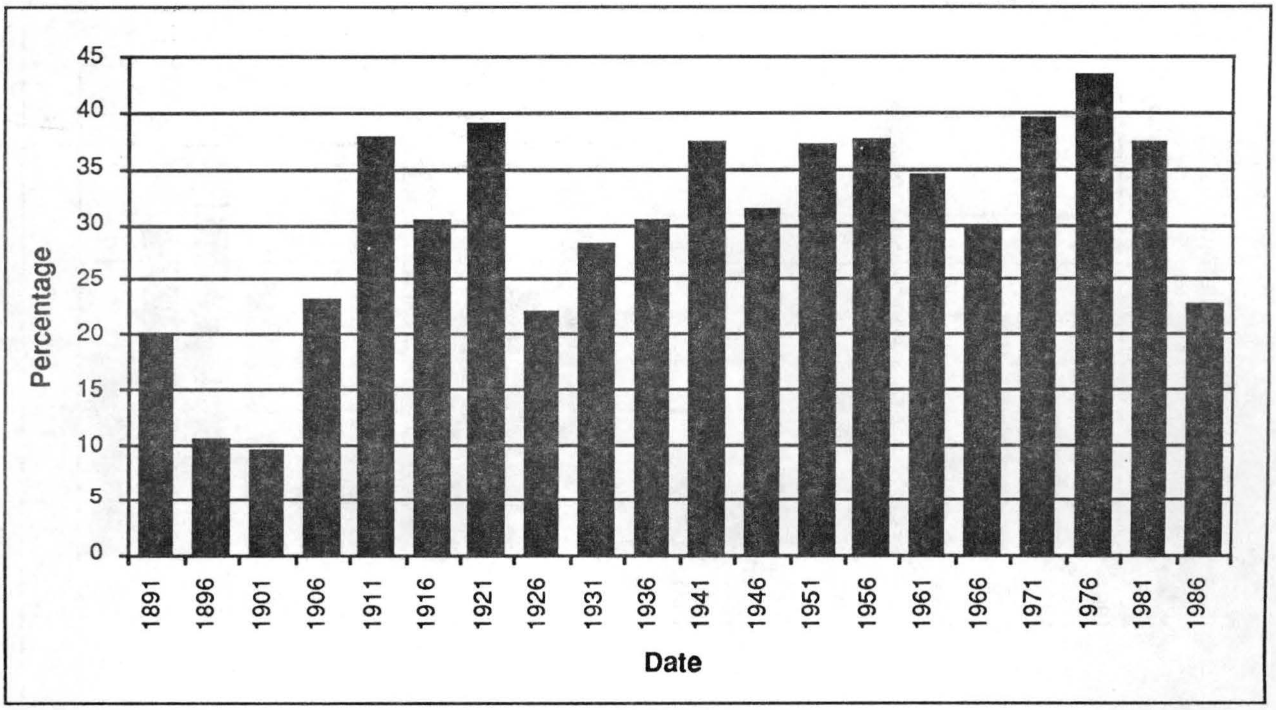

Figure 4. Monographs on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 33.6%.

the long lag time in discovering and acquiring some types of monographs.

Federal Monographs

We have 1,876 federal monographs on Washington geology in the data set (Fig. 5). Before 1941 the data set is statistically unreliable. On an incremental basis the percentage of citations for 1941–1985 citations is close to the 100-year average of 11.2 percent. The sharp decline in the 1986–1990 materials is probably due to the lag time in acquiring non-USGS federal monographs.

State Monographs

State monographs account for 842 items in the data set. There are extreme variations in the publication rate of state monographs from 1891 through 1930, due, at least in part, to fluctuations in the funding of the state geological survey in those years (Schuster, 1991). Nevertheless, that set of citations is too small for reliable conclusions. From 1931 through 1980, state monographs constitute about 5 percent of all citations, close to their overall average (Fig. 6), although with some sharp variations. In the last 10 years, the publication rate for state monographs has declined.

Theses

The data set includes 1,409 theses on Washington geology. The early extremes in the percentages are interesting—theses accounted for almost one-quarter of all citations on Washington from 1921 through 1925—although, before 1931, the data set is too small to be reliable (Fig. 7). From 1941 through 1985, theses settle down to their overall average of 8 percent of all citations, with remarkably small variation over time. The sharp drop since 1986 could be due to the much-discussed decline in the number of graduate students in the geosciences, to a recent increase in the number of non-thesis Master's degrees in the geosciences (Steve Hiller, University of

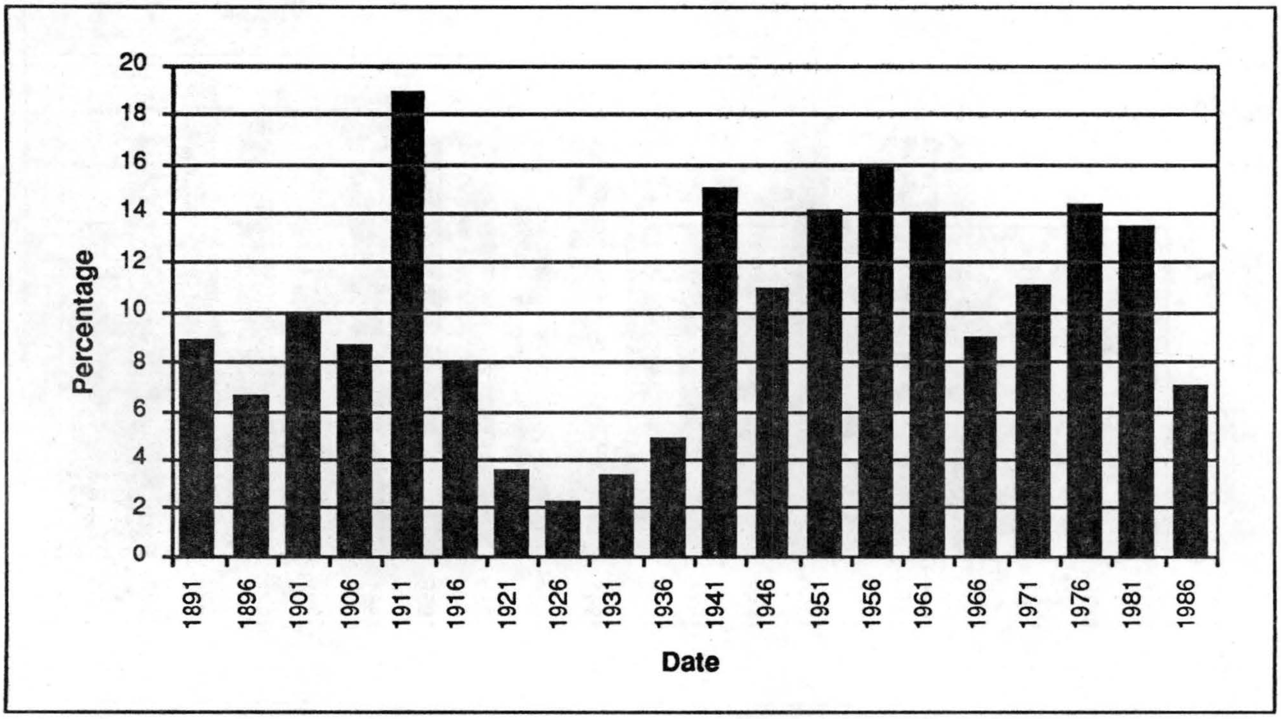

Figure 5. Federal monographs on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 11.2%.

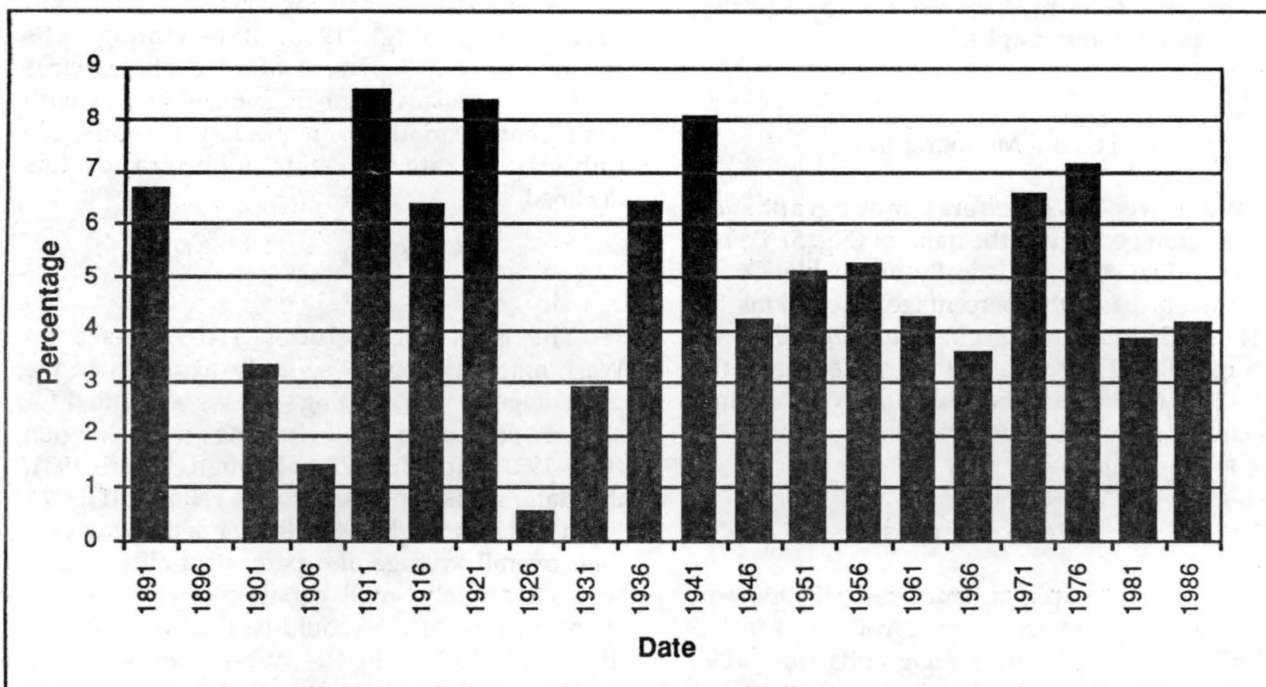

Figure 6. State monographs on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 5.0%.

