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ROLES AND RESPONSIBILITIES IN GEOSCIENCE INFORMATION

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ROLES AND RESPONSIBILITIES IN GEOSCIENCE INFORMATION

Edited by

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PREFACE

The papers in these Proceedings were presented during the 1983 annual meeting of the Geological Society of America in Indianapolis, IN. The Geoscience Information Society is an associated society of GSA, and papers in geoscience information are read as part of the GSA program.

The Geoscience Information Society was founded in 1965 in order to improve the exchange of information in the geosciences. Its main concerns have been with the activities and services of geoscience libraries and information centers, the analysis of information needs and products, and the processing and delivery of data and documents. The last decade has seen dramatic developments in the field of information technology, and the resulting changes in information materials, methods, management and scope is clearly reflected in the problems and issues treated in the present papers.

The Proceedings are divided in two parts:

1: Invited papers presented in the GIS Symposium "Roles and Responsibilities in Geoscience Information," and

2: Contributed papers read at the GIS Technical Session.

One of the papers was not available at the time of publication and will be represented by an abstract only. The papers appear as submitted by authors.

PART 1

SYMPOSIUM:

ROLES AND RESPONSIBILITIES IN GEOSCIENCE INFORMATION

Introductory remarks, by U. H. Rowell

It is my privilege and pleasure, on behalf of the Geoscience Information Society, to welcome you to our symposium on "Roles and Responsibilities in Geoscience Information." Whether you are planner, producer, vendor, broker, messenger, gatekeeper, or plain old user of geological information, I believe that our speakers will have something interesting to you in particular.

We have in the last decade or so had such a technical revolution in information management! At our disposal we have commercial and private databanks and databases, computers and terminals ranging from giants to pet-size, with automatic handling of data and documents--and much too often also of information users. Our technical wonders are so wonderful that it is easy to lose perspective and forget the purpose of our information systems.

In this symposium we mean to take a look at the ethics, issues and principles of geoscience information, analyze our ways and the responsibilities the information community has both to individuals and to society in a wider perspective.

In the first part of the symposium we will hear producers of geological databases, from the American Geological Institute and from the Institute for Scientific Information, talk on database ethics and on alternative formats for database information, and the leaders of the U.S. Geological Survey's library system will give their views on past accomplishments and their future responsibilities. Each of these three papers has been allocated 30 minutes. They will be followed by a brief discussion period.

The last part of the symposium is devoted to the education of geology students in the methods and sources of geoscience information. A representative from the Canadian mineral industry will reveal what a mineral exploration company expects their new geology candidates to know about information systems--and speculate on how they better can meet these expectations. From a faculty member in Library and Information Science at the University of Texas at Austin we will learn how geology students are taught--or not taught--

to use geological information sources in our major academic libraries. The final paper, by a Geology professor from Pomona College, California, who for a long time has been concerned with pedagogic methods, will deal with his use of online, bibliographic geological databases for teaching his courses in geology and geophysics. At the very end we will have a second discussion period.

DATABASE ETHICS: DECISION-MAKING CONSTRAINTS IN AN ENVIRONMENT OF CHANGE

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Abstract: Computerized bibliographic databases, a product of the seventies, are facing economic challenges in the eighties. To maintain the balance of their online services and their printed products, as well as to produce a quality product in general, will take much ingenuity on the part of the decision-makers involved.

Ethical considerations involved in this process of quality maintenance, include responsibilities to the authors of articles cited in the database, the publishers of these articles, and the users of the resulting citations. While the responsibility to authors is fairly clear and simple, that to the publishers and especially to the users is more complex. The users can be industry, academia, governments, or individuals, each with their own demands. The "ethics" of database production also involve the price of the product and its distribution vis-a-vis cost in relation to different kinds of users. National vs. international concerns are also examined briefly.

Technological progress has merely provided us with more efficient means for going backwards. -- Aldous Huxley

Knowledge without conscience is the ruination of the soul. -- Rabelais

Introduction

Without being as pessimistic as Huxley or as moralistic as Rabelais, it is nevertheless clear that the information industry of the eighties is facing some wrenching decisions. Money is not pouring in as it did in the seventies; the novelty of online databases is wearing off; and a new generation of information users is asserting its presence: a generation of PC-owners to whom a slide rule is an antique (if they know about it), access to information is a right, and science -- after a generation of ethical scandals -- has lost its aura of sanctity and incorruptibility.

A new environment is at hand.

Truisms of the present environment:

1. The amount of information available to the average U.S. citizen is growing rapidly. In a recent article de Sola Pool (1983), estimates that from 1960 to 1977 words made available to Americans over the age of 10 through 17 public media of communication increased at the rate of 8.9 percent per year (more than double the 3.7 percent growth rate of the GNP in constant dollars).

2. At the same time, the growth of available information is growing faster than it is absorbed by its intended audience. The words actually attended to from those media increased at just 2.9 percent per year, while per capita consumption of words from those media (allowing for population growth) increased at 1.2 percent per year. This is the age of information overload.

3. The market for this information is becoming more competitive with more information produced and smaller audience available (given population growth stability).

4. Point-to-point media ("personal" media) are preferred to mass media; and the consumers are willing to pay more by one or two orders of magnitude for these media.

5. The technology for producing information greatly improved in the past decade, and therefore much more material was produced. (e.g. The GeoRef database produces approximately double the amount of references produced a decade ago, with essentially the same number of staff.)

6. There is a demonstrable shift from print to electronic media: more interactive retrieval, long-distance telecommunications and intelligent processing of records.

7. Books with a scientific orientation or inspiration (including computer books) now outnumber literary (fiction) books.

8. The number of online databases has grown from about 400 in 1979 to more than 1500 English-language, widely diversified databases ranging from the minute in size to the behemoth. The producers of these databases (which are mostly bibliographic still) are for the most part the traditional abstracting and indexing services, but the picture is getting muddied. Some databases are being produced by publishers of the primary journals such as Elsevier, John Wiley and Pergamon. And these same publishers are investigating the possibilities of becoming vendors of databases, while the vendors (some 200 of them at present) are emphasizing the "supermarket" concept developed by Dialog, while moving into database publishing at the same time.

   In the meantime, some database producers such as the Institute for Scientific Information and Chemical Abstracts, are themselves selling their own online products, although the economics of such a venture are not at all clear and it may therefore be a bit premature to judge its feasibility in the long run.

9. The U.S. economy and that of the Western World in general is in recession and despite marginal spotty recovery, it promises to remain so for some time to come.

10. The proportion of database income from online services to that from printed bibliographies is increasing but still slowly and in many cases this increase is at the expense of the printed products. (It is estimated that 50-85% of the income comes from printed products; see Neufeld, 1982). The overall income of database producers is also declining or remaining steady in constant

dollars suggesting possible market saturation in the U.S. if not worldwide.

11. The significant online databases remain essentially the products of the culture and technology of the United States and in the English language; that despite the international pretensions of most of these databases.

12. The number of Ph.D.'s produced by American universities while increasing at a fast pace in the early and mid seventies, has increased at a very low rate in the past five years, and the pay of faculty members is declining in constant dollars.

13. There are tendencies to restrict the "free flow" of information between scientists. These tendencies may spring from outside forces as in military or industrial applications of science, or they are self-imposed for reasons of profit-seeking.

14. The end users (the scientists) are being courted vigorously by some if not all database producers, but, some suggest, we have to wait till the present high school generation (the natural computer manipulators) become database users.

Of ethics and morality:

Ethics is not fashionable today: not in society at large, a society fascinated as it is by the "bottom line", by "cost effectiveness", by "what works"; not in science where scientists are being told that they must be "communicators" (whatever that really means) in order for science to survive, and where suddenly you begin to notice those staid gentlemen (not a single well-known woman science communicator yet, but they will come) wearing three-piece suits and explaining the mysteries of the universe to the ignorant masses.

Not that long ago, Lord Rutherford when asked about the implications of splitting the atom, replied that he did not see one practical application from the thing. Nowadays, our media-hip science "celebs" would have laughed at his naivete: if you don't know exactly what you are talking about, predict anyway; people will forget these instant predictions in time for new ones. The instant celebrity afforded some scientists by morally bankrupt media voraciously hungry for "news" but not willing to make the effort of proper analysis and information transmission, is envied and sought after by new generations of scientists, some of whom seem not to mind cutting corners and even falsifying research results to reach the goal of becoming rich or, at the least, a quotable sage. One wonders parenthetically how did geology make it so far without the "popularity" of plate tectonics or without comparing volcanoes to electric popcorn makers.

Ethics is not very popular in the field of database production either. Scientific databases are themselves not far removed from science although once removed from research: they reflect science, the good and the bad and the ugly, and being in their electronic manifestations rather recent in appearance, they have been growing somewhat indiscriminately and with little overall planning.

The basic line taken by database producers, if any, is that "what sells" is basically good, and therefore, as long as one is selling, there is no real need for a code of practice where one does not exist (Online, 1983) or, if one does exist (as in the case of the American Society of Indexers), it is rarely followed in practice.

The times of megabucks have brought with them the era of microethics, but the problem of moral choice in databases (as practiced so far) is more complicated than it is in scientific research where the guidelines are well delineated and the system of penalty-reward is well established.

Databases are repositories of good science and bad science democratically presented and preserved for eternity by the computer: a museum of data, but a museum with an unconscious curator. So while it is estimated by some that of all books published some 80% are entirely forgotten within fifteen years or so, these same forgotten books (or reference to them at any rate) remain enshrined somewhere in a database unless purged purposefully by some authority, and the question here is: who will that authority be? Who will be accountable? And on what basis? These questions are being asked at a time of economic uncertainty which lends at once urgency to them but at the same time complicates the issue by introducing economic (database survivability) imperatives. A further complication introduced by the computer age is the tangled relationships between database accountability and the increasingly important role computer-generated information plays in decision-making often directly affecting people's lives. Managers of databases plead innocence for the consequences of actions based partially at least on what computers tell policy makers, while the latter claim that they simply acted on the information available.

So again: what is to be done? And who is going to do it?

For purposes of easy management we shall divide the areas of database responsibilities and ethics into four: database/author interface, database/publisher interface, and finally, international and geologic aspects of database information.

1. Database/author interface: Ideally authors should index their own work. Lacking that, it is important in a bibliographic database to represent the author's statement fully, accurately and rationally, to be retrieved by others for use as they wish. An indexer and surrogate maker should be "a specialist of things in general" in order to do justice to an original work.

Several questions arise here: should a database attempt to cover all articles in a given subject equally and promptly? What about the same article published in the same or slightly different form appearing in different publications? What about obvious errors in author names or titles: should they be left as they are or corrected? Should the author's name be standardized or left as it appears in the publication?

Such questions affect the retrieval of an author's work from a database and therefore, to some degree, the assessments of scientists in the market of tenure and scientific reputation. (One wonders here how those all-time champion authors in geology managed in pre-computer days; how many articles of E. D. Cope (1395 titles), C. R. Keyes (1293) or J. A. Cushman (427) were read?)

There are people who argue for equal division of credit among authors to reduce the probability of seniority being misused, and the online databases with their "computer-objectivity" effectively do that by giving equal weight to authors.

But the question of inclusion has broader implications than that of presentation. Should book reviews, book articles, long letters or short letters be considered as referencable material as well as journal articles? And what about informal reports and sketch maps? A letter-writer to Science recently raised some of these questions and concluded his letter by stating "If long letters are worth more, I'll be happy to rewrite and resubmit this one."

2. Database/publisher interface: The issue here is whether the contents of a given publication or a series of publications are completely, consistently, and thoroughly covered by a database or not.

There have been cases where some publishers have sued databases for "willful non-inclusion" of their material in that database.

There have been other cases where a publisher has requested a database not to include their material, although this admittedly is a rare case and relates to material considered to be in a preliminary form.

Given the realities of database costs, it is inevitable that the ability of a given database producer to acquire the information is related directly to its inclusion, and thus factors such as proximity (see international section) and price play an important role.

Copyright, which is usually defined by the originality of expression, not the ideas themselves, has profound implications for databases but has been dealt with extensively elsewhere. So has the question of the right to market databases in terms of the relative role of government and private industry, witness the court case involving Elsevier's Excerpta Medica and the National Library of Medicine's MEDLARS.

3. Database/user interface: The responsibilities of a database producer are the most important perhaps when it comes to the user, whether an intermediary user (librarian) or end user (scientist). The user pays for the information one way or another and therefore should be given the maximum service possible.