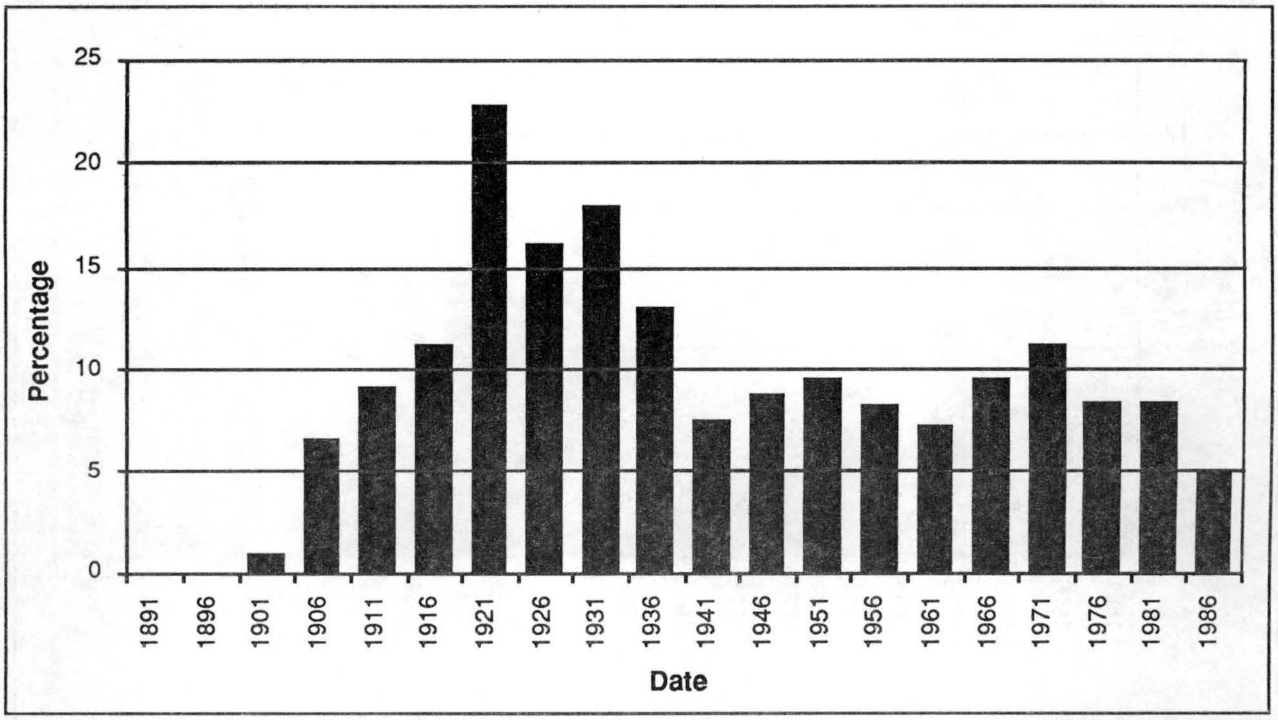

Figure 7. Theses on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 8.4%.

Washington, oral communication, 1991), or to the excessive lag time (as much as 8 or 10 years) in discovery and acquisition of theses about Washington from non-Pacific Northwest universities.

Other Monographs

The data set includes 1,509 other monographs about Washington: 116 from Public Utility Districts and local government agencies; 163 from professional societies; 496 from research organizations and universities; 197 from commercial publishers; 509 from consulting firms; 28 from private publishers or individuals. Since 1931, this group shows steady growth, peaking at about 13 percent for the period 1976 through 1980 (Fig. 8).

Papers

A paper is a smaller part of a larger work. It may be an article in a journal issue, one of many papers in a collected volume, or an appendix of a monograph. Papers very rarely receive individual indexing ("analytics") in traditional library cataloging systems. Papers about Washington geology account for 6,730 items in the data set: 4,067 in journals and 2,663 in compiled monographs. As a whole, papers are a significant portion of Washington literature. Although the data set is too small to be statistically valid, it is interesting that in the early years papers were the predominant medium (Fig. 9): through 1910, papers accounted for three-quarters of all citations on Washington geology. From 1911 through 1955 papers were, rather uniformly, about half of all citations. The percentage of papers steadily declined from 1956 through 1980. That trend has reversed, and from 1981 through 1990 papers have shown a sharp increase as a percentage of the total.

There has been a change in the relative percentages of journal papers and collected papers. Journal papers predominated from 1891 through 1980, and the two were about equal in the next 5 years. However, from 1986 through 1990, collected papers surpassed journal papers.

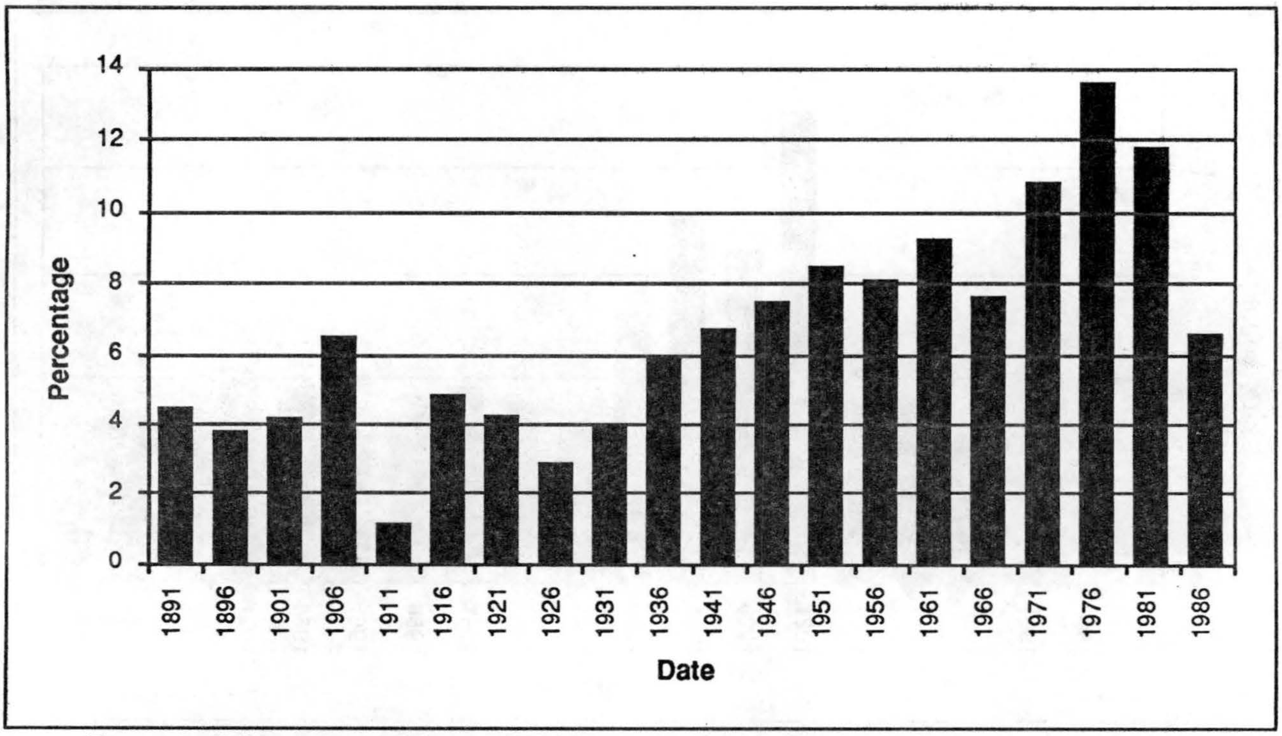

Figure 8. Other monographs on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 9.0%.

This trend can be expected to increase as the data set becomes more complete because journal papers become known quickly (so we can expect to already know about most of them) and collected papers come in more slowly (so we can expect there to be many more to be found).

Abstracts

As a summary of research or of a larger work, an abstract may be, but is not necessarily, related to a larger work. In recent years, abstracts have most commonly been descriptions of a conference presentation. Abstracts are never indexed in card or online catalogs.

The data set includes citations for 4,377 abstracts on Washington geology: 3,287 conference abstracts; 574 abstracts of published monographs or papers prepared by abstracting services (primarily between 1921 and 1965); 249 summary abstracts of work in progress (primarily published by the USGS and the Geological Survey of Canada), and 267 abstracts of Master's theses or doctoral dissertations.

The few pre-1931 citations vary greatly in number for 5-year increments (Fig. 10). The 1931 through 1960 abstract citations also show variation, from a low of 14 percent for 1951–1955 to a high of 26 percent for 1946–1950. However, from 1961 through 1990, abstracts as a percentage of all citations about Washington geology show an ominous trend, rising steadily to the current rate of about 32 percent (1986–1990). This is the most persistent trend of any reference type.

Connections between abstracts and their related, larger forms in papers or monographs are often obscure. Except for abstracts related to theses, there is rarely an exact match among the author(s) and title of the two; some authors intentionally give different titles to abstracts. Some abstracts are a small part of a larger study by a group of authors, so there might be multiple abstracts, variously authored and titled, and only one or a few published papers or monographs that combine and expand the pieces.