A recent phenomena that has attained certain fashionability in online circles is that of "downloading" and what should be done about it. The capture of information for reuse while paying for it only once was once confined, like computers, to major organizations, but with the advent of microcomputers, downloading is probably (no one really knows) occurring more and more and will increase even more as online prices are perceived to be excessive.

Efforts aimed at cutting costs by limiting coverage (or output) to "core" journals will affect most the browsers who are supposed to be the future users of databases, and in geoscience at least, most users have emphasized their interest in (a) comprehensive coverage, and (b) special coverage of small, out-of-the-way journals. Some users rank these journals as more important than core journals precisely for the reason of their general inaccessibility.

4. Geologic and international aspects: Geology is a unique science in the sense that geologic information often has an added value beyond that of research alone and reaching into the area of national economy and security. The discovery

of an ore or oil deposit and the timing of announcing its details can be of great political and financial importance. Examples abound: the spurious oil discovery in Siberia of two years ago, the CIA's estimate of Soviet oil resources, references to and estimates of strategic minerals, the U.S. Geological Survey's estimates of oil reserves, predictions of earthquakes and other natural hazards, are all instances of the far-reaching nature of geologic information.

Coupled with that is the fact that much of geologic information is descriptive by nature despite the increasing relative importance of geophysics and other mathematical applications in geology. There is less consistency in geoscience description and less objectivity overall than in other branches of natural science.

Geoscience is also international in a real sense: not only do geologic units disregard political boundaries, but the geology of one area is always bound and circumscribed by forces operating in adjacent areas.

Production of geoscience information in the form of online databases however is essentially an American phenomenon. Many users of databases have discovered that the coverage of these databases of information on countries outside the industrialized world is often sketchy at best.

A recent study (Byrne, 1983) revealed that of the number of scholarly journals indexed in American databases it was found that out of all Australian titles only about 20% were included. The situation for other countries and languages is certainly much worse. This not only represents (in geology) economic shortsightedness, but also, as Byrne suggests, raises questions about the integrity of research conducted in ignorance of what others are doing and have done.

Conclusions:

In the best of times, online databases are not cheap to produce at all and very expensive to produce well. And this is not the best of times.

Economic pressures are coming from everywhere: the general economy (less usage), the user (complaints about price of service), even from some of the database producers themselves where unsophisticated management having made gross errors of judgment in other areas of business is surprised and irritated that the online database doesn't bring in more money.

Discipline-oriented databases of course are limited by the size of the potential user market and the only way to increase the size of that market is by increasing the quality, to strive for excellence.

That translates, in practical terms, into:

a. Better coverage (subject and geography both)
b. More prompt coverage
c. Less intrusiveness between creators and users of information (between authors and researchers)
d. Less duplication
e. More simple output format
f. More ranking of material, to provide choice
g. More quality
h. More subjective information, to improve choice criteria

All of which, or most of which at least, costs money. Or so it seems. So again, what is to be done?

One choice seems to be to reduce coverage and hope for the best. Such a path is obviously suicidal for a database unless competition does not exist (and even then competition will spring up).

A better path to try seems to be that of increased productivity while maintaining if not increasing quality, and this is not as difficult as it may seem at first glance.

As the cost of computer and communication technology decreased in the last few years, the cost of human input has remained fairly constant or even decreased in real terms. It follows therefore that productivity has increased in net effect and there is no reason to believe that it cannot continue to do so for at least a short time given the trends already mentioned in this article. This increase in productivity however cannot do much unless accompanied by a decrease in the rate of production of scientific articles and scientific journals, and increased international cooperation to reduce duplication and cost (see Rassam, 1980). A code of ethics for the database industry is needed but a common understanding with publishers, librarians and users must also be achieved to better rationalize the flow of information which is not only becoming unmanageable but also is leading to curtailment of the quality of databases often by unqualified outsiders.

It is in fact opportune to call for a concerted effort by all concerned to curtail the publication and the citation of unfinished research, of simple laboratory data, of progress reports.

In the meantime, the database industry must at least make an effort at producing a code of ethics, a statement of responsibilities and a delineation of roles.

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THE U.S. GEOLOGICAL SURVEY LIBRARY AND THE USER COMMUNITY: A PAST AND FUTURE VIEW

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Abstract: The U.S. Geological Survey Library was established in 1882 with a nucleus of 400 volumes gathered during the Hayden and Powell Geological and Geographical Surveys of the West. From its modest beginning, the Library has evolved into a headquarters facility and three branches having combined collections of more than 1 million volumes. Although its primary mission is to be responsive to the research requirements of U.S. Geological Survey scientists and researchers, the Library system traditionally has made its resources available to various components of the U.S. Department of the Interior, other Government agencies, State geological surveys, universities and colleges, research organizations and the general public by means of interlibrary lending, reference service, and onsite use of its collections.

As it enters its second century, the Library system, faced with the prospect of staffing and budgetary limitations, is studying new ways of better serving its primary constituency while continuing to accommodate an ever-growing non-Survey user community. As one step in reaching that goal, the Library will be installing the Integrated Library System (ILS) in Reston, Va., and the branch facilities. ILS is a minicomputer-based automated library system designed to support a variety of library activities by using one Master Bibliographic File (MBF). ILS will enable the Library staff to provide improved service to all groups of users while allowing for better use of available human resources.

The First 100 Years

"PROVIDED,.....all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization...."

With these words from the Organic Act that established the U.S. Geological Survey (USGS) on March 3, 1879, the 45th Congress also authorized a library for the new organization. Subsequently, 400 books from the early scientific and exploratory surveys of the West were transferred to the Geological Survey Clerk's Office to form a nucleus for the future library collection. In 1881, Georgie Marvine, who was a sister-in-law of geologist G. K. Gilbert, was selected to temporarily oversee the materials. A year later, the Geological Survey Library officially became a reality when Charles C. Darwin was appointed first Librarian in February 1882. For the 10 years preceding his USGS appointment, Darwin had served as Assistant Librarian in charge of the Smithsonian Deposit at the Library of Congress.

During the first years of its existence, the USGS Library occupied space, along with other Survey offices, in the Smithsonian Institution Arts and Industries Building. In October 1884, the Geological Survey transferred into new quarters in the Hooe Building, 1330 F Street, NW, Washington, D.C. The Library remained in that location nearly 33 years, until May 1917.

Darwin's first report on library actvities, which appeared in the Fifth Annual Report of the Geological Survey to the Secretary of the Interior, 1883-84, revealed that a major effort during those early years involved acquisitions. The Library Accessions Catalogue, a numbered record of books received, was begun with the first entry, dated April 18, 1882, for volume one of the Proceedings of the American Association for the Advancement of Science. From that point on the collection grew steadily. One thousand volumes of scientific serials, collected by Ferdinand V. Hayden while he was serving as Superintendent of the Geological Survey of the Territories, were donated to the Library, and in October 1882, the geologic collection of Robert Clarke, a prominent Cincinnati, Ohio, publisher and avid book collector, was purchased, adding many valuable materials to the collection.

In addition to gifts and purchases, a primary means of adding to the collection was -- and continues to be -- the program of exchanging USGS publications for those of other scientific organizations and researchers. Initiation of such a program of mutual cooperation was begun by Hayden in order to provide research materials for the early Surveys, and the policy was subsequently mandated for USGS in the Organic Act. Because of the close association of the distribution of Survey reports and the acquisition of works for the USGS Library, the Librarian was placed in charge of both scientific exchanges and sales of publications. In 1886, it was reported that the Survey had exchanges with 153 American and 208 foreign geologists and with 187 American and 887 foreign insitutions. As a result of gifts, purchases and exchanges, Charles Darwin noted in his 1883-84 report growth in the collection from 400 volumes to a total of 18,415 books and pamphlets -- an impressive beginning for the Geological Survey Library. (U.S. Geological Survey ... 1885, p.xxxv)

In the Eighth Annual Report of the Geological Survey to the Secretary of the Interior, 1886-87, John Wesley Powell, the second Director of the USGS, discussed the need for the geologic investigator to keep abreast of the literature, and emphasized the Survey's committment to providing the means of fulfilling that need through its library:

> "It is essential that the geologic investigator, if he seeks to maintain a place in the foremost ranks of the science, shall keep himself constantly familiar with the current geologic literature of this and other countries, and since it is the policy of the Survey to employ the ablest geologists it is important that the means of keeping well abreast of geologic science shall be afforded them ... Great efforts have been made to render the Survey Library as complete as possible ..." (U.S. Geological Survey ... 1889, p. 54)

This philosophy has changed little over the years and remains relevant to future library planning.

Director Powell also mentioned in the Eighth Annual Report the importance of the Library staff's bibliographic work in furthering geologic investigations. The result of this work was a long series of annual volumes, covering the North American geologic literature. The first bibliography was published as USGS Bulletin 44 in 1887. Nelson H. Darton was the author of the initial five volumes, the last of which included a comprehensive list of references back to 1732. Fred B. Weeks, succeeded him and compiled the next 14 volumes. In 1900, Weeks appointed as his assistant, John M. Nickles, a paleontologist and former teacher. Nickles was the sole compiler of the following 20 volumes which covered the literature up to 1932. Nickles retired from the Survey in 1932 but moved immediately to the Geological Society of America (GSA), where he compiled the first 10 volumes of the Bibliography and Index of Geology Exclusive of North America. The Bibliography of North American Geology continued to be prepared by the Library staff until 1960 when responsibility for the publication was transferred within the Survey to the Office of the Staff Geologist, and machine processing was introduced.

In 1970, USGS relinquished sponsorship of the Bibliography of North American Geology to GSA, and it was combined with the Bibliography and Index of Geology Exclusive of North America to form one publication providing worldwide coverage of the geoscience literature. The most recent development in the evolution of the publication occurred in 1979 when production of the Bibliography of Geology (BIG) was assumed by the American Geological Institute (AGI) which also produces GEOREF, the computerized counterpart of the printed bibliography. Currently, AGI indexers review Survey Library acquisitions for inclusion in the BIG; therefore, despite many changes throughout a long history, the bibliography has remained closely associated with the Survey Library.

After guiding the library's growth to a size of almost 50,000 volumes, 80,000 pamphlets and 29,000 maps, Charles Darwin resigned and was succeeded as Librarian in December 1902 by Fred B. Weeks, a geologist who had been working in the Library as a bibliographer. Under Weeks' direction the Library moved into a period of rapid change. As Weeks had studied Library of Congress procedures, his first major project was the adoption of a classification scheme for the collection, which until 1903 had been acquired without an acceptable scheme or complete catalog. Because the Dewey Decimal system was inadequate to cover the full range of geologic materials and the Library of Congress scheme was yet unpublished, Weeks assembled John M. Nickles of the USGS Library staff and three consultants from the New York Public Library to devise a unique classification scheme, which has continued in use to the present time with only slight modifications. By the end of 1904, the arrangement of volumes on the shelf by the new scheme was nearly completed, but cataloging by author and subject was not finished until 1915 under Weeks' successor.

In his 6 years as Librarian, Weeks also arranged with the Library of Congress for printing catalog cards from Survey Library manuscript copy and revised the publication exchange lists of 400 foreign and 350 domestic exchanges. He replaced the flammable wooden shelves with steel shelving in 1905 after the first in a series of fires damaged some of the collection. In 1908, Weeks resigned as Librarian and returned to scientific work, first with the Survey and then with private industry.

Julia L. V. McCord, employed by the Survey since 1882 and by the Library since 1887, was named third Librarian in April 1908. During her 21-year administration, she served through many important episodes in Survey life, including two more fires, one in 1910 and another more extensive one in 1913. Both fires damaged the collection, but the 1913 fire seriously threatened the entire Hooe Building in which the Survey was housed. During the period of World War I, European exchange agreements were seriously disrupted, and the long, carefully-assembled runs of scientific and technical serials were broken. Although the library was heavily used by other government agencies at this time, the staff continued to be of moderate size - 7 people, consisting of librarian, assistant librarian, 2 catalogers and 3 clerks.

In May 1917, the Survey moved into the New Interior Building (now the General Services Administration Building) at 19th and F Streets, NW, Washington, D.C., and the Library occupied Room 1033 in one wing. The facility was unique because it was the first time space had been designed specifically for a library within a U.S. government building. The library remained in that location for 57 years.

In September 1929, after Julia McCord's retirment, Guy E. Mitchell, a Survey employee since 1907, was selected as the fourth Librarian. He had previously served as chief of the agency's executive division. Mitchell examined the collection from the viewpoint of a working geologist, and concluded that much extraneous material had been accumulated. In 1930, he sent 5,500 volumes to the Library of Congress and gave 600 surplus publications to university libraries. A more careful review of new acquisitions and a revision of exchange lists further tightened the collection. Mitchell had more success than his predecessors in obtaining increases in the annual book purchase appropriation, which had been established by Congress for the previous 50 years at a meager $2,000. The Depression of the 1930's caused severe reductions in funds for the Survey but brought some benefits to the USGS Library because civil relief projects accomplished an inventory of the collection and eliminated backlogged work such as the mending, labeling, and cataloging of materials.