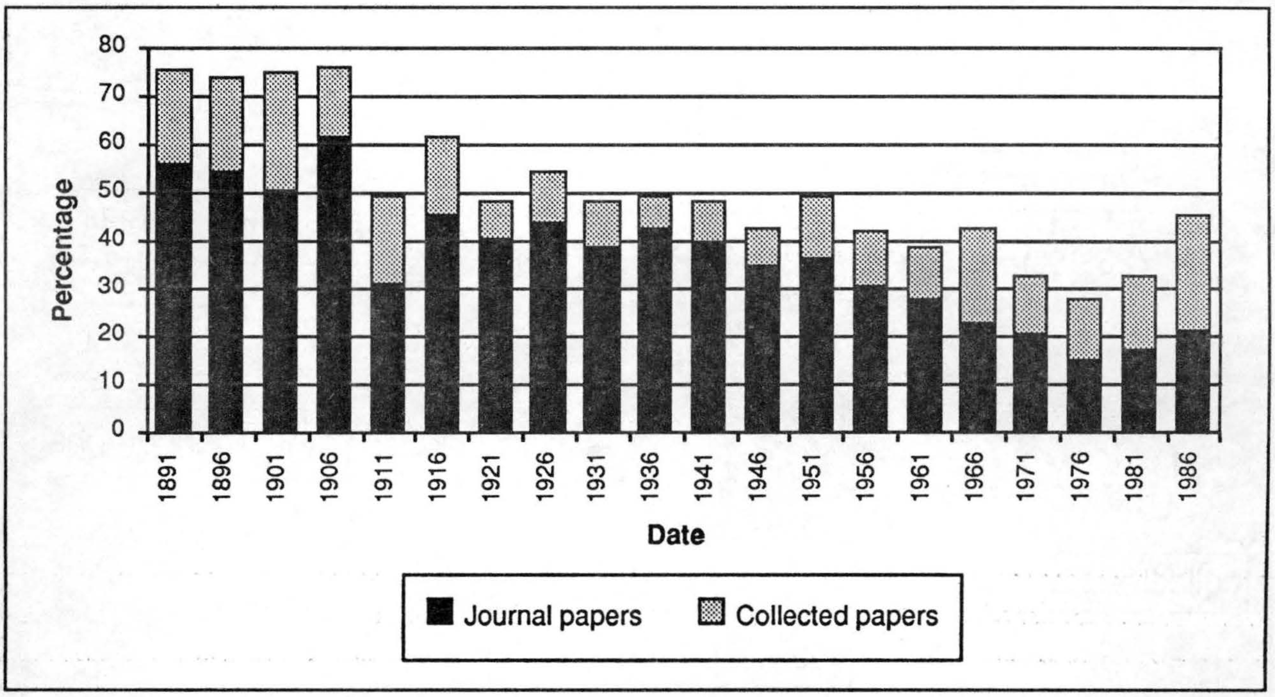

Figure 9. Papers on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Journal papers are shaded dark and average 24.3%; collected papers are shaded light and average 15.9%. Overall average = 40.2%.

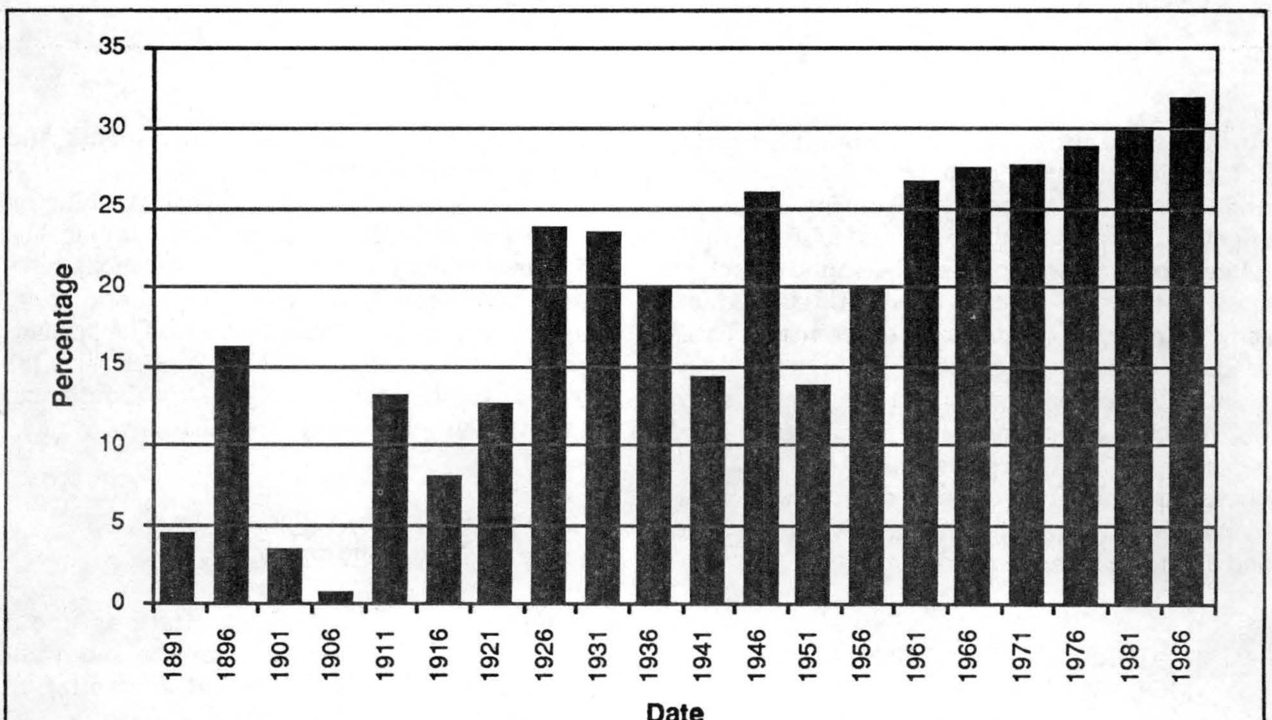

Figure 10. Abstracts on Washington geology, 1891–1990, as a percentage of all materials on Washington, in 5-year increments. Average = 26.1%.

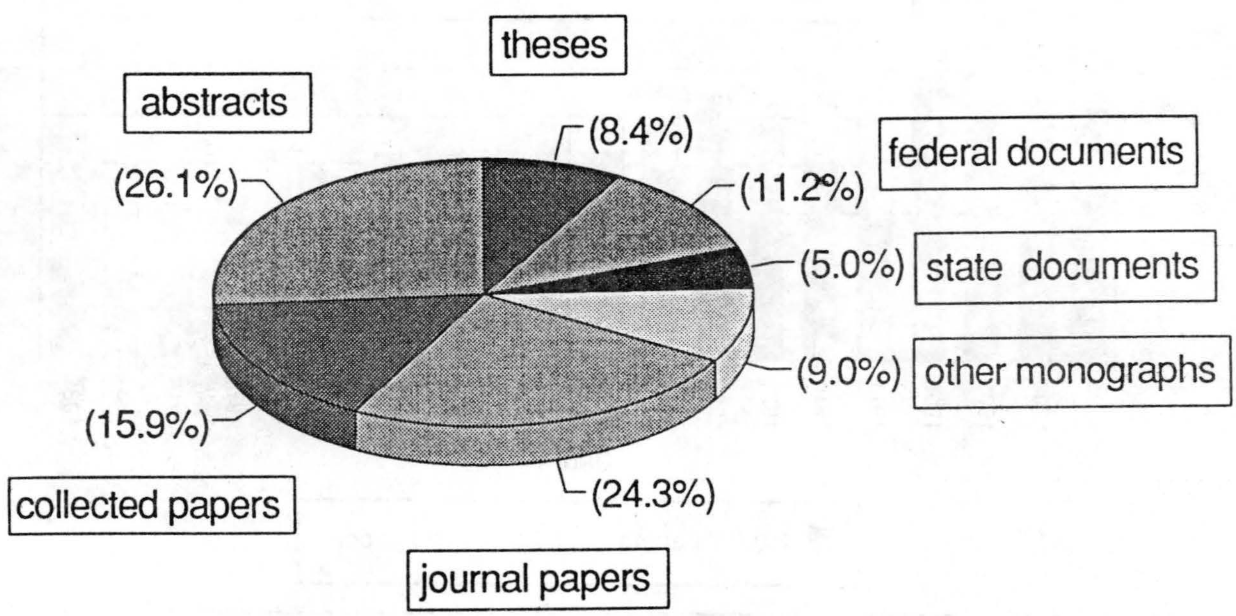

Figure 11. All items on Washington, 1891–1990, exclusive of Mount St. Helens citations, by type. Overall, monographs are 33.6 % of the total, papers are 40.2%, and abstracts are 26.1%.

Further, some abstracts refer to work in progress, not published later, or to completed work in unpublished or proprietary documents. A simple check of nearly 200 abstracts to find their related papers or monographs found exact or close matches for about 50 percent, but, because some matches are disguised by different emphases or titles, the percentage is probably higher.

Of all the citations on Washington geology, 33.7 percent are monographs, 40.2 percent are papers, and 26.1 percent are abstracts (Fig. 11). These percentages have changed over time: a relative decline in papers, an increase in monographs, and a notable increase in abstracts.

CURRENT CITATIONS AND MOUNT ST. HELENS CITATIONS

Mount St. Helens (MSH) erupted in May 1980. Figure 12 shows the number of citations on MSH from 1891 to 1975 in 5-year increments and annually from 1976 to 1990.

In comparison to all materials on Washington in the last 100 years and to those in the last 10 years—when the flood of MSH citations hit—there have been fewer monographs and more papers written about MSH (Table 2). The percentage of abstracts about MSH is higher than the 100-year Washington average, but is about equal to the Washington average for 1981–1990.

CITATION ANALYSIS–ASSUMPTIONS AND PITFALLS

Because the data set of citations about Washington geology is so complete and well-understood, we are confident that citation analysis comparisons to it are valid.

But any citation analysis is perilous. Just what are we measuring? We assume that

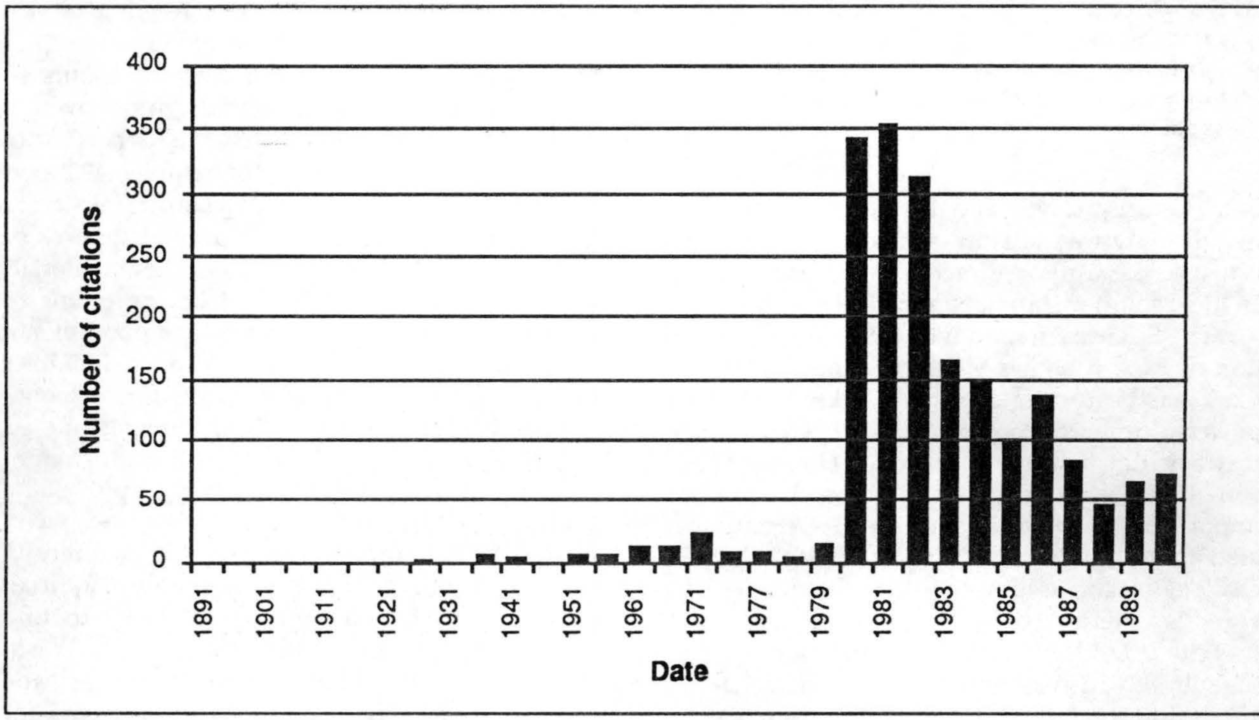

Figure 12. Items on Mount St. Helens, 1891–1990, in 5-year increments from 1891 through 1975 and annually from 1976 through 1990. Total number of references = 1,929.

authors have listed all the influences on their work, all the important previous works, and their sources. But have they? Or have they, instead, given those they knew about or could get? And what items were added or deleted in the review and editing processes? How reliable are authors' references cited (RC) lists as sources of information?

Table 2. Comparison of the percentages of non-MSH materials 1891–1990, non-MSH materials 1981–1990, and MSH materials 1891–1990.

	non-MSH 1891–1990	non-MSH 1981–1990	MSH 1891–1990
Theses	8.4	6.5	2.9
Federal	11.2	10.0	9.0
State	5.0	4.0	0.9
Other	9.0	9.0	4.5
Monographs	**33.6**	**29.5**	**17.3**
Journal	24.3	18.5	30.7
Collected	15.9	21.0	20.9
Papers	**40.2**	**39.5**	**51.6**
Abstracts	**26.1**	**30.9**	**31.1**

Citation analysis is commonly done by counting the publication dates and sources of RCs in journal papers (see, for example, Brown, 1956; Craig, 1969; Kohut, 1974; Haner, 1990). Often, the goal of such analyses is to determine the most significant sources and their obsolescence rates, or the usage patterns in different disciplines. By its very nature, citation analysis makes assumptions about why specific items were cited. Recent studies have challenged the validity of some of those assumptions.

We assume that an author's RCs are a roughly valid indicator of influence on his or her work. However, in a study on the history of an idea, MacRoberts and MacRoberts (1988) wrote (p. 343–345)

> Most authors did not cite the majority of their influences, and none cited all influences...[and]... simple citation counts missed the complexity of the underlying events [and that]... even

> though citation content analysis is no longer in its pioneering stage, it can claim little more than the discovery that citations are not simple events and cannot be treated as such.

Both Lindsey (1989) and Bichteler (1991) noted that the only way to know why an item was cited is to ask the author directly about each item—an ideal solution, but not a practical one.

The Science Citation Index (SCI) is a compilation of RCs; it shows where and how often one work has been cited in other works. It can be a powerful research tool to locate related works or to track the history of an idea. However, SCI sometimes is interpreted to show the relative importance of a work. Lindsey (1989) enumerated many flaws in a "blind reliance" on SCI, challenging the assumption that the quality of a work is determined by the number of times it was cited. Lindsey noted that a citation represents the subjective assessment of the citer, that citations are sensitive to fads and popular trends in science, and, conversely, do not reflect the ethical and moral dimensions of the quality of a scientific contribution. Lindsey wrote (p. 200), "...an approach that relies on citation counts as a measure of quality may too often be measuring what is measurable rather than what is valid." For example, Anderson (1991) reported the furor among British academics over using the number of times a person's paper(s) had been cited, as given in SCI, as an indicator of departmental quality. In reply, Bateman (1991) noted that SCI primarily indexes American journals and few of the British journals he published in. However, because counting is a measurable parameter, citation counting will continue. Recognition of the pitfalls in the counts requires that they be used with caution.

Other recent studies give some indication of why authors cite one item rather than another. Authors cannot cite something unless they have read it, cannot read it unless they can get it, cannot get it unless they know it exists. How, then, do geoscientists find out about and obtain materials? Bichteler and Ward's (1989) study of the information-seeking behavior of geoscientists shows that these geoscientists relied most heavily on personal collections and networks and less on bibliographic databases or printed indexes. The biggest frustrations of their information hunt were the time required and a lack of physical access to the materials.

In geology, these problems are compounded by the oddities of the materials. As shown in Figure 11, for the last 100 years, 33.7 percent of Washington materials are monographs, 40.2 percent are papers, and 26.1 percent are abstracts. Even if geoscientists did use printed indexes or bibliographic databases, not all of these materials would be listed there. Typical library online or card catalogs list only the monographs but not the papers or the abstracts. And as Bichteler (1991) and Figure 11 show, most of the monographs are "gray literature"—documents, theses, technical reports, and other non-trade monographs that are outside the established publishing channels and so are more difficult to deal with in traditional library systems. Consequently, these materials generally are slowly acquired, poorly indexed, and difficult for users to find (Bichteler, 1991). Other than the series of Washington bibliographies, GeoRef provides the only good national access to these items for Washington.

USES OF MATERIALS ON WASHINGTON GEOLOGY

The RCs in three recent publications were examined to determine how Washington materials are used: 210 references on Washington cited in 9 journal papers on Washington published in 1991 (Fig. 13); 223 references on Washington cited in 21 papers on Washington in a collected volume (Fig. 14); and 602 references on Washington cited in the 2 published quadrants of the Washington State geologic map (Fig. 15). These sources are listed in the appendix. Comparisons, by percentage of type, are made for these groups (Table 3) and for uses and sources of geologic mapping (Table 4).

Monographs

Monographs constitute 33.7 percent of all citations in the 1891–1990 data set but were cited more frequently than that in all three RC groups. The 65.5 percent level of citation in the two state maps is probably because, as geologic map compilations, the primary sources were previous

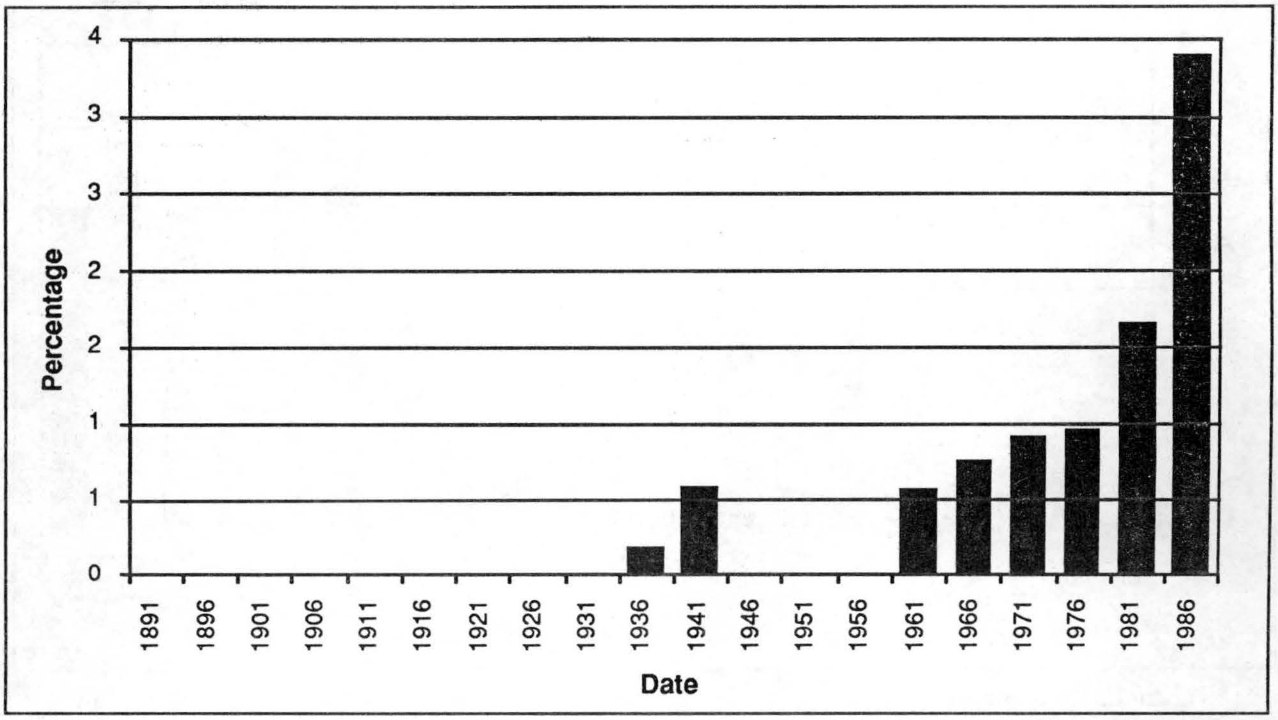

Figure 13. References cited in 9 journal papers on Washington geology, by date, as a percentage of all materials on Washington geology. Total number of references = 210.