Very early use of the library appears to have been primarily by USGS employees, and circulation statistics were more closely associated with employment levels of the Survey's Geologic Division than with the size of the collection. However, in 1930 growth in use of the Library by those outside USGS consistently grew over the years until Mitchell emphasized the service rendered to the public: "The library of the Geological Survey ... is a public library, as provided by law. It serves the members of the Geological Survey, but its service to others is numerically greater -- 51 per cent according to records kept since January, 1930. This outside public service is but one expression of the general Geological Survey policy to make freely available the information it has collected." (U.S. Geological Survey ... 1930, p.88) Throughout the 1930s the annual reports continued to note an increasing use of the library by new agencies of government and a predominance of non-Survey members in the count of readers.

After a month's illness, Mitchell died in December 1939, a year before his planned retirement, and William H. Heers became the fifth Librarian of the Geological Survey in 1940. Heers had previously worked at the Library of Congress and the Department of State, while earning a degree in library science at George Washington University. The Survey changed greatly during World War II. In 1942, the Branch of Military Geology was established, and as it grew to 75 professionals in 1944, it became the largest single user of library information and was responsible for doubling the library's annual circulation to 75,000 items.

A major turning point for the Library was its transfer in 1947 from the Office of the Chief Clerk to the Geologic Division, traditionally the heaviest user of its services. In the same year, the legal limitation on book funds was lifted, providing the opportunity to increase purchases to supplement the material received through exchange. The Library also received four additional positions, the largest increase in staff of any year of the library's history thus far.

The rapid Survey growth after 1940 and the scattering of personnel to many field locations brought new demands for library services and resulted in the formal establishment of branch libraries: first at the Denver Federal Center, Denver, Colo. in 1948; then in Menlo Park, Calif. in 1954; and finally in Flagstaff, Ariz. in 1965. Other administrative changes affecting the Library, were the 1949 and 1950 transfers of two very old and valuable collections to the Denver branch library, where they remain today: (1) The Survey's photographic collection, at the time containing 100,000 prints and negatives gathered from geologic studies since 1869, and (2) the field record notebooks pre-dating the Survey's earliest geological investigations.

When Heers retired in February 1969, he could look back on 29 years of tremendous growth and development. In a letter to Heers, W. T. Pecora, Director of the Geological Survey, wrote, "You are leaving behind as your personal monument the greatest geological library in the world."

George H. Goodwin, Jr., former Librarian at the American Museum of Natural History, succeeded Heers as sixth Librarian in March 1969. His first major task was to complete plans for the move of the Library from the GSA Building to the National Center in Reston, Virginia. Ground was broken for the new facility in 1971, and the first units of the Survey were transferred to the building in 1973. On March 25, 1974, the Library began its Reston move, which was completed in 6 weeks.

Since its move to Reston, the Library has continued its efforts to build a collection of earth science literature capable of supporting the requirements of its patrons and to develop a staff trained to fully exploit the richness of those holdings. In addition, the first steps toward automating library services were taken in 1975 with the initiation of online bibliographic data base search services, followed later that year by online cataloging of books and serials using the Online Computer Library Center (OCLC) system. Other major developments through 1982, which marked the Library's 100th anniversary, have involved automation of additional services and functions. Though completely transformed from its humble beginnings 100 years ago, the Survey Library remains committed to the principles and philosophy of Director Powell, Charles Darwin and their successors and is planning for the challenges of library service in the 1980s and beyond.

A Future View

Integrated Library System

During most of 1981 and nearly half of 1982, King Research, Inc., a Washington-area firm specializing in library management studies, evaluated the Geological Survey Library system to determine how best the Library could respond to the challenges of the 1980s. King examined the Library's current operations, considered short-term objectives and long-term goals, and developed and recommended a master plan for automation.

Immediately after the Geological Survey accepted the King Research feasibility study in June 1982, a decision followed to examine and evaluate the Integrated Library System (ILS), which had been conceived and developed at the Lister Hill National Center for Biomedical Communications of the National Library of Medicine (NLM). ILS is a minicomputer-based library system designed to support all library activitiies by utilizing one Master Bibliographic File (MBF) consisting of catalog records in MARC format and related activity records. The MBF supports a variety of library functions including circulation, on-line catalog access, serial records control, acquisitions, cataloging, and the production of statistics and management records.

Visits to ILS installations at the Pentagon's Army Library, the Naval Research Laboratory Library, and other libraries in the Washington-Baltimore area, discussions with the Lister Hill National Center staff, and attendance at meetings of the ILS User's Group, convinced Library and Survey managers that ILS would meet the needs of the Library system. By October 1982, work had begun on a Request for Proposal (RFP) that would incorporate the Library system's specific requirements for an ILS installation. In April 1983, arrangements were concluded with the Federal Library Committee (FLC) whereby the Survey Library would use the Library of Congress contracting office to expedite the RFP and procure the ILS. By mid-July, the RFP had been put out for bid; proposals were received by mid-August and were reviewed and evaluated during the next several weeks. On September 29, 1983, the Library of Congress awarded a contract to Avatar Systems, Inc., for a turnkey installation of the Integrated Library System at the Reston Library and the Denver, Menlo Park and Flagstaff branch facilities. Initial meetings have been held with the vendor, hardware and software are being ordered, and the Library staff is determining the parameters for the circulation and on-line catalog access functions. Current projections call for both functions to be installed simultaneously in all locations and up and running by May 1984.

The minicomputer, a Data General Eclipse S/280 with 1024K of memory, will be located at the National Center in Reston, and interactive communication links will be established between Reston and the three branch facilties. Peripheral equipment, an enhancement of the 2.2 version of the ILS software, available from and licensed to specific libraries by the National Technical Information Service (NTIS), the Meditech Interpretive Information System (MIIS) operating system, user-friendly cathode-ray tube (CRT) terminals, thermal printers and fixed and portable bar-code readers are other essentials of the ILS.

When first loaded, the Master Bibliographic File (MBF) will contain 80,000-85,000 catalog records that were produced by using the Online Computer Library Center (OCLC) Cataloging subsystem. Current plans for the retrospective conversion of selected manual cataloging could add 100,000-125,000 more records to the MBF.

Demands on the Survey Library

Automating specific library functions is viewed as an opportunity to discontinue such labor-intensive operations as the charging and discharging of library materials and the filing of catalog cards in four libraries and to replace these operations with an interactive automated system permitting the Library to make better use of available human resources.

The goals for Geological Survey Library service in the years immediately ahead are simple. First, the Library would continue to provide effective and efficient service to all Geological Survey scientists and researchers wherever they are. That is its primary mandate. Beyond that, the Library would attempt to continue meeting the ever increasing demands from all types of non-Survey users for access to monographs, periodicals and serials, maps, dissertations, technical reports, photos, field-record notebooks, in short, to the full range of the geoscience information it collects and maintains.

In fiscal year (FY) 1970, the Library system processed 19,634 interlibrary loan requests, and in FY 1982 it handled 38,960 such transactions. Further, the staff responded to 12,091 reference inquiries in FY 1970 and to 35,827 in FY 1982. This doubling and tripling of the volume of selected public services provided by the Library has been accomplished with no significant staffing increase. Although authorized staffing levels occasionally have exceeded those of the early 1970s, the chronic difficulties experienced in filling approved positions, especially shelvers, circulation desk attendants and interlibrary loan technicians, have persisted.

As would be expected, the predominant service demands placed upon the Geological Survey Library system by non-Survey users consist of reference inquiries and requests for interlibrary loans. For the three most recent fiscal years, that is, FY 1980 through FY 1983, 41% of all services provided have been in response to the needs of the non-Survey user. Several factors account for this rather surprising statistic.

(1) The Geological Survey Library has a tradition that is as long as the Library is old of making its resources available to all who request them.

(2) Budget cuts and staff reductions have forced many librarians to rely upon the holdings of other libraries to meet the needs of their institutional users. Many academic, governmental, and corporate libraries benefit from resource sharing, and the Survey Library is keenly aware of its obligations and responsibilties as a major resource repository for the earth sciences.

(3) Both librarians and researchers are accessing an ever growing number of pertinent bibliographic data bases. Currently more than 175 active files are available through DIALOG Information Services, Inc. GeoRef undoubtedly is the principal earth-science data base being queried, but other relevant files such as Tulsa, Geoarchives, Chemical Abstracts, Biosis, and Water Resources Abstracts, are searched with increasing frequency. Thus, the data base searcher, whether a librarian or a researcher in his office, has acquired in a few short years, the capability and the expertise to locate and exploit a far greater proportion of both the basic and peripheral earth-science literature than ever was possible by manually searching the card catalog and the printed bibliography. The

single-subject search of a half-dozen data bases during one session at the terminal is common; the receipt from the data base utility of several hundred, and occasionally more than a thousand, offline prints is also common. Because few searches are carried out merely to compile a list of citations, easier access to a multitude of pertinent data bases has resulted in escalating service demands, especially interlibrary loan requests. At least this has been the experience at the Survey Library.

(4) Increasing use of the OCLC Interlibrary Loan subsystem by member libraries has resulted in a greater demand for access to USGS library holdings. Staffing problems may be forcing some libraries to limit or otherwise restrict interlibrary lending, thus directing attention to the Survey Library's holdings and its willingness to lend.

(5) Finally, the Library's services are provided at no cost to the user. Since October 1st of this year, the National Library of Medicine has been charging non-Federal, domestic patrons the nominal fee of $5.00 to process an interlibrary loan request or to make a photocopy. In a unique arrangement, the establishing of deposit accounts and the invoicing of customers will be handled by NTIS. (NLM...1983)

Several questions should be posed. Will the Survey Library system be able to continue responding to the needs of more and different users? Will it be able to do so satisfactorily? Will its public service functions in the 1980s and beyond be vastly different from what is offered today? Can it do more with limited human resources? If so, fine; if not, then how does it order the priorities of its available services and to whom will they be offered? Can it continue to provide public services without instituting user fees?

Improved Access Equals Increased Use

Projects now underway and planned, both within and outside the Geological Survey, are likely to have a far greater impact upon the Library system than anything that has happened in its first 100 years. They should provide some answers as well as elicit further questions. ILS has been identified, but other activies should be briefly mentioned.

Earth Science Information Network

The U.S. Geological Survey has established the Earth Science Information Network (ESIN) as a major new thrust in disseminating information resulting from scientific investigations by its staff and information acquired from other sources. Part of the Survey's mission is to provide earth-science information to the public and to Federal, State, and local governments who are concerned about earth-science related issues. Effective and prompt delivery of this information will be possible through the network in spite of general reductions in funds and staff at the Federal level.

The major emphasis of ESIN is to link the offices answering requests from the public and to augment them with Earth Science Information Centers to provide in-depth scientific answers to requests from the scientific community within the public sector and especially to help colleagues in the Department of the Interior. Initially, the National Cartographic Information Centers and the Public Inquiries Offices will be provided with uniform and comprehensive reference sources, and supported by current computer and telecommunications technology. The primary difference between the Earth Science Information Centers and the existing public access points is the level of expertise provided to meet initial inquiries for information. Centers will not provide technical consultation services to the general public on an open-ended basis but frequently will refer inquiries to specialists within the Survey.

The first Earth Science Information Center, scheduled to open in early 1984, will be collocated with the Washington Public Inquiries Office in the Department of the Interior, Main Building. Investigations are underway to analyze the feasibility of establishing Centers in Denver and Menlo Park.

Distributed Information System

The Distributed Information System (DIS) of the Water Resources Division (WRD) consists of decentralized Prime minicomputers and other data processing equipment. They are tailored to the specific District or Subdistrict Office's requirements and are linked by telecommunications to a central mainframe where hydrologic information is processed and maintained. When completed, the DIS will comprise 75 systems nationwide. In FY 1984, two of the Geologic Division's largest data bases, the National Coal Resource Data System (NCRDS) and the Mineral Resources Data System (MRDS), which is almost entirely bibliographic, will become available through the DIS. Plans are underway within WRD to provide District and Subdistrict personnel with direct access to both governmental and commercial bibliographic data bases, through means of a user-friendly system on the DIS that translates an ordinary language question made by the searcher to the commands used for a data base. It is anticipated that WRD personnel, especially those stationed away from the Survey's Regional Centers, will utilize the ILS on-line catalog access feature once it is made available.