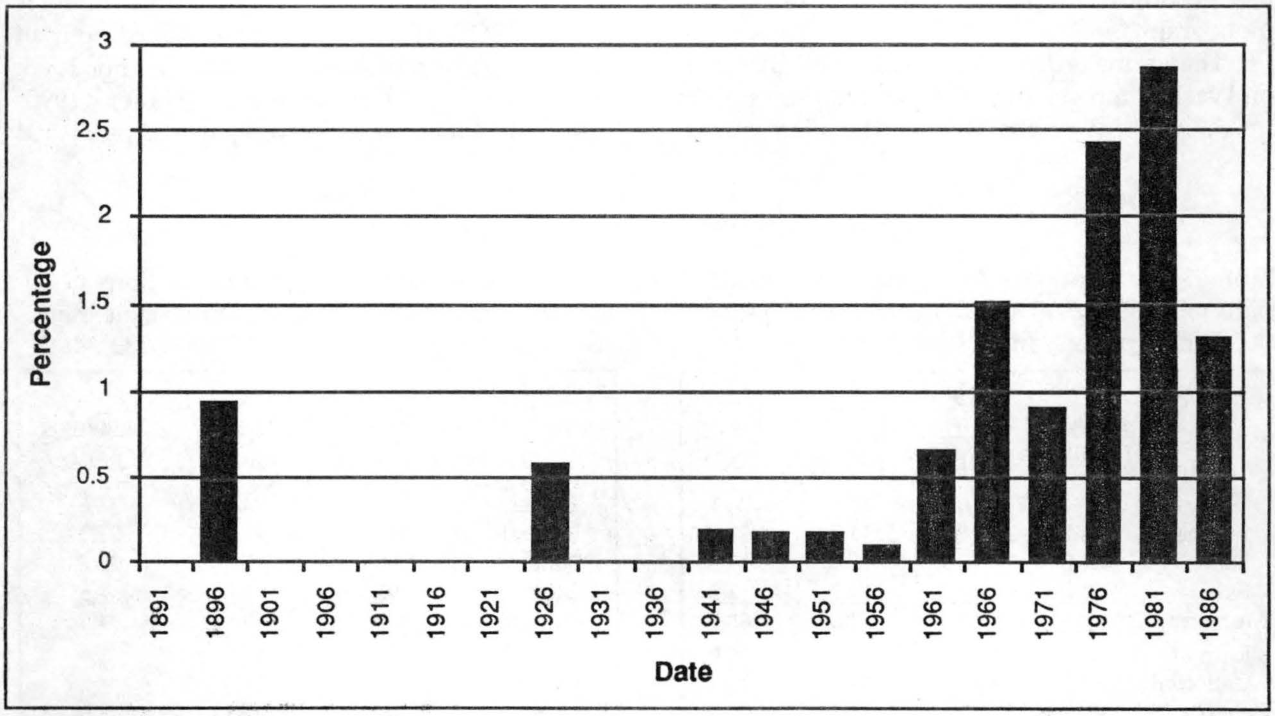

Figure 14. References cited in 21 collected papers on Washington geology, by date, as a percentage of all materials on Washington geology. Total number of references = 223.

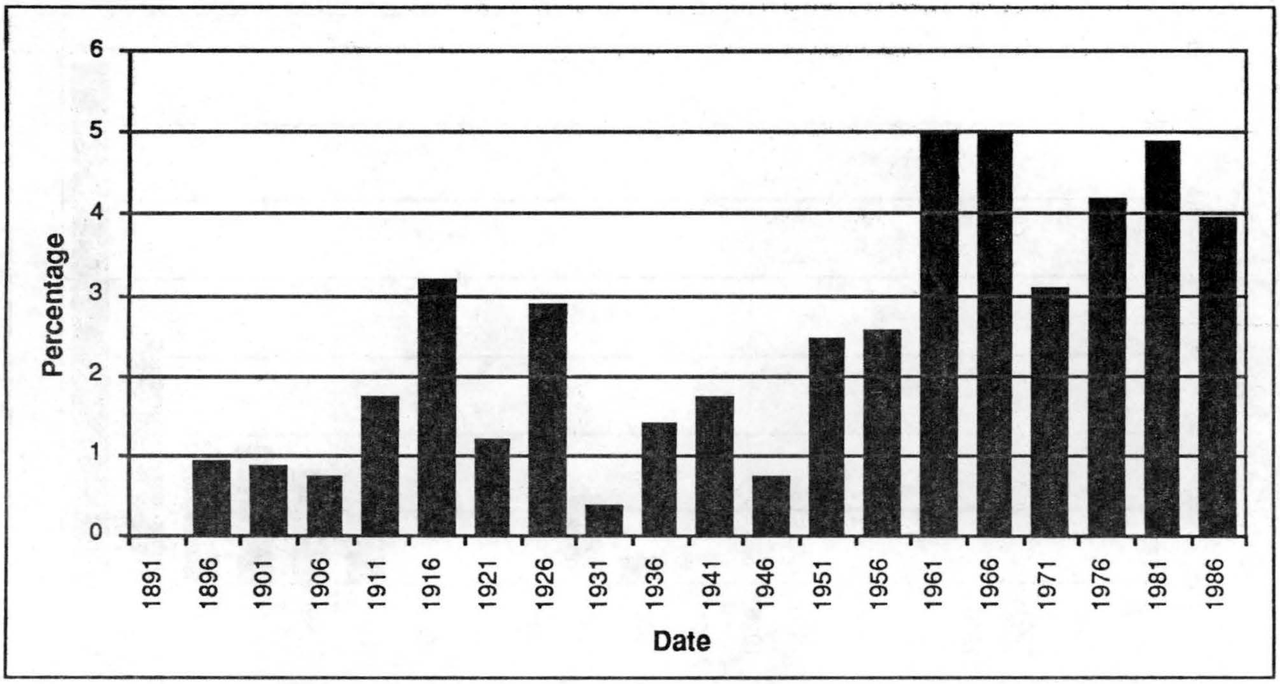

Figure 15. References cited in 2 large geologic maps of Washington, by date, as a percentage of all materials on Washington geology. Total number of references = 602.

geologic maps and because 94 percent of all the geologic maps of Washington are in monographs.

Theses make up 8.4 percent of all materials on Washington geology. Citations to theses make up 6.7 percent of the RCs in the nine journal papers. This is significantly higher than previously reported. In a 1969 citation analysis (Craig, 1969) of 800 geoscience items cited in journal papers published in 1960 and 1965, only 0.75 percent were theses. Haner (1990) found that of all RCs in seven journals published

Table 3. Percentages (by type) of non-MSH materials 1891–1990 cited in 9 journal papers, 21 collected papers, and 2 state maps.

	non-MSH 1891–1990	9 journal papers	21 collected papers	2 state maps
Theses	8.4	6.7	12.6	24.1
Federal	11.2	11.0	11.7	21.8
State	5.0	12.9	5.8	17.3
Other	9.0	8.6	11.7	2.5
Monographs	**33.6**	**39.2**	**41.8**	**65.5**
Journal	24.3	35.7	28.3	16.9
Collected	15.9	13.8	14.8	11.0
Papers	**40.2**	**49.5**	**43.1**	**27.9**
Abstracts	**26.1**	**11.4**	**15.2**	**6.5**

Table 4. Percentages (by type) of citations in all non-MSH materials 1891–1990, in two state maps, and in all geologic maps of Washington, 1891–1990.

	non-MSH 1891–1990	2 state maps	all geologic maps
Theses	8.4	24.1	38.6
Federal	11.2	21.8	27.3
State	5.0	17.3	20.7
Other	9.0	2.5	7.5
Monographs	**33.6**	**65.5**	**94.0**
Journal	24.3	16.9	
Collected	15.9	11.0	
Papers	**40.2**	**27.9**	**6.0**
Abstracts	**26.1**	**6.5**	**0.0**

in 1985, 1967, and 1929, theses were 3.0 percent, 2.9 percent, and 0 percent, respectively.

To have the theses used at a rate almost equal to their representation in the Washington data set is encouraging, especially in light of the difficulty in obtaining them (Walcott, 1987). The inclusion of theses in GeoRef increases their visibility and probably increases the usage. On the other hand, this level of use may also reflect the need for these geographically specific source materials. As Bichteler (1991) and Walcott (1987) noted, theses are particularly valuable as a source of localized geologic information. However, neither Craig nor Haner indicated how many of the journal papers they analyzed had a geographic focus; if few did, then that comparison would not be valid.

Theses made up an even higher percentage (12.6 percent) of the RCs of the 21 collected papers and were nearly 25 percent of those in the 2 state maps. This last number is explained, at least in part, in Table 4: 38.6 percent of the geologic maps of Washington are in theses. Since the two maps were compiled at the Washington Division of Geology and Earth Resources (WDGER), and since the Division library has a complete set of all known Washington theses, the compilers had full, ready access to them.

Federal monographs make up 11.2 percent of all citations about Washington and were cited at very nearly that level in both the journal papers and collected papers. They were cited far more frequently (21.8 percent) in the two state maps. Again, this probably reflects the greater percentage (27.3%) of federal monographs available as a source of geologic mapping of Washington.

Five percent of all citations on Washington are state monographs. The citation rate was much higher than this in the nine journal articles. This is probably explained by the phenomenon noted by Bichteler (1991) and Haner (1990): personal access to or knowledge of these materials. The authors who cited state survey reports had personal involvement with the state survey. State monographs were cited at about their existence rate (5.8 percent) in the collected papers. However, these reports were cited at a much higher rate in the two maps, 17.3 percent. Again, this is probably because state monographs make up 20.7 percent of all geologic maps, because the compilers had full access to them, and because many recent WDGER reports were done in support and anticipation of their contribution to this state map project.

Other monographs constitute 9.0 percent of all citations on Washington, and they are a diverse lot (Table 1): consultants' reports, university press publications, commercial press publications, and the like. They were used at about their existence rate in the journal articles (8.6 percent) and at a higher rate (11.7 percent) in the collected papers.