PUBMANUS

The PUBMANUS (Publications and Manuscripts) data base, at present consisting of bibliographic data for all formal Geological Survey publications and Open-File reports issued since 1981 and selected Survey publications produced since 1879, will prove a useful tool for the Survey's nine Public Inquiries Offices and five National Cartographic Information Centers. PIO and NCIC employees will be able to access this data base by author(s), title, subject, and series and number, thus facilitating their ability to handle queries.

Depository Library Access

An Ad Hoc Committee on Depository Library Access to Federal Automated Data Bases, established within the Joint Committee on Printing of the U.S. Congress, is studying the feasibility and desirability of allowing Federal depository libraries to access unclassified government data available in electronic format. The ad hoc group will look into what government information is now available in that format, determine the ability of depository libraries to access it and calculate the cost and benefits of providing such information to the depositories. There are an estimated 1,400 regional and selected depositories in the U.S.; most function as integral parts of academic and public libraries, which someday will probably receive legislative approval to search government data bases -- including the Library's Master Bibliographic File.

Conclusion

The conclusion to be drawn from the projects described above is that continuing improvements in the techniques for accessing bibliographic data bases most likely will insure increased use of a library's collections.

The clearly demonstrated need for information contained in the Library system's holdings is more than sufficient evidence that access must continue to accommodate both Survey scientists and the rest of the geoscience community. Although there is an awareness that additional dialup ports eventually may be needed to handle an increased demand for on-line catalog access, the Library's main problem will occur as it attempts to balance the acknowledged priority needs of its own institutional users against those of all others.

Does the high-tech field of robotics offer a possible panacea? It apparently does for Japan's Kanazawa Industrial University library, where more than 30 tiny robots fetch and replace some 2000 video and 1000 audio tapes for 4500 students. The activity is described as follows: "Shuttling between stacks and players are 'intelibots,' battery-driven, wheeled robots no bigger than a shoe box. Each has a 'magic hand,' a manipulator which swings from vertical, for fishing tapes out of stacks, to horizontal, for slotting them into players. When not making deliveries, the intelibots wait in a parking area, where they charge up their batteries." (Enter ... 1983) Realistically, robotics does not appear to be a near-term solution for the Survey Library.

While it was responding to more than 30,000 loan requests in FY 1983, the Survey Library system was itself borrowing nearly 5,700 items from other libraries. In FY 1982, the figures were approximately 33,500 loan requests processed and 5,200 items borrowed. Clearly, members of the geoscience communnity depend upon one another. And the need-to-know demands from geoscientists in the 1980s and beyond will only reinforce that dependency. The demands will <u>not</u> go away and they <u>will</u> get worse.

How then, collectively, do we meet this challenge? Perhaps an answer is to be found in that portion of the King Research study dealing with suggestions for long-term Survey Library goals. The King report viewed the Survey Library system as being essentially the national library for the earth-sciences with major responsiblity for supporting and improving access to earth-science information, improving the Library's resource-sharing capability and for promoting geoscience library and information networking.

It is this last mentioned goal that is most intriguing. Can networking be viewed as a solution to coping with the anticipated earth-science information demands of the future? Agriculture and medicine provide two examples of currently working library and information networks. Do the state geological surveys, geoscience research libraries in academic institutions, corporate libraries and the Federal sector constitute the basic ingredients for a successful network? Certainly an informal network exists already, but is it functioning effectively? In its present form will it be capable of responding to future needs? Rather than the long-term goal envisioned by King Research, a dynamic, more formalized, interactive geoscience library network would appear to be an essential short-term objective.

This presentation has advanced a number of questions: some directed at the Survey Library; others aimed at those it serves.

It is difficult to provide explicitly detailed responses to the questions concerning the Survey Library, since so much of what may or may not be possible is tied to staffing limitations and the budget process. Nonetheless, the Geological Survey Library system is firmly committed to serving the Geological Survey and the geoscience community to the best of its ability with all the resources at its command, now and into the future. A trained and dedicated staff and the Integrated Library System are surely two convincing reasons for believing that commitment will be met.

As for those other questions -- they can best be answered by you.

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THE FUTURE OF INFORMATION RETRIEVAL IN THE EARTH SCIENCES: FROM BIBLIOGRAPHISM TO ENCYCLOPEDISM

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Abstract: Secondary information services have traditionally provided access to bibliographies of relevant literature. Online searching has automated the process, but the end result is still a bibliography. The Institute for Scientific Information (ISI) looks forward to a time when a qualitatively different type of information, encyclopedic information, will be provided.

ISI has pioneered an objective literature classification technique called co-citation clustering, and has applied that technique to provide online information services, one of which is designed specifically for earth scientists. Since clustering will play a key role in providing encyclopedic information, ISI's online services are viewed as a transition from bibliographism to encyclopedism.

Users will someday be able to quickly identify the core papers of a given specialty, and to retrieve another group of current papers which form the research front of that specialty. Users will also have access to up-to-date overviews which describe the evolution of a specialty, and to cluster-maps which show the degree of content similarity among papers within a specialty, or even of one specialty to another.

More than 20 years ago, when the Institute for Scientific Information® (ISI®) began operations, our objective was "bibliographic control." We wanted to help scholars locate those papers relevant to their research projects. Today, it is safe to say that goal has been met. In most cases, we can obtain reasonably complete bibliographies on almost any topic. In fact, it's easy to become overloaded with information. To cope with this problem, ISI is developing information services that go beyond the provision of mere bibliographies.

Suppose you need information about a specialty with which you're not very familiar. Today, you may have to be satisfied just to get a list of current papers. But in the future, you will also have at your fingertips a summary of how that field developed, and where it is going. Your personal computer will provide an instant review which identifies both the milestone papers and the most current papers in that field. You could also learn how relevant other disciplines are to your own, and thus where you might find additional pertinent information. At ISI, we call this type of information "encyclopedic information."

ISI is embarked on a long-range plan to make encyclopedic information available. Since the information services we've developed as part of this plan are based on citation indexing, it's important to understand the simple principle behind this literature classification technique. Almost all papers contain references, or citations. These cited publications support, illustrate, elaborate or provide precedent for the author's statements. Each of these references denotes a subject link between the present work and the cited work. In a citation index, papers are classified according to the older documents they cite. ISI now produces three major citation indexes, each covering a broad area of scholarship: the _Science Citation Index_® (_SCI_®) for the natural sciences, the _Social Sciences Citation Index_® for the social and behavioral sciences, and the

Art & Humanities Citation Index®. These retrieval tools enable you to locate recent documents on a subject you know someone else has written about.

For example, if you wanted to update yourself on the topic of a paper which Z. E. Peterman, U.S. Geological Survey, had published in Geochimica et Geophysica Acta in 1970, you would turn to his name in the most recent Citation Index. There you'd find all authors who had cited Peterman during the indexing period (Figure 1). For full bibliographic information, including article titles, on the papers that cite Peterman, you'd turn to the Source Index section of SCI. This is an author index, which lists every paper an author has published during the indexing period.

The SCI also includes a Permuterm® Subject Index which lets you search for papers by key words in their titles. Every significant word in a title is permuted -- that is, paired -- with every other significant word in that title. To find papers on strontium isotopes, for example, you might look up "strontium" and then glance throught the co-terms until you found "isotopes." Next to this term would be the names of authors whose papers included "strontium" and "isotopes" in their titles. Again, you would turn to the Source Index for full bibliographic information on these papers.

I should mention that the SCI is available online through

SCISEARCH®. With SCISEARCH, as with the SCI, users can search by author, cited reference, title words, and institution. SCISEARCH, however, also lets you search by any combination of these terms. This data base covers the 3,000 journals in SCI plus an additional 900 journals covered only in Current Contents®, our weekly current awareness service.

SCI was developed as an information retrieval system. And its presence in more than 1100 major libraries throughout the world attests to its value. However, even before SCI, sociologists and historians of science realized that citation indexing had another role to play. These scholars found that highly cited papers are often the milestone papers of science. Thus, citation analysis can identify significant papers, journals, and even individuals in a field. The later realization that citation analysis could also reveal "fields of knowledge" and emerging specialty areas brought ISI a step closer to the era of encyclopedism.

In 1963, the late Derek J. de Solla Price proposed that we use citation analysis to systematically diagram the structure of science. He believed that by studying citation relationships among documents, we could view the structure of science "in which the parts of science are conceived as mapped like a territory."[1] In 1974, Henry Small of ISI, with Belver Griffith of Drexel University, found a way to create this map.[2] They discovered that papers could be grouped together according to how often they are cited together, or co-cited, by more recent papers. Each of the groupings, or "clusters," they identified in this manner consisted of highly cited and closely related papers -- in effect, the core literature of a given specialty. By examining these clusters, and the more recent papers that cite them, we found we could write comprehensive encyclopedic reviews of each of the specialty areas identified through our clustering process.

ISI begins the clustering process[3] by identifying the group of journals that are most important to scientists publishing in a broad subject field. This could be all of science or, for example, the geosciences. Then we identify the papers that have been cited a given number of times. This reduces the number of papers to be included in clusters considerably. For example, less than one percent of papers cited in the 1982 SCI were cited 17 or more times.

The next step in the clustering process is determining which of these highly cited papers have been cited together -- or co-cited. In our geosciences data base, this produced a list of about 5,000,000 co-cited pairs out of a theoretically possible 600,000,000 pairs.

Each pair of co-cited papers identified in this manner could be considered a cluster. However, large groups of co-cited papers with rather tenuous relationships to one another would be formed through this process. So we limit the number of papers in a cluster by setting thresholds on the number of times a paper must be cited to be included in a cluster. We also set a "strength threshold." This indicates how related two documents are in terms of the proportion of their total citations that are co-citations. The formula used to set this threshold is:

$$\frac{\text{Co-citations to A + B}}{\sqrt{\text{Total citations to A x total citations to B}}}$$

The strength threshold can be increased to eliminate less strongly co-cited papers and, thus, make a more sharply focused cluster. It can also be decreased to make the cluster larger, and therefore less focused.

Since research is an active, evolving process, the literature cited by scientists changes from year to year. These clusters also change from year to year to reflect this evolution. Figure 2 shows how these clusters change and, therefore, represent a truly dynamic classification scheme.

The first opiate receptor cluster shown in Figure 2 was created in 1974 and includes six documents. The 1971 paper by Goldstein provided the conceptual framework for physically demonstrating the existence of opiate receptors. Papers announcing the discovery of such receptors were published more or less simultaneously, in 1973, by Pert and Snyder at Johns Hopkins, Simon and colleagues of New York University, and Lars Terenius at Uppsala University in Sweden.

The 1975 cluster map reflects the increase of activity following the initial discovery of opiate receptors. Notice that Hughes's paper was cited enough times in 1975, the year it was published, to make the cluster. It announces the isolation of an endogenous opiate, which Hughes and Kosterlitz would later name enkephalin. Papers by Pert and Terenius continue to appear in the cluster, as do papers by Goldstein. Later clusters continue to show these people publishing high impact work in the field.

These clusters reveal the historical development of opiate receptor research. By looking at the papers that cite documents in these clusters, you can also find out what issues researchers in that field are currently addressing. Thus, co-citation clustering provides a means of gaining an overview -- or encyclopedic perspective -- of any research area.

ISI now uses its co-citation clustering technique to produce several disciplinary online databases, one of which is designed especially for earth scientists. But we do not view online searching as an end in itself. Thanks to the potential of clustering for providing encyclopedic perspective, we consider ouronline data bases as representing a transition from bibliographism to encyclopedism.

At present, three clustered data bases are available through the ISI Search Network. _ISI/BIOMED_® serves the biomedical community. ISI/CompuMath® covers the literature of mathematics, computer science, statistics, operations research, and management science. ISI/GeoSciTech® provides access to the literature of geology, meteorology, mineralogy, oceanography and metallurgy, to name just a few of the disciplines covered. This data base includes articles from about 400 fully covered and 6300 selectively covered journals published since 1978. ISI/GeoSciTech is updated monthly, with about 4,000 new articles added each month. At present, it includes almost 300,000 articles. Each subscriber to ISI/GeoSciTech is given an index to the more than 3,500 research front specialties in this data base. You use the Index to Research Fronts in ISI/GeoSciTech to find research front specialty names that reflect your interest. Each significant word or phrase appearing in a research front specialty is alphabetically arranged in this guide, followed by a list of the specialties in which it appears.

For example, if you were interested in precambrian granulites, you would look up the term "precambrian" in the alphabetically arranged guide and find an appropriate specialty. Then you'd key the numbers for this specialty into your computer terminal (Figure 3). The computer confirms the specialty by displaying its name, and tells you the number of hits, or papers, it includes. These are assigned to set one on Figure 3. If this were more papers than you cared to review, you could have the papers ranked by relevance to the specialty area. In this manner, you could retrieve the papers that cited the largest number of core cluster documents. In Figure 3, the group one papers each cite three core documents, the group two papers each cite two core documents and the group three papers each cite one core document. After having each group of papers assigned to a set, we've asked that the most relevant group be printed out.

Although research front specialty searching is unique to ISI's data bases, ISI/GeoSciTech offers many other options for selecting items for your bibliography. You can limit the search to the most current papers, or specify the type of articles you want according to the author's name or institution, journal title, language of publication, or document type. In any case, our systems will provide you with highly focused bibliographies.

ISI's clustered data bases represent a major step forward in our march toward encyclopedism. Through these data bases, you retrieve groups of closely related papers that focus on narrowly defined specialties. This is clearly superior to retrieving papers classified by what are usually outdated and inaccurate subject headings.

As I envision things, ISI's new data bases will be used by researchers when they requirerapid access to a few highly relevant articles. However, our ultimate goal is to provide review-type information about fields of inquiry. We want to provide incisive information about each of the specialty areas that comprise scholarly reseach. The encyclopedic services we plan to offer will include bibliographies of the most important papers in each area, and a description of how these papers fit into the general scheme of research activity. Although ISI's total conversion to encyclopedism is still some years off, we have created a prototype of what encyclopedic information may look like[5].

In this prototype, called the Atlas of Science, we've used clustering to identify the specialties that represent the cutting edge of research in biochemistry and molecular biology, and more recently, in biotechnology. The Atlas is designed to acquaint researchers with the state-of-the-art in a field by reviewing important scientific events in each specialty and leading them to the newest research in that area. Each Atlas chapter includes a map, which is intended to provide some insight into the growth of the specialty and the names of some of the key scientists working in the field. One such Atlas map is shown in Figure 4. It includes those papers most frequently co-cited by scholars involved in research on deformation and fracture of metallic glasses. The distance between two documents on the map is a measure of their relatedness. For example, the 1974 paper by J. Logan, of Harvard University, has been frequently co-cited with the 1976 paper by T. Murata of Tohoku University in Japan. Not shown here, but also included in each Atlas chapter, is full bibliographic information for each paper on the map, plus the number of times it was cited. A list of recent articles that cite the core papers on the map is also provided.

Each *Atlas* chapter also includes an essay that provides an historical summary of the specialty, describes what scientific papers played an important role, and summarizes ongoing research (Figure 5). Since this essay guides the reader directly to the documents most relevant to the specialty, you don't need to read dozens of papers.

Encyclopedism can be applied to virtually every field of scholarly inquiry. Eventually, we hope to use this novel approach to make incisive encyclopedic information available in all the disciplines of science, social science, and the arts and humanities. Although we're starting out with print products, some day we'll be offering computerized access to minireviews of the thousands of specialty areas that comprise scholarly research.

But this is still some years off. Meanwhile, ISI has developed a unique software package which, we hope, will one day facilitate access to such encyclopedic reviews. Called *Sci-Mate*® this microcomputer-based software package includes a personal, offline data base management system and a system for accessing numerous commercial online data bases. The online component, called the *Sci-Mate Universal Online Searcher*, makes it possible to search data bases using a user-friendly, menu-driven language or the host system's native language.[6] Offline, the *Sci-Mate Personal Text Manager* is a free-text searchable system that also operates in the menu-driven mode.[7]

The *Sci-Mate* software is designed for use with the IBM PC or XT, Vector 3 or 4, the Apple II, IIe, and II+, the TRS-80 Model II and 12, Kaypro 4 and 10, or any CPM--80 based system. ISI also recommends users have a printer, an 80-column screen, and at least two disk drives, one of which could be a hard disk for maximum storage. A modem is also required for the online component.

Although the *Personal Text Manager* and *Universal Online Searcher* are available as separate packages, users gain a number of benefits by using both as an integrated system. With both packages, bibliographic information retrieved with the *Universal Online Searcher* can be captured in a work file in the *Personal Text Manager*, provided the data base vendor allows such "downloading". In the work file, records can be sorted and merged, and citations flagged for reprint requests. From there, the bibliographic information can be transferred into a user file for permanent storage (Figure 6).

The *Sci-Mate Personal Text Manager* was initially envisioned as an offline system for managing personal reprint collections.[8] However, in the process of developing it, we realized scientists and librarians required a personal data base capable of handling a much broader range of textual materials. The *Personal Text Manager* is ideally suited for storing bibliographic citations to reprints or other documents. But its flexible file layout can accommodate several types of textual material. Lab notes, correspondence, and medical case reports can be entered into the _Personal Text Manager_. Scientists who use _Sci-Mate_ to keep track of reprint files can also add notes, abstracts, and comments to their records to help them search and retrieve relevant material.

The _Personal Text Manager_ actually consists of two interrelated files. Users can temporarily store and manipulate data retrieved online, captured from other users' files, or keyed themselves, in the _work_ file. The _user_ file is a free-text searchable system where information is permanently stored. Information can be entered into the user file as free text, or by using one of 50 user-defined templates. Each template includes 20 fields, to which the user can assign field names of up to eight characters. The maximum length of each separate record is 1900 characters.

The menu-driven system for formatting information into templates in the user file is essentially a succession of screens presenting users with a question, and a short list of options. A user wishing to create a template is presented with a sample format and asked to assign one name at a time to each field. Once all field names are assigned, the user can build records in the user file by entering information into one field at a time. Every entry or change made to a record is immediately searchable.

Searching the _Personal Text Manager_ also involves a question and answer process, with each new screen offering options for further refining the search. Any character, word, or phrase that appears in a record can be used to seach the user file. Truncation or "wild card" symbols can be used in any position of a word being searched, so that variants of words can be found. And Boolean operators, such as "and" and "or" can be used to refine or extend searches. These operators make it possible, for example, to search for papers with the words "precambrian" <u>and</u> "granulite" in their title. Finally, records obtained in a search can be sorted by selected fields. The system automatically lists sorted items alphabetically by the field chosen or, if the user wishes, by accession number.

<u>Sci-Mate</u> also includes a report generator for printing up lists of items in columns. Information about specified fields is printed horizontally in columns. For example, a geologist wishing to generate a report on rock samples recorded in his or her user file might request such fields as strata, distribution, and chemical composition. This report generator is also useful for preparing reports on the status of projects in a file.

As I mentioned, the work file portion of the <u>Personal Text Manager</u> is designed for temporarily storing and manipulating records transferred from the permanent user file or, with the data base vendor's approval, offloaded from the online component of <u>Sci-Mate</u>. Data can also be copied from other <u>Sci-Mate</u> users' work files. In the work file, records can be reviewed and sorted. Information retrieved online from a variety of data bases can also be collated here, and duplicate records deleted. Finally, users can transfer selected hits or the entire work file into their user file for permanent storage.

Sci-Mate's online component, the Universal Online Searcher, is designed for the individual with no experience searching online data bases. Users can automatically dial up, and log on and off, a variety of data bases. These include such ISI data bases as ISI/BIOMED®, ISI/CompuMath® and ISI/GeoSciTech®. Data bases on DIALOG, BRS, NLM, and SDC are also searchable with Sci-Mate. Once logged on to a data base, users search by using a menu-driven language that automatically translates their requests into the host system's language. At each step in the menu-driven search, the user can return to an earlier step or enter a question mark for an explanation of search terms.

Although searching data bases in the menu-driven language is substantially easier than using the host system's native language, most of the search features offered by the host system are retained in the menu-driven mode. Users can search by bibliographic terms, such as the author's name or article title. They can also combine bibliographic terms by using Boolean operators (and, or, not) and can specify how close together the words they're using to search should be in a title. A truncation character, or a browse feature, can be used to obtain derivatives of words.

The *Universal Online Searcher* offers a number of other features besides sophisticated menu-driven searching. Users can save considerably on online search costs by directly offloading all records to the work file for evaluation. However, users should obtain the data base vendor's permission before offloading records. Users can also flag hits as they're offloaded as a reminder to order reprints. With *Sci-Mate*, search strategies can also be saved for use with other data bases. Users simply reply to the appropriate queries until their search strategy is displayed. They can either retain the entire strategy or just the portion that proved most useful. Finally, *Sci-Mate* has a selective dissemination of information capacity. Users can periodically return to a data base and limit their search to that part of the data base that has been updated since their last search.

One of the *Sci-Mate* features ISI is most enthusiastic about is a system for tracking reprint requests and other correspondence. This system employs a series of flags users can assign to hits as they are reviewed in the offline work or user files. These flags can be used to tag documents to be ordered through *OATS*®, ISI's document delivery service, or through BRS's and DIALOG's fulfillment services. Flags also serve as reminders to send out reprint requests or order papers through interlibrary loan. Scientists and librarians can use the tracking system to periodically generate status reports on reprints ordered, or on overdue correspondence. A status report contains all records that have been assigned the same flag, listed by accession number or date flagged. After documents arrive, flags can be removed or changed.

In addition to maintaining personal files, tracking and ordering reprints and performing SDI searches, Sci-Mate has proved useful for preparing bibliographies. Users can retrieve relevant citations from their permanent user files, and quickly obtain missing items by searching data bases through the online component. They can then use the report generator to prepare the full bibliography on their printers. (Figure 7)

Encyclopedism, coupled with Sci-Mate, may some day make instant knowledge a reality. At a touch of a button, you'll be able to examine maps depicting the entire structure of any discipline -- perhaps even the entire structure of scholarship. You'll be able to determine how specialties within a discipline relate to one another, or to research going on in seemingly unrelated disciplines. In minutes, you'll have a complete and unified view of any field of inquiry along with insight into how this field relates to the whole range of scholarly research.

REFERENCES

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2. Small H G & Griffith B C. The structure of scientific literatures. 1: identifying and graphing specialties. Sci. Stud. 4:17-40, 1974.

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4. ----------. Introducing ISI/GeoSciTech and the GeoSciTech Citation Index -- the 50 most-active research fronts in 1981 in the earth sciences illustrate the unique retrieval capabilities of our new online and print services. Essays of an information scientist. Philadelphia: ISI Press, 1983. Vol. 5. p. 607-14. (Reprinted from: Current Contents (28):5-12, 12 July 1982.)

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6. ----------. Introducing Sci-Mate - amenu-driven microcomputer software package for online and offline information retrieval. Part 2. The Sci-Mate Universal Online Searcher. Current Contents (14):5-15, 4 April 1983.

7. ----------. Introducing Sci-Mate - amenu-driven microcomputer software package for online and offline information retrieval. Part 1. The Sci-Mate Personal Data Manager. Current Contents (12):5-12, 21 March 1983.

8. ----------. Introducing PRIMATE -- Personal Retrieval of Information by Microcomputer And Terminal Ensemble. Essays of an information scientist. Philadelphia: ISI Press, 1980. Vol. 3. p. 551-5. (Reprinted from: Current Contents (29):5-9, 17 July 1978.)