That higher rate in these 21 papers shows another information link. All these papers were about the Columbia River Basalt Group, which was extensively studied from about 1976 to 1986, primarily by the Rockwell Hanford Operations; the studies were funded by the U.S. Department of Energy. The focus of these studies was the possibility of burying high-level nuclear wastes at the Hanford Nuclear Reservation. Most of the authors of these papers had worked for Rockwell at some time, so it is no surprise that they cited a disproportionate number of Rockwell reports. That use also reflects an internal Rockwell policy: to preferentially cite reports they knew and had reviewed in their Quality Assurance program, such as a Rockwell report, rather than an outside report, such as a federal monograph.

Other types of monographs were little used (2.5 percent) in the two state maps. This could reflect the difficulty of acquiring consultant reports and the tendency of commercially published books to cover broad topics and general areas.

Papers

Papers constitute 40.2 percent of all citations on Washington. They were used in excess of their existence rate in the journal papers (49.5 percent) and in the collected papers (43.1 percent). This is unsurprising. As Bichteler and Ward (1989) found, journals have high prestige among geoscientists. Journals are also very accessible: according to *Ulrich's International Periodicals Directory 1990-1991*, the *American Association of Petroleum Geologists Bulletin* has a circulation of 42,000; *Geological Society of America Bulletin* has a circulation of 15,500; *California Geology* has a circulation of 13,000; and *Eos* has a circulation of 20,000. (Compare this with the typical thesis, which has a guaranteed circulation of one—to the university library. And as Walcott (1987) found, many universities will not lend theses.) Journals are also well indexed and relatively easy to get via interlibrary loan.

Papers were used less commonly in the two state maps (27.9 percent). Again, part of the explanation for this is that only 6 percent of geologic maps are in journal or collected papers.

Abstracts

Abstracts make up 26.1 percent of all citations on Washington. Abstracts are not generally accorded high prestige, so it is logical that the rate at which they are cited is much lower than the rate at which they are published. They *are* used, however, and were cited in all three groups: 11.4 percent of the RCs in the journal papers, 15.2 percent of those in the collected papers, and 6.5 percent of the citations in the two state maps.

Publication Dates

In general, in the nine journal papers, the authors used primarily recent material, and some older, perhaps classic, works (Fig. 16). The use by date is similar for the 21 collected papers, with greater use of older works (Fig. 17). However, in the two state maps, the use of material by date is more evenly distributed (Fig. 18). This could simply be an indication of availability. Because all the cited studies are held in the WDGER library, it would be as easy for the authors of these maps to get a 1910 doctoral dissertation as a 1989 *GSA Bulletin* article.

CONCLUSIONS

Of all the citations on Washington geology, 33.7 percent are monographs, 40.2 percent are papers, and 26.1 percent are abstracts (Fig. 11). These percentages have changed over time: a relative decline in papers, an increase in monographs, and a notable increase in abstracts.

Most of these monographs are gray literature as defined by Bichteler (1991). This has implications for libraries: in order to serve the geologic community well, they should provide as much access to this gray literature, in terms of acquisition and cataloging, as they do for traditional sources. Geology libraries must also be aware that two-thirds of their sources are not monographic, and so these libraries should also provide strong access to those materials. Facilitating access to the GeoRef CD-ROM and to local bibliographies and special indexes will benefit users.

Abstracts are an increasingly important information source. They are cited in all groups of reports studied, and they commonly point to a larger work. They should be included in bibliographies and indexes and, because they often report current research and state-of-the-art knowledge, should be included in a timely fashion.

Raw citation counts can give a skewed view of the use and utility of geoscience materials because they do not reveal why specific items were cited. We can notice patterns and guess at links, but the only way to know for sure is to ask the authors.

Comparing the references cited by date and type to the whole data set shows the great variation in the use of geoscience materials. These variations are linked to the variations in certain types of materials (like geologic maps) and to the access geoscientists have to them.

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BIBLIOGRAPHIC CD-ROMS IN AN EARTH SCIENCES SETTING: A USER STUDY

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Abstract—The Earth Sciences Library and the INSTAAR Reading Room at the University of Colorado, Boulder, have both recently acquired several bibliographic CD-ROM databases. This paper examines end-user interaction with these databases.

A literature search revealed that although CD-ROM user studies abound, none used these databases or featured geoscientists as end-users. Our study builds on previous work on information-seeking techniques of geoscientists (Bichteler and Ward, 1988a, 1988b, 1989; Andrews, unpublished, 1990). Our primary goals were to (1) identify various characteristics of the users such as level of subject expertise and searching experience, (2) discover how users found out about the database and what sort of training they received in its use, and (3) ascertain the users' satisfaction with information found in the database.

Results indicate that graduate students are the heaviest and most satisfied users. Most users were made aware of the system by the library staff, whereas a few heard of it from professors and associates. Those who used the system with the help of library staff were the most satisfied with the results. There was a high rate of repeat use, another indicator of satisfaction with the system.

Implications are that this type of information access is well received by end-users, all of whom indicated that they preferred CD-ROM over the paper indexes. It was also evident that weekend users (when no librarian or staff member was present) found the system more difficult to use. This indicates a need for contact with staff members or librarians in order to ensure productive searches.

INTRODUCTION

The purpose of this study was to identify certain characteristics of a CD-ROM user group; that is, to find out who is using the system, how they heard about it, and how satisfied they are with it. Other points of interest were how they received their training and their overall perceptions of the databases. The Earth Sciences Library and the INSTAAR Reading Room at the University of Colorado were the test sites for the study. The two are located several miles apart.

The Earth Sciences Library, located in the Geology Building, is one of five external branches of the University Libraries. The collection comprises about 35,000 volumes, including bound serial volumes, monographs, and government publications. There are about 350 current periodical titles. Over one-fourth of the collection is in storage due to space constraints.

The Institute of Arctic and Alpine Research is an interdisciplinary research institute of the University of Colorado. Primary areas of interest are earth's extreme environments at high altitudes and high latitudes as well as Quaternary research in paleoclimatology, paleoecology, ecology, and environmental processes. The INSTAAR Reading Room collection consists of about 2,400 monographs, 225 periodical titles, 4,200 government and university reports, and a collection of 350 theses. Several hundred maps and air photographs are also maintained for active research.

Although each library has unique holdings, there is quite a bit of overlap in the user population, and to some extent, in the collections. The two libraries own five bibliographic CD-ROMs between them, with no common titles (Table 1). PolarPac, now accessible at INSTAAR, has been ordered for the Earth Sciences Library. INSTAAR has access to the holdings in the Earth Sciences Library through dial-up access to the Colorado Alliance of Research Libraries (CARL) system.

Table 1. Bibliographic CD-ROMs in this study.

Earth Sciences Library	INSTAAR Reading Room
Earth Sciences	Arctic & Antarctic Regions
GeoRef	PolarPac
Selected Water Resources Abstracts	

The portion of our study dealing with the INSTAAR Reading Room users is still in progress. Many from INSTAAR, especially the graduate students, are familiar with the CD-ROM databases in the Earth Sciences Library. The two CD-ROMs in the Reading Room serve two different functions. The Arctic & Antarctic Regions CD-ROM is a reference database containing 250,000 records. As a bibliographic database it provides sophisticated search capabilities by author, title, or topic; many of the records are for items held in the Reading Room or elsewhere in the University of Colorado campus. It is very useful in identifying obscure references: a researcher was able to locate a picture of a native costume from Siberia in an article in an Italian journal, *IL POLO*, which could not have been found efficiently any other way. The PolarPac CD-ROM serves as an online catalog for over 85% of the monograph collection and for all of the journal titles held in the Reading Room. It can also be used to search for or identify items not held in the Reading Room but located at one of the other participating institutions, such as the Geophysical Institute at the University of Alaska, Fairbanks. The other functions of this CD-ROM, such as cataloging and interlibrary loan, are obviously much more useful to the librarian than to the end-user.

SURVEY OF THE LITERATURE

Our survey, involving graduate and undergraduate students in the geosciences, investigates the impact of CD-ROM technology on the end-user. It expands the body of literature on information-seeking behavior in the geosciences pioneered by Bichteler and Ward (1988a, 1988b, 1989). Numerous recent sources in the literature show that librarians are devoting close attention to the relationship between CD-ROM and the end-user. Clark and Silverman (1989), in a discussion of online rather than CD-ROM searches, found that although most faculty use online searching, they are unsuccessful at conveying its techniques and benefits to the student. This finding raises questions about student perceptions as they approach CD-ROM searches and about end-user instruction.

Discussions of end-user instruction in the use of CD-ROM appear in two articles in the same issue of *Laserdisk Professional*. Whitaker (1990) concludes that although point-of-use instruction was determined to be most effective, group instruction was more cost effective. Johnson and Rosen (1990, p. 40) take a more detailed approach, asking first what the needs of end-users are and then what kind of instruction can best satisfy those needs:

> Professionals should be less concerned with whether users are satisfied with the results and more attentive to how well the users are assimilating the search process.

End-users' response to CD-ROM was examined in three papers—Steffey and Meyer (1989), Welsh (1989), and Schultz and Salomon (1990). Steffey and Meyer composed a useful survey form for evaluating user success and satisfaction. End-users were particularly impressed with the time savings of using CD-ROM over printed indexes, as documented by Andrews (1990, p. 17), "Lack of time is the most prevalent problem in finding and using information." Welsh (1989) concluded from his study that both library staff and users favor CD-ROMs over conventional formats. The study by Schultz and Salomon (1990) was extremely pertinent to our study. Of students surveyed, 83% found that time was saved, possibly two-thirds of the time it would have taken to search printed indexes. They recognized the necessity for knowing how end-users approach the use of CD-ROM; the student, for example, is often only looking for a few good articles and approaches searching by using likely words to search free text.

Our paper follows lines of enquiry previously pursued separately by both authors surveying geoscience students and faculty. Larsen (1990) found that graduate students were the heaviest users of free, librarian-assisted online searching and thus were, along with undergraduates, potentially more likely than faculty to be heavy CD-ROM users. Andrews (unpublished, 1990) found that while faculty frequently access information by direct contact with colleagues, graduate students are more likely to use CD-ROMs, which were new at the time of the study, and "free" electronic search services such as online public access catalogs (OPACs) with their associated bibliographic databases. We both found that only approximately half our subjects avail themselves of online searching even when searching is free.