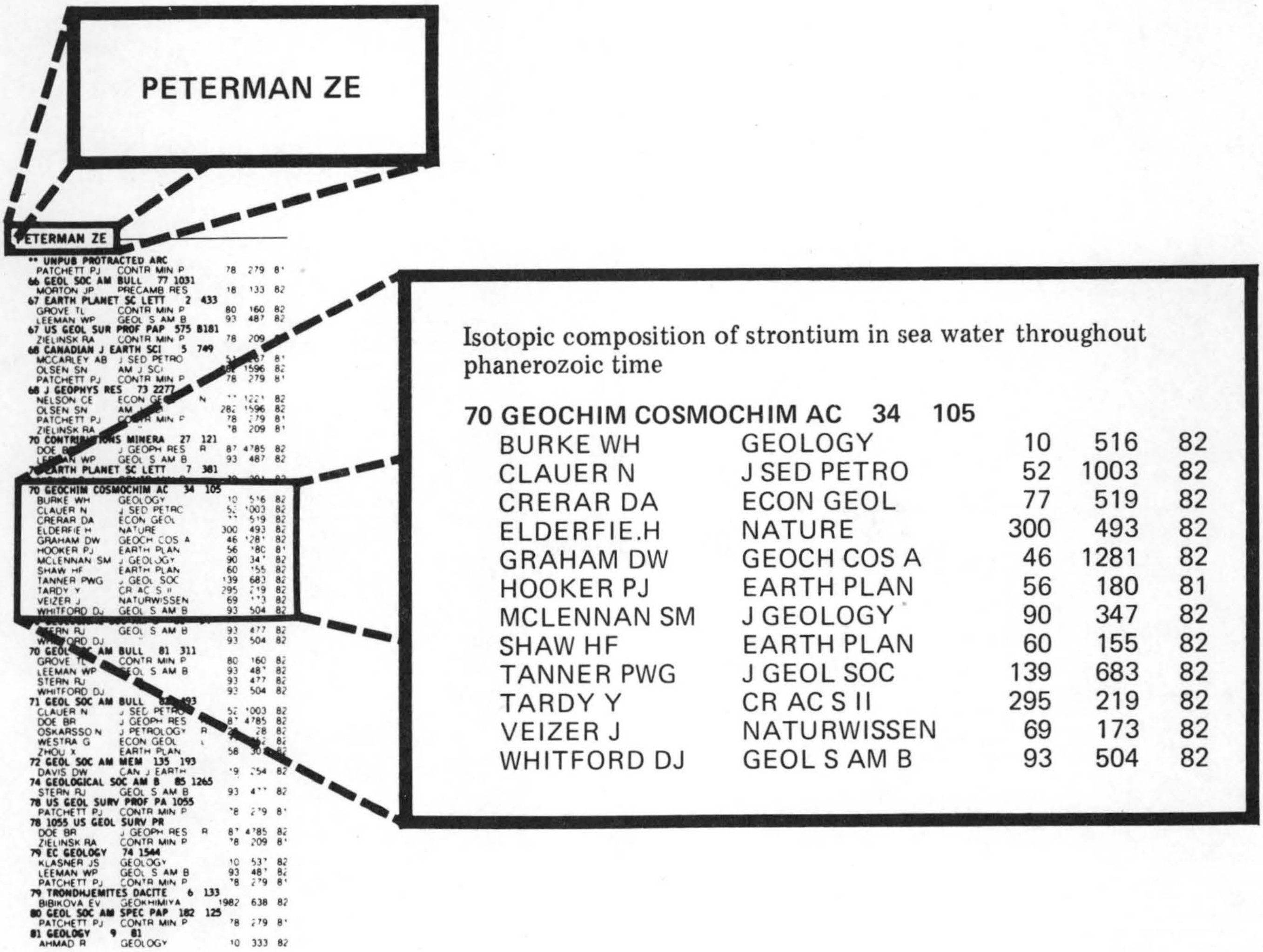


Figure 1: 1982 *Science Citation Index*® Citation Index Entry

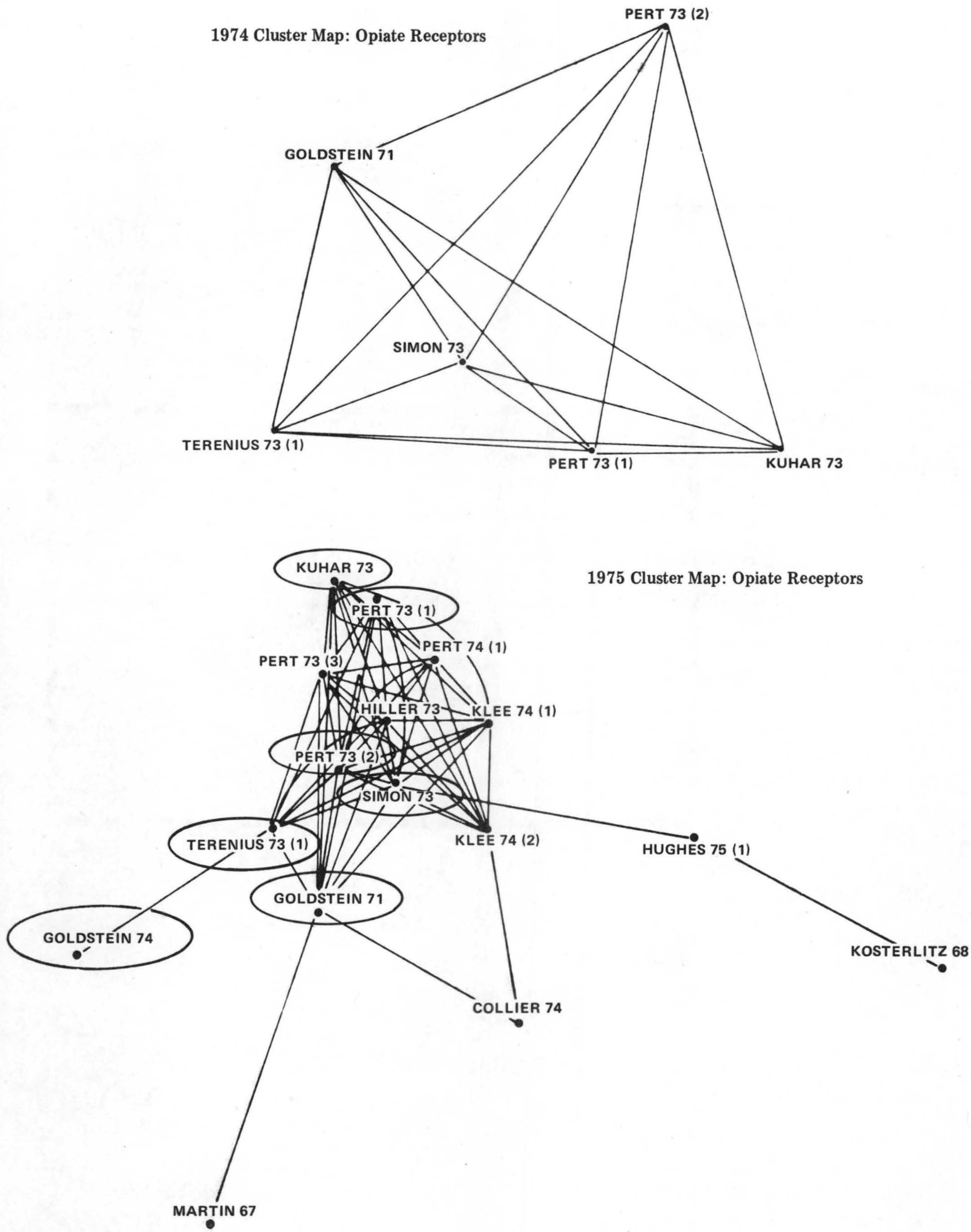


Figure 2: 1974 and 1975 opiate receptor research cluster maps. The circled names on the 1975 map represent papers that have been carried over from the 1974 map.

Research front specialty number

Research front specialty name

```
SP=81-3384
    GEOCHEMISTRY OF PRECAMBRIAN GRANULITES
SET 1:47 HITS
```

Number of papers in front

```
EXPAND SPWT=81-3384
TYPE: SPWT
1 <7>      81-3384-03
2 <14>     81-3384-02
3 <26>     81-3384-01
NO MORE HITS
SEPARATE ALL
SET 2: 7 HITS
SET 3: 14 HITS
SET 4: 26 HITS
```

Group to which papers are assigned

Number of papers in each group

Number of core papers cited by each member of group

Papers ranked by relevance to specialty

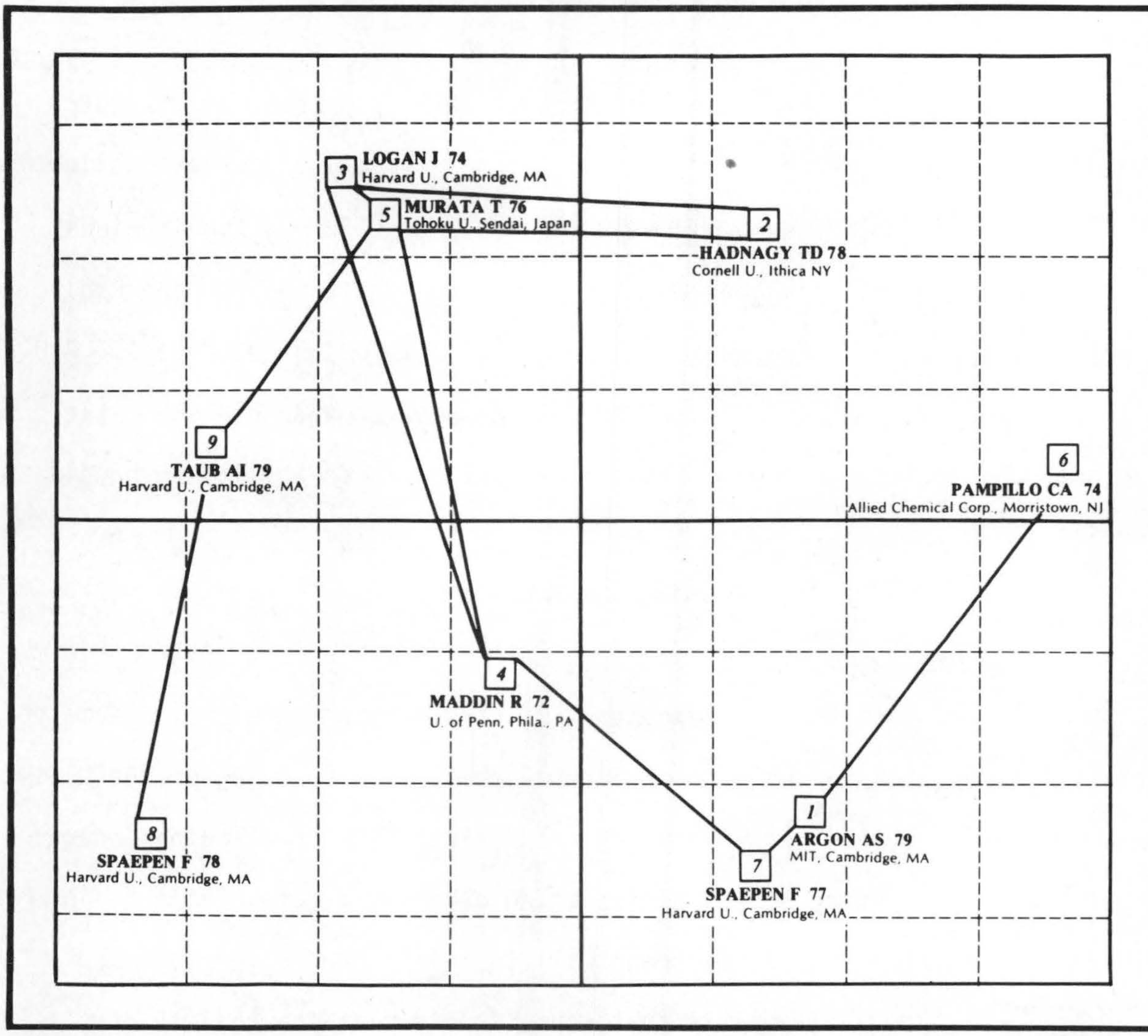
```
* FORMAT 3 PRINT 2
```

Command to print set 2 papers in format 3

```
* SET 2: 7 RECORDS (FORMAT: 3)
```

Figure 3: *ISI/GeoSciTech*™ Specialty Weight Search on the research front "Geochemistry of Precambrian Granulites".

Deformation and Fracture of Metallic Glasses



☐ represents a core document. Axes provide orientation
Proximity of ☐'s defines subject similarity

Cited Core Documents

		CF
1	ARGON AS Plastic deformation in metallic glasses *Act Metall* 27:47-58, 1979 M.I.T., Cambridge, MA 02139	25
2	HADNAGY TD, KRENISKY DJ, AST DG, LI CY Load relaxation studies of a metallic glass *Act Metall* 12:45-48, 1978 Cornell Univ. Dept. Mat. Sci. and Eng. Ithica, NY 14853	11
3	LOGAN J, ASHBY MF Mechanical properties of two metallic glasses *Act Metall* 22:1047, 1974 Harvard Univ., Div. of Eng. and Applied Physics Cambridge, MA	25
4	MADDIN R, MASUMOTO T The deformation of amorphous palladium-20 at.% silicon *Mater Sci E* 9:153, 1972 U. of Penn, Schl. of Metallurgy and Mat. Sci. and the lab for Res. on the Structure of Matter, Phila, PA 19104	28
5	MURATA T, KIMURA H, MASUMOTO T Anelastic strain recovery of amorphous metals *Scrip Metal* 10:705-709, 1976 Tohoku U., The Res. Inst. for Iron Steel and other metals Sendai, Japan	12
6	PAMPILLO CA, CHEN HS Comprehensive plastic deformation of a bulk metallic glass *Mater Sci E* 13:181-188, 1974 Allied Chemical Corp., Materials Res Center, Morristown, NJ 07960	16
7	SPAEPEN F A microscopic mechanism for steady state inhomogeneous flow in metallic glasses *Act Metall* 25:407-415, 1977 Harvard U., Div. of Eng. and Applied Physics Cambridge, MA 02138	34
8	SPAEPEN F, TURNBULL D Atomic transport and transformation behavior (Gilman JJ, ed) *Metallic Glasses, Paper Seminar* 1976, Metals Park, OH: ASM, 1978-P.114 Harvard Univ., Div. of Eng. and Applied Physics Cambridge, MA 02138	14
9	TAUB AI, SPAEPEN F Isoconfigurational flow of amorphous Pd_{82} Si_{18} *Scrip Metal* 13:195-198, 1979 Harvard U. Div. of Applied Sciences Cambridge, MA 02138	17

Figure 4: Atlas map and bibliography of cited core documents on the map.

Specialty (288)

Deformation and Fracture of Metallic Glasses

Liquid metallic alloys invariably crystallize on cooling unless cooled at an extremely high rate. The high cooling rate achieved by various rapid quenching techniques (as high as 10^7K/sec) avoids crystallization and retains the structure of the undercooled fluid in the solid state. This occurs in certain temperature ranges below the melting temperature because the viscosity of the melt increases very rapidly. It reaches a value more characteristic of solids at a temperature called the glass transition temperature. The composition of an alloy with a good glass-forming ability is either metal-metal, or metal-metalloid with one or more metals and one or more metalloids. Metallic glasses were obtained by rapid quenching from the liquid state as early as 1960, but deformation experiments with them were not possible because of the absence of suitable, i.e. large and uniform, specimens. In the early seventies quenching techniques were developed that produced ribbons and wires of practically unlimited length, and compositions were found with high glass-forming ability that allowed quenching of bulk specimens. Extensive research lead subsequently to the discovery of many properties of interest both scientifically and technologically. These properties arise from the unique characteristics of the glassy state: compositional homogeneity and absence of long-range atomic order. One of the most striking features discovered was the combination of high strength with ductility and toughness. For example, iron-based metallic glasses have yield strength higher than the strongest steel available (the hard-drawn piano wire), but unlike the high-strength steels and oxide glasses, they fail by plastic deformation. Unfortunately, the annealing treatment causes deterioration of mechanical properties and drastically reduces ductility.[1] The exact mechanism of embrittlement is still not known, but it is clearly the consequence of subtle changes in the short-range atomic order; this phenomenon is called structural relaxation.

The elastic moduli of as-quenched metallic glasses are generally on the order of 20% lower than corresponding crystalline materials, but this difference is reduced by annealing to less than 10% in relaxed glasses. The elastic moduli also have large stress and temperature dependence, generally higher than that for the fully crystallized state.

It was found initially that metallic glasses fail catastrophically in an apparently brittle manner in tensile experiments at temperatures well below their glass transition temperature[2,3]. A viscous type tearing was present, however, at the fracture surface. Consequently, compressive plastic deformation experiments on bulk metallic glass specimens have shown that plastic deformation is highly localized and it proceeds by inhomogeneous slip due to a very small work hardening of the glass ([6], 16). In tensile tests, when the first shear bands form in the specimen, the specimen initially undergoes localized shear along the direction of the maximum shear stress and then fractures by decohesion in the locally deformed material. The fracture surface exhibits two morphologically different zones: one is smooth and relatively featureless, and the other consists of a "vein", or "river" pattern of local necking protrusions. The large local plastic shear produces the smooth zone, and the vein pattern is formed during rupture. The smooth zone increases and the protrusions become more distinct when the strain rates and the temperature of the sample are increased. Thermal treatment has an opposite effect on the size of the zones. The mode of deformation changes from inhomogeneous localized shear to homogeneous viscoelastic flow at a critical temperature close to the glass transition temperature; this critical temperature depends on the strain rate ([1], [7]). The value of the fracture strength changes with temperature as a result of Young's modulus temperature dependence. The highly localized deformation and the temperature-insensitive fracture strength indicate that the inhomogeneous flow is nearly athermal with little work hardening. Under mechanical constraint such as in uniaxial compression, bending, rolling, drawing, and indentation, the catastrophic instability characteristic of the tensile test is avoided. In such tests, a network of multiple shear bands forms with some of them terminating on each other or inside the material. The absence of the work hardening makes very large plastic deformation possible.

Since the discovery of the highly inhomogeneous character of plastic deformation in metallic glasses, there has been a continuous interest in the structure of the shear bands. If the surface of a deformed specimen is polished and etched, the deformation bands are etched preferentially ([4]). This demonstrates that the chemical potential of the bands differs from that of the bulk. The preferential etching tends to disappear on annealing close to the glass transition temperature, where structural relaxation occurs. Differential thermal analysis and transmission electron microscopy studies of deformed metallic glass also indicate a change in the short range atomic order in deformed zones; they have a more disordered structure with higher atomic mobility. This finding is further confirmed by the enhanced stress and magnetic

Figure 5: Example of an Atlas essay.

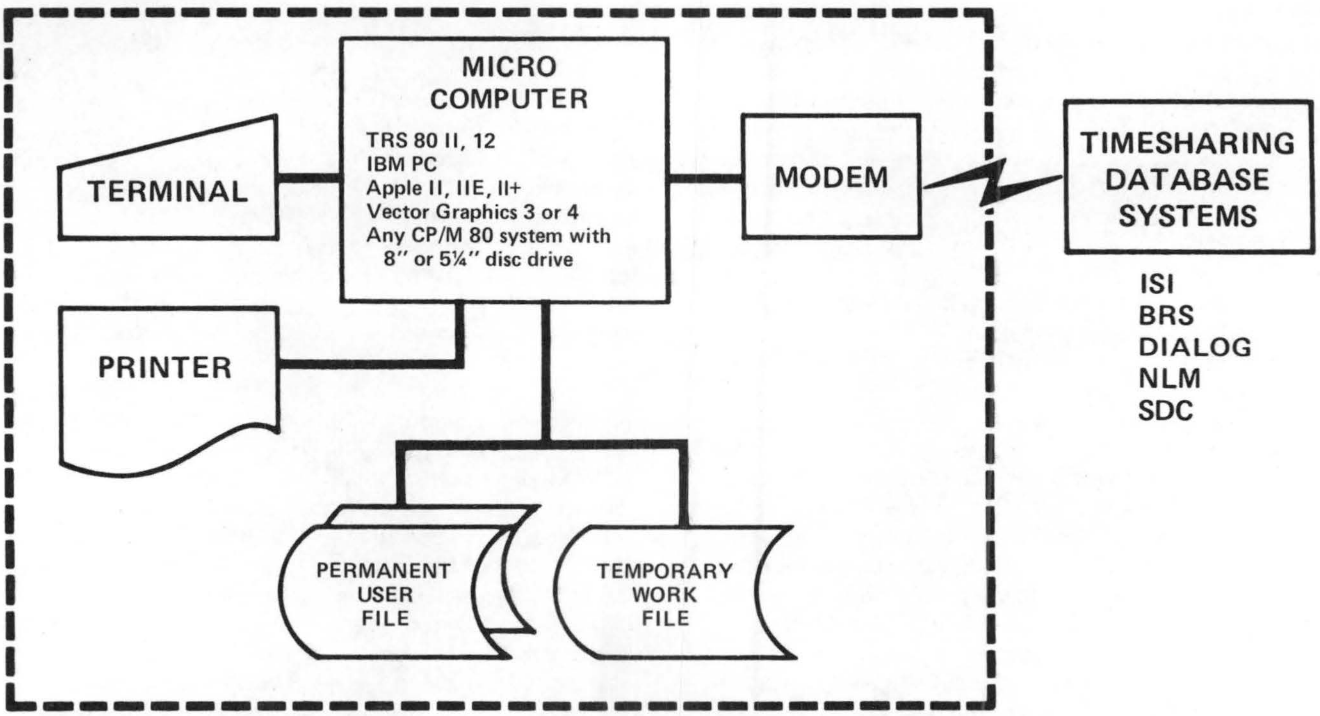


Figure 6: *Sci-Mate*® System Architecture.

Coal Desulfurization Bibliography

10/28/83

Author(s)	Article Title	Bibliographic Citation	Year
CHANDRA D; CHAKRAB ARTI JN; SWAMY YV	AUTO-DESULFURIZATION OF COAL	FUEL 61(2):204-205	82
ANDREWS GF; MACZUG A J	BACTERIAL COAL DESULF URIZATION	BIOTECHNOLOGY AND BIO ENGINEERING 1982(S12) :337-348	82
MURRAY HH; WRIGHT B	COAL CLEANING (DESULF URIZATION) BY HIGH-IN TENSITY MAGNETIC SEPA RATION	AAPG BULLETIN-AMERICA N ASSOCIATION OF PETR OLEUM GEOLOGISTS 62(3):548-548	78
MURR LE; MEHTA AP	COAL DESULFURIZATION BY LEACHING INVOLVING ACIDOPHILIC AND THERM OPHILIC MICROORGANISM S	BIOTECHNOLOGY AND BIO ENGINEERING 24(3):743 -748	82
HSU GC; KALVINSKAS JJ; GANGULI PS; GA VALAS GR	COAL DESULFURIZATION BY LOW-TEMPERATURE CH LORINOLYSIS	ACS SYMPOSIUM SERIES 1977(64):206-217	77
HUANG ETK; PULSIFE R AH	COAL DESULFURIZATION DURING GASEOUS TREATM ENT	ACS SYMPOSIUM SERIES 1977(64):290-304	77
BORGWARDT RH	COMBINED FLUE-GAS DES ULFURIZATION AND WATE R TREATMENT IN COAL-F IRED POWER-PLANTS	ENVIRONMENTAL SCIENCE + TECHNOLOGY 14(3):29 4-298	80
PETRAKIS L; AHNER PF; KIVIAT FE	DESULFURIZATION AND DEASHING OF SOLVENT REFINED COAL (SRC-I) BY HIGH-GRADIENT MAGN ETIC SEPARATION TECHN IQUES	SEPARATION SCIENCE AN D TECHNOLOGY 16(7):74 5-772	81
KOR GJW	DESULFURIZATION AND SULFIDATION OF COAL AND COAL CHAR	ACS SYMPOSIUM SERIES 1977(64):221-247	77
CHUANG KC; MARKUSZ [illegible]	DESULFURIZATION OF CO [illegible]	FUEL PROCESSING TECHN [illegible]	83

Figure 7: Example of a bibliography prepared using the *Sci-Mate*® report generator.

INFORMATON SERVICES IN MINERALS EXPLORATION

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ABSTRACT: An examination of the information needed by explorationists reveals that they need to cope with a variety of complex information systems. As geoscientists they need to be current in their field as well as have knowledge on specialized subjects or geographical areas. In addition, they are required to be current with legislation and government regulations and policies. In the private sector they are required to be aware of industry trends with a good sense of economic as well as geoscientific evaluation. As office workers they need to operate within office and management systems. They also need to be familiar with the logistics of field operations.

Explorationists require not only the knowledge of the tools and techniques of their work, but also an obvious and often overlooked need to master the information gathering and handling techniques within their areas of concern. Faced with an ever growing volume of information and the proliferation of computer applications, they increasingly need an ability to organize their information. They also should have a realistic expectation of the role of an information specialist. A better understanding of this role would relieve the exploration personnel of the pressures brought on by the need for information, by the overwhelming amount of information which presents itself, and by the tasks of gathering and handling the informaton.

A. INTRODUCTION

Part of this paper attempts to explore the information needs of geoscientists active in minerals exploration. In doing so, the paper will outline the major areas of concern pertinent to explorationists and illustrate that each of these areas is a major field of knowledge and entails coping with a vast amount of information. This will serve to show that the explorationist requires information from other fields of knowledge other than the geosciences. This information is needed not simply as peripheral to the geoscience aspects of minerals exploration; it is needed in the explorationist's day to day operations. We shall see that the explorationist must deal with a variety of forms of information and a variety of resources. The implication is that over and above the need for information, there is a need for the explorationist to learn the techniques of gathering, selecting and managing the information. This need should not go unconsidered in any discussion of information needs. The paper will then explore the role of the information specialist in the explorationist's quest for information and its control. Finally, some consideration will be given to how educators might address these concerns.

- The information explosion -

Before isolating the major information concerns of the explorationist, let's reiterate the notion of an "information explosion". "Data today is proliferating exponentially. Magnitude of the problem is reflected in the estimates that 75% of all available information was developed during the past twenty years and that over 70 billion new pieces are produced annually. The sum total of mankind's knowledge is currently doubling each decade -- and as heavy as that load appears to be, by the year 2000, less than twenty years hence, it will be speeding up four times faster than the human population" (Lee, 1982).