METHODOLOGY

Our questionnaire (Appendix) was aimed at a broad range of users. Some of the ques-tions and examples found in the literature served as models (Steffey and Meyer, 1989; Welsh, 1989). When the study was first run in Spring 1991, near the end of the semester, the questionnaire was four pages long. People tired of filling it out, however, as indicated by the incompleteness of many forms. Before rerunning the study, we decided to rework the questionnaire using some of the same questions but condensing it to a single page. The study was then run a second time early in the Fall 1991 semester. Both studies cover approximately a 2-week period.

ANALYSIS

In the Spring study in the Earth Sciences Library, 26 users filled out the questionnaire. This was probably about two-thirds of the actual users; unfortunately a system was not devised to track the number of actual uses compared to the number of questionnaires completed.

Use was distributed evenly between 12 graduate and 12 undergraduate students, 1 public patron, and 1 research associate. This pattern of use was not anticipated because casual observation had suggested that graduate students were the heaviest users of CD-ROMs, as they were of online databases (Larsen, 1990). However, much of this undergraduate use can be attributed to a large class on global change that required a research paper.

The use level in Fall Semester 1991 was again 26: 22 graduate students and 4 undergraduates. This period was before any papers were assigned in the undergraduate classes, leading us to the conclusion that cyclical heavy use by undergraduates is driven solely by class assignments.

Faculty members have not been regular users of the system as yet. No faculty used the system during the first survey period, and only one faculty member used the system during the second period. Lack of time and the specter of learning to use a new system are factors they mention when using the system is suggested. They continue to use mediated online searching when they need information. They are aware of the CD-ROM system and do suggest its use to their students, especially to undergraduates doing research papers, as indicated by this study. Professed interest in the system has been growing among the faculty recently, primarily because they are beginning to see what their graduate students are doing with the system.

In the first sampling period, use was overwhelmingly by geology students. In the second period the use was still heavily by geology students, but there was a significant component of users from other disciplines. The Selected Water Resources Abstracts (SWRA) database is a primary reason for this, because through it graduate students in hydrology from the civil engineering department have become aware of the system. Also, bibliographic instruction emphasizing the CD-ROM databases was given to a large class in stream biology in the Fall semester.

This pattern of use points to a major problem with interdisciplinary CD-ROM databases. Distributors' licensing agreements, which require substantial increases in the cost of the databases when mounting them on local area networks, on mainframe systems, or in multiple sites, very nearly prohibit widespread use of these options. Access is thus much more difficult for potential users in a multi-site library system like the University of Colorado's.

Our questionnaire indicated that most of those surveyed heard of the system once they got to the library; a little more than one-third heard of it from their professors. Most people learned to use the system from the library staff. Levels of instruction varied from detailed instruction by the librarian to briefer instruction by the student assistants who work evenings and weekends exclusively. From comments on the questionnaires, it was obvious that when a user's first contact with the system was in the evening or on the weekend, their level of satisfaction was good but not as high as that of weekday users. Few of those surveyed used the CD-ROM users' manual, which is clearly marked and located near the workstation. Even fewer state that they used the system's help screens.

Patterns of Use

Not surprisingly, GeoRef was the most heavily used of the five databases. In the Spring survey, 21 used GeoRef, 9 used SWRA, and 3 used Earth Sciences. In the Fall, 19 used GeoRef, 13 used SWRA, and 4 used the Earth Sciences database. This is another reflection of the broader distribution of subject specialties represented in the Fall user group. The databases on the Earth Sciences disc are not as heavily used because they are not as easily identifiable, being hidden under the generic title of "Earth Sciences," and also because they do not mirror a print index. In actuality, the USGS Library file on this disc is especially important to Earth Sciences Library users for two reasons. First, it gives subject access to state and federal documents the Library owns but are not included in the OPAC. Second, the Denver branch of the USGS library system is less than an hour's drive from Boulder, giving easy access to USGS publications.

Search Strategy

Most people in both survey periods responded that they searched for information by keyword. A few searched by author, but without specialized instruction searching by author tends to be frustrating because of the lack of standardization of names in any of the databases.

User Satisfaction

Users on every level were generally very pleased with both the number and the value of the citations they retrieved. Only one person, who probably used the system on a weekend, was completely dissatisfied. But even this person in reply to an open-ended question stated that it was a useful system. A question that appeared on the first questionnaire but not the second asked if anyone preferred the print index. Not a single person did. Obviously then, even if the search does not live up to the expectations of the user, the CD-ROM system outperforms the printed index. These conclusions were borne out independently by Kuehn and Welborn (in press), who found that undergraduates vastly preferred the Aquatic Sciences and Fisheries Abstracts on CD-ROM instead of print sources while librarians tended to compare the CD-ROM to online searching and found it inadequate.

User Dissatisfaction

Comments made in reply to the open-ended questions were quite revealing. One person who searched SWRA commented that many of the journals it cited were unavailable or old. Given that the University of Colorado Libraries owns most of the sources cited, this misapprehension may have arisen because s/he unknowingly used the older disc or may have used archaic terminology. Another person suggested that the CD-ROM give call numbers for the sources cited. Both of these comments point to the ongoing problem of finding the material within the University Libraries once it has been identified by a search. Many students do not use the OPAC adequately, and so their sophisticated CD-ROM searches are less effective than they should be.

Many users, especially undergraduates, are unaware that the databases may cover only certain subject fields or may cover some fields better than others. Part of this common misunderstanding could result from using the online catalog, which covers all subjects. Choosing the correct terminology is also a stumbling block. Many users are not aware that the terms they have chosen are not the most appropriate and so accept a less productive search than they might otherwise have had. It is in these particular areas—subject coverage, search terminology, and sophisticated search strategy—that contact with a librarian seems to really be necessary.

The users repeatedly stated that they liked the speed, thoroughness, and simplicity of the system, but several felt that it could be more user friendly and self-explanatory. Frustration with the physical limitations of the workstation surfaced in comments about the printer's predilection for eating paper and the need for a multidisc server.

CONCLUSIONS

Bibliographic databases on CD-ROM are more than just an alternative to online searching: this means of accessing bibliographic records must be viewed in light of its own characteristics. To a librarian, or other experienced online searcher, CD-ROM is an improvement over online searching primarily in terms of cost. However, to the end-user, for whom online searching was generally expensive and required complicated search strategies or an intermediary to perform the search, CD-ROM provides a welcome alternative.

If CD-ROM is to succeed as a medium, it must excel on at least two fronts: it must target the end-user rather than the librarian, and it must present the user with a value-added product not available competitively.

In summary, even though CD-ROM systems have some problems, they have been a great success with the users. Librarians tend to be more critical of the system because they see what the users could have access to if only they were more sophisticated in their search techniques. It may be that librarians must accept the fact that although the end-users are not finding everything, they may be finding all the information they really need.

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APPENDIX . CD-ROM SURVEY FORM
University of Colorado
Earth Sciences Library
INSTAAR Reading Room

Please take a moment to complete this form and return it when you are finished.
Thank you for your participation! Suzanne Larsen and Martha Andrews
You may circle more than one answer.

1. You are: 1. An undergraduate 2. A graduate student

2. What is your departmental or institutional affiliation, if any?
   1. Geological Sciences 2. INSTAAR 3. Other ____________

3. How did you hear of the CD-ROM product you are using?
   1. Professor 2. Friend 3. Library Staff 4. Other ____________

4. How did you learn to use the system?
   1. Library staff 2. Manual 3. Help screens 4. Friend 5. Other _________

5. Which CD-ROM database(s) did you use?
   1. GeoRef (ES Library) 2. Earth Sciences (ES Library) 3. Water Resources Abstracts (ES Library)
   4. PolarPac (INSTAAR) 5. Arctic & Antarctic Regions (INSTAAR) 6. Other

6. Did you find the databases easy to use?
   1. Yes, which databases?________________ 2. No, which databases?________

7. How did you search?
   1. Author 2. Title 3. Keyword in title or subject 4. Subject index 5. Other_________

8. Were you satisfied with the number of citations you retrieved? Very 1 2 3 4 5 Not satisfied
   Why?

9. Were you satisfied with the value of citations you retrieved? Very 1 2 3 4 5 Not satisfied
   Why?

10. If you could improve this product, how would you do it?
    1. Improve contents - In what way?
    2. Improve search procedure - In what way?
    3. Other:

11. Any other comments you would like to make?

GEOSCIENTISTS' ACCESS TO PUBLICATIONS OF STATE GEOLOGICAL SURVEYS

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Abstract—Publications of state geological surveys are invaluable to the geoscience community in that they often contain unique, specialized information found nowhere else. They may, however, have been underutilized, due in part to limited access. To provide data on which to base improvements in access, this study investigated the means by which geoscientists first became aware of survey publications that they cited in journal articles published in 1991. A personalized letter to the first author of 53 journal articles requested information on the specific mode of access. The return rate of 96% confirmed geologists' interest in this question. Results show that most geologists accessed these publications through citations in papers they read, suggestions from colleagues, or personal connections with the survey. No one used the *Bibliography and Index of Geology* or GeoRef, and librarians played little or no role in access. An obvious conclusion is that information specialists should be much more aggressive in providing information awareness and dissemination to their users.

INTRODUCTION

State geological surveys produce an impressive variety of publications. Often containing unique, specialized information found nowhere else, these maps, reports of investigations, information circulars, special papers, bibliographies, open-file reports, and software are a valuable resource for the geoscience community. Nevertheless, the access and use of these publications have been somewhat problematic.

Haner (1990) examined the use of all government documents (including state survey publications) in seven major geological journals, as revealed by citation analysis. She found that only 2% of the citations were to publications by state surveys. She also noted a strong correlation between employment of the citing author and citation rates to government publications; USGS or state survey geologists tend to cite survey publications at a much higher rate than do other authors.