We have been told that we are in a post-industrial society, the information age. Statistics show that "the overall number of white collar employees engaged in the "information" field is close to half the workforce, accounts for almost half the GNP and is growing 2% a year" (Lee, 1982). There can be no wonder that information management has become an inter-disciplinary concern. The following discussion will isolate the concerns of the people involved in minerals explorations.

B. INFORMATION CONCERNS OF EXPLORATIONISTS

Four major areas of concern to explorationists will be isolated. These areas are 1) the geosciences, 2) law, 3) office systems, and 4) field operations. Coping with information in any of these fields is task enough; however, it must be stressed that the explorationist must cope and do so effectively. All of these areas must be drawn upon if the explorationist is to be successful in the search for a mine which, after all, is the objective. Each of these areas will be covered in turn with the objective of illustrating their importance and the amount of information which confronts the explorationist.

1. Geoscience information

- Bibliographic information -

First and foremost, the explorationist is a geoscientist. As a geoscientist, the explorationist has the responsibility to keep current in that field. This society has already dealt with the issue of keeping current with geoscience information by addressing the issue at the 1980 annual meeting. There is no intention of reiterating any of the points discussed at that time. Within the goals of this paper; however, it is necessary to provide some indication of the amount of information readily accessible in the Geosciences.

GEOREF now has nearly 900,000 citations (821,840 as of Sept. 83) and the number of citations added for 1982 was 66,341. This is only one of the major bibliographic databases in the geosciences.

- Digital information -

Over and above the type of documentation represented by these citations, the explorationist retrieves information from many other types of resources. Some of these resources are automated, some are not. As an indication of the size that can be attained by automated databases, let us note that "the volume of USGS data in digital form at this time is the equivalent of between 10^{13} and 10^{14} characters and continually increasing. This is more than 8 times the amount of data in characters that a million volume library might contain" (Albert, 1982).

- Image and cartographic information -

Another diverse type of resource is cartographic and image data. Among these data are to be included aerial photographs, topographic maps, Landsat images, geologic maps, aeromagnetic maps, gamma-ray spectrometer maps, gravity maps, and many more.

- Mineral deposit and assessment files -

Also of use to the explorationist are the various mineral deposit files whether available from a government department or an industrial source. Further, there is the information which can only be obtained from the mining recorder's office (or its equivalent) and the assessment files. The latter two resources represent sources of information which is not available otherwise.

- Information on technology -

More particular to the situation, the explorationist must be aware of the developments in exploration technology and the applicability of this technology to field operations. This entails an awareness of both the hardware (or machinery) and the methods of interpreting the data collected or processed by the hardware. To this we need to add the information on the vendors of the technology.

- Information on consultants -

From time to time, the explorationist may need or wish to make use of a consultant firm. Most often, this may take the form of using a laboratory for geochemical analysis. It may also include contracting out a geophysical survey. Here there can be no replacement for a sound knowledge of the expertise, quality of work and stability of consultant services. This must be culled from contact with the service representatives, from other users of the service and from sources, often not given the prominence they deserve, such as catalogues, annual reports and a company's prospectus.

2. Legal information

- Mining legislation -

The second area that has been listed for discussion is law. As it concerns the explorationist, this is a smaller and well defined set of information. The explorationist needs to be well acquainted with the mining legislation of the jurisdiction in which the exploration is taking place. This is only complicated by the fact that legal requirements vary from one jurisdiction to another and by changes to the legislation which may be enacted by the government. However, the need to be completely informed cannot be underestimated since failure to comply with the laws or regulations can result in the loss of claims or mineral rights.

- Contracts and agreements -

In addition to legislated procedures which are binding to the explorationist, there may be further bounds imposed by contractual agreements involving the explorationist's company and another company or individual. These are no less binding than legislation and again, failure to comply can result in loss of claims or mineral rights.

Companies will generally provide the explorationist with the means to keep controls on the legal requirements; it is far too important not to do so. Still, the ultimate responsibility lies with the explorationist. Arguments may be made over small points of geological interpretation but there are no small points in the law. You have either complied with the requirements or you have not. And rest assured that your competitors are out there waiting for you to slip up.

- **General industrial legislation** -

Over and above specific mining legislation, there are other legislation which affects the mining industry. Areas affected may be as diverse as the load weight of trucks and land use policies. Not to be overlooked is the very important area of environmental issues. Ontario and Manitoba have 33 and 34 acts respectively, among the provincial legislation which have a bearing on the mineral industry. This overlooks the essential Federal legislaton, another 23 acts.

3. Office systems

- **Volume of information** -

In moving into the next area it must be stated that the explorationist's environment is different from the earlier academic environment experienced while studying. The explorationist is now in an office setting. Without expounding on behavioural differences between the two environments, let's examine the statistics on hard copy documents in the office. "It is estimated that there were in excess of 21 trillion pieces of original information in offices throughout the United States at the end of 1979 and growing everyday at the rate of one million additional pages per minute around the clock. Overall, businesses average 18,000 documents and 4 file drawers for each white-collar employee. Further, this load currently increases 4,000 pages and one file drawer per employee per year" (Lee, 1982).

- Explorationist as generator of information -

It is in the office setting that we clearly see that the explorationist is not only a consumer of information, but also generates a fair amount of information. In order to generate this information, the explorationist must make use of people and machines, everything from a typist to the most sophisticated office technology. Like the need to acquire skills in information gathering and control, it often goes unconsidered that another information skill is the effective generation of information. This includes well-developed writing practices and the efficient use of people and machines.

4. Field operations

- Administration -

The final area to be considered to further exemplify the information needs of an explorationist is that of field operations. We shall also be able to clearly illustrate the diversity of the information needs of the explorationist. One of the roles of the explorationist within field operations is that of administrator. Any field operation requires budget control and the management of staff and time. Aside from the skills required in these areas, let's focus on the information needs.

- Safety measures -

First and foremost, there must be a concern for safety requiring knowledge of legislated safety measures and knowledge of the particular safety measures necessary for specific terrains. Occupational health and safety legislaton, as well as mining legislation, covers specific aspects of the safety of all employees. There is also legislation to cover land, air and water transport. The explorationist must also be aware of the effects of exposure to the elements and of safety measures required in hazardous terrains such as mountainous areas. Nor can there be any substitute for a good sound knowledge of first aid. The aim of safety measures is the prevention of mishaps; however, if there should be an accident, first aid may save a life.

- Transportation -

As concerns the logistics of field operations, there are the obvious needs for transportation, accommodation and communication. Transportation includes the need to get to and from the base of operation and, depending on remoteness, getting to and from the exploration site. The explorationist must be well acquainted with the transportation facilities available in the area and be able to select safe, cost-effective modes of transport.

- Accommodations -

The accommodations necessary to a field operation may require a knowledge of facilities in the area, such as hotels or motels, or may require setting up a camp. If the situation calls for the latter, then the explorationist must have the ability to provide for a complete list of supplies including fuel, food and proper accommodation. Just as it is necessary to keep abreast of developments in, and vendors of, expoloration technology, it is also necessary in terms of camp supplies.

- Communication -

Communication lines (e.g. telephones) may be readily available to the explorationist for links between exploration sites or to the home office. Then again, they may not; in which case it is necessary to provide alternate means of communication. As a fast means of communication, it may be necessary to acquire radio licences and frequencies. This provides the need for another whole set of information.

- Environmental issues -

Last, but not least, there can be no neglect of the environment in field operations. The explorationist requires the knowledge of measures to be taken to prevent environmental accidents, no matter how small. Disasters might range from the improper disposal of waste to carelessness causing a large forest fire.

C. MANAGEMENT OF INFORMATION

Having reaffirmed that the explorationist does require information from other fields as well as in the geosciences, and having also reaffirmed that the information is voluminous, let us turn our attention to the management of that information.

- Development -

The concept of information management has existed in some degree or another for as long as there has been an exchange of information. The primary or first information management tool was, and is, our memory. Once information was recorded, other management tools were necessary to organize, store and retrieve the information. The first major profession which grew up around information management was librarianship. Now however, where once there had been only the term librarianship, there are such terms as 1) information science, 2) information management, 3) information resource management, 4) records management, 5) information systems management, and 6) data management. It all comes down to one thing and probably not more clearly stated than as follows: "If information is to be of maximum usefulness, it must be highly organized" (Alexander, 1981).

- Importance of information management -

In the face of the importance and volume of information, it cannot be considered less than mandatory for all of us to be individually concerned about the proper management of information. We need to encourage, support and contribute to national and international systems; we need to impress on others the needs for information management. After all, the advantages of better management and greater usage of information is going to benefit each of us. And to ensure benefit to each of us, we must support the right to information for each individual.

- Perception of information -

Now, what of the individual explorationist? There now seems to be almost no limit to the information which a person can access. It is important that people realize this and realize also that there is some benefit to information. This is the beginning of a new perspective on information which the individual requires to better cope with the information explosion. The individual must reach a perception of information to include an understanding of personal needs and interests, career and professional needs and interest, and an understanding of the responsibilities engendered by information generation and dissemination. This is a subjective process. As individuals we have different capacities for the amount and kind of information we can realistically use or assimilate. We must realize that needs and interests, like other facets of the individual will change.

- Information is not static -

The development of a personal perception of information is the first step toward developing a personalized means of information gathering and handling. The next step is to realize that information is far from static. A book may sit on a library shelf for some time or some digital data may be stored on a particular disc. Something is static. That something is merely a record of the information. The apparent inactivity of the information is one part of the movement or transfer of information from source to user. The inactivity results from an imposition of some rules of organization and gives us the ability to access and retrieve the recorded information in some less than haphazard fashion. We are only one of the users whom the information has reached. With others, as with ourselves, the information received undergoes change whereby it may be improved, refuted or lead to new ideas and new information. The fact that the information can undergo these changes again confirms the notion that information is not static.

- Relevancy of information -

Nor is information static in relation to time. Remember when a journal article crossed our desk and we said "This is just what I need for the report I'm working on." Most likely, we remember the times when we said "if only I had this last month when I was writing that report." Then there are the times when we feel that an article is good and that it might be very handy to have since the topic is something we may expect to deal with in the near or distant future. The essence of the information in that article doesn't differ in each circumstance, but certainly its relevancies and applications are different. Again, we are back to a subjective approach to information with the value of the information dependant on our need and circumstance.

- Information handling by explorationists -

We have arrived at a focal point. Merely because a bit of information exists, any and every individual has the potential to need and use that information. The explorationist then has the potential to need or use all of the information ever produced. Earlier, this paper has examined only the areas of greatest potential which proved to be voluminous enough. Given the large amount of information available, the explorationist must make use of the tools and techniques of information retrieval.

- Information gathering -

The explorationist must also make a conscious decision about how much to depend upon existing information systems for retrieval from the complete store of information and how necessary it is to create a personalized database of information along with a system of storage and retrieval. With the latter, it will be of more importance to have some knowledge of information handling techniques.

The exercise of keeping current will illustrate why this decision is necessary. One of our intentions in the exercise is to screen the current output of information for material which we need immediately and for material which is of potential use to us. As was said before, our need and use for information is relevant to time and circumstance. We can be fairly accurate about our immediate needs, but as for our potential needs, we are only in a best guess situation. Without a doubt, our feeling for potential needs will be influenced by and be peripheral to our current needs. If this was not the case, we would recognize our potential for the need to an unlimited amount of information. Another tendency in the keeping current exercise is to select information which comes closest to confirming or reflecting our own ideas.

- Storage and retrieval -

Having selected information for potential use from the exercise of keeping current, what does the explorationist do with it? Is the memory to be trusted to remember? Is a hardcopy to be kept nearby? Can it be found again when it is of immediate use? Is the awareness that the information exists sufficient? Is the information ever to be found again?

If a hardcopy is kept, we may not remember we kept it when we need it. Or, we may not remember where we put it; especially, if like some people, we have a tendency to keep seemingly everything. At times, when we are unable to retrieve something we thought we had, we are left with the feeling that the information for which we're looking may be a wishful figment of our imagination. If we depend upon an information source such as a library for future retrieval, can we expect access fast enough to meet immediate needs? Do we know enough about indexes and other search tools to locate the information we wish to retrieve?

- Need for good organization -

Regardless of the choice made between whether to personally hold on to any piece of information we think we may need and whether to depend upon information storage and retrieval systems such as libraries, there is no replacement for the organization of the information. It