Access to these publications continues to be a concern of the geological community. Traditional listing in survey catalogs and state indexes has been augmented by increased coverage by information services such as GeoRef. For example, in recent years the American Geological Institute (AGI), concerned about lack of access to state open-file reports, has made a concerted effort to add these publications to the database. Planning for further improvements in access should benefit from research that describes how geologists actually find out about state survey publications, hence this investigation.

In studying the information-seeking behavior of geoscientists several questions arise. To what extent do geologists actually use bibliographic sources and libraries to locate survey publications? Which sources do they use? Do most users continue to depend on recommendations by colleagues, citations in the literature, personal experience with the survey, or other informal means to locate publications of interest? How can access be improved?

A recent study of the use of gray literature by geologists (Bichteler, 1991) revealed that, in a small sample, no one used "standard" access such as the *Bibliography and Index of Geology* or GeoRef in accessing state survey open-file reports. This non-use of bibliographic tools considered essential by information specialists led to speculation concerning the question: how do geologists access all types of state geological survey publications? The present study addressed this question.

METHODOLOGY

The hypothesis of this research was that geologists use informal means of accessing state geological survey publications at least 90% of the time. In other words, formal access through bibliographic sources and databases is relatively insignificant, utilized less than 10% of the time. To test the hypothesis I examined the bibliographic references in each research article by U.S. or Canadian authors published in *Geology* and the *Bulletin of the Geological Society of America* (GSA *Bulletin*) from January through August 1991. The authors of 53 articles published in this eight-month period cited at least one state or provincial geological survey publication (see the appendix). One such survey publication was selected randomly from each of the articles in order to ascertain exactly how the citing authors had first become aware of its existence.

A brief survey seemed to be the most appropriate and straightforward method of determining the access used. Each of the first authors of the 53 papers received a one-page personalized letter that began by stating:

> In your recent article, [title of the paper], published this year in [GSA *Bulletin* or *Geology*] you cited the following state geological survey publication: [title of the cited publication]

This approach seemed likely to catch the attention of the geologist and ward off immediate discard of the survey. The remainder of the letter briefly explained the project and requested the geologist's assistance in specifying exactly how he or she had first become aware of the cited survey publication. The geologist had merely to check the appropriate category that best described access.

These categories included access through *individuals*, such as a colleague, formal *printed bibliographic sources*, such as the catalog of the survey, *online sources*, such as GeoRef, published *literature*, such as a reference in a publication that the geologist had read, previous or current *work with the survey*, and *other*. From the "other" category two additional categories were derived from the respondents' answers. An enclosed, stamped, self-addressed envelope facilitated completing and returning the survey.

The enthusiastic and immediate response was very gratifying. Many geologists wrote additional notes, commenting on their experience with state survey publications. Some five or six follow-up telephone calls to improve the return rate further confirmed my high opinion of geologists and their cooperative, friendly attitudes. Some had not answered because they had moved to a new position or had graduated and left the university; others because they were out in the field or, in one case, at sea for months. In some instances the second or third author provided the necessary information.

Characterization of all the journal articles by employment affiliation of their authors yielded an interesting contrast between articles that cited state survey publications and articles that did not. This analysis required examining each article and tallying the appropriate employment category of its authors. Because of joint authorship, the categories represented all combinations of academia, government, and private organizations.

RESULTS

After follow-up telephone calls, the return rate for the survey was 96%. The relative use of the various modes of access was as follows:

- 31% from a reference cited in the literature
- 21% through the suggestion of a colleague
- 16% through previous or current work at the survey or with survey employees
- 13% as either the author or the editor of the cited work or receipt of a copy from the author or editor taken from responses in the "other" category)
- 10% by examination of the survey catalog of publications
- 5% other (described below)
- 3% through a field trip guidebook (taken from responses in the "other" category).

The "other" category generated the following untabulated responses:

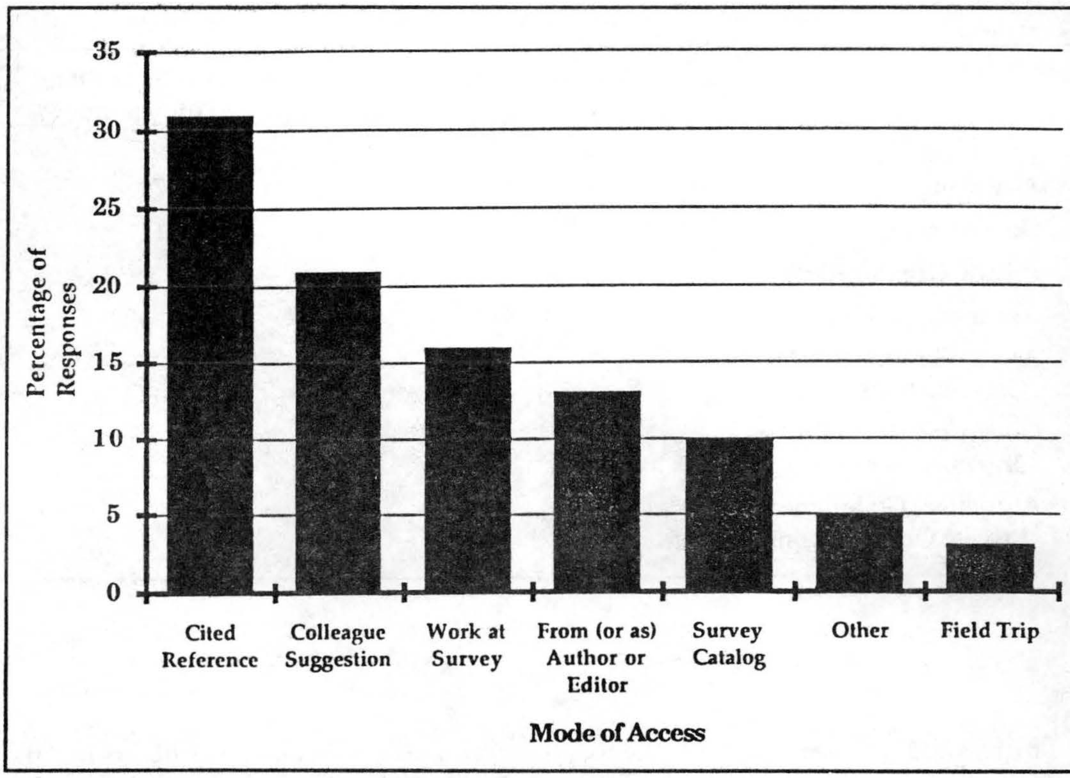

Figure 1. How geologists learn of state survey publications.

> This report showed up on the new acquisitions shelf in the library; our library has a standing order for many surveys.
>
> I ran across this in old company files.
>
> I saw a publicity flyer on this report and later looked at it in a convention booth.
>
> I've known about this important work for a long time—I don't remember how I first heard about it.

A graphical display of the methods of access appears in Figure 1.

Other than subject matter of the publication (not considered in the present research), the single overriding factor that appears to determine most strongly whether an author cites a state survey publication is *contact with another geologist.* Such contact may take the form of an obvious personal connection [work at survey; as (or from) author or editor], references in the literature, or suggestions from colleagues. Conversations with citing academic authors, for example, confirmed many paths to the survey: students' summer jobs, dissertations written through the survey, consulting, colleagues and former students taking professional positions at the survey, and so on.

A startling finding is the nonexistent role played by the two most important bibliographic tools in geology, the *Bibliography and Index of Geology* and GeoRef, in locating state survey publications. Since AGI has been diligent in acquiring and indexing these publications, one would hope that at least a few geologists would have located their survey publications through these sources. However, this survey revealed that the only bibliographic source consulted was the catalog of the survey.

The individual librarian also apparently played no part in alerting the geologist to the existence of the survey publication that was cited. Some respondents did volunteer the information that they had actually *retrieved* the publication through their library, however.

Table 1 characterizes the journal articles examined in the study in terms of the authors' employers. It contrasts articles that cite state and provincial survey publications with all

Table 1. Characterization of journal articles by author affiliation.

	All Articles (%)	Articles Citing State Survey Publications (%)
Academia	71	79
Government	10	11
Private Organizations	1	2
Academia and Government	12	4
Academia and Private Organizations	4	4
Government and Private Organizations	1	0
Academia, Government, and Private Organizations	1	0

articles published in *Geology* and the GSA *Bulletin* during the period in question. Clearly, geoscientists in academic institutions cite state survey publications to a greater extent than their representation overall in the sample would predict. The category "academia and government," on the other hand, seems to be surprisingly underrepresented in papers citing survey publications.

The explanation of this apparent anomaly is that the great majority of these papers have *academic and USGS* authors, rather than *academic and state survey* authors. For example, none of the January–May articles in *Geology* by academic and USGS authors cited a state survey publication, but all of the January–May articles in the same journal by academic and state survey authors cited state survey publications. In addition, authors in the "government" categories represent many other government agencies besides geological surveys, i.e., NASA, the Naval Research Laboratory, the Department of Agriculture, the Army Engineers Waterway Experiment Station, and so on.

IMPLICATIONS AND CONCLUSIONS

If geoscientists depend almost exclusively on one another to access state survey publications, where does that leave the library and the librarian? Where does GeoRef enter the picture?

From the data collected in this study, one would conclude that geoscience libraries are primarily depositories and document delivery services. Once the geologist discovers a useful publication, he or she turns to the library to retrieve it. One user's comment summarizes this approach: "After I found out about the report, I could get it in our library."

Information specialists should investigate ways of encouraging geologists to use GeoRef online or on CD-ROM; certainly the exclusive use of informal means to access survey work suggests that important, applicable publications are being missed by our users. Did a high percentage of those who did not cite survey publications not do so because there were no publications relevant to their work or because they lacked the appropriate personal connection or did not happen across the right cited reference?

Librarians need to do more than encourage the use of standard bibliographic sources. If geologists are not interested in accessing GeoRef, the information specialist can do it instead without waiting to be asked. If users do not consult a state survey catalog that might produce useful references, the information specialist should. By staying aware of users' research interests and projects and by actively supplying relevant references and documents before they are requested, librarians place themselves in the enviable position of being equal partners in the organization and critical to its success.

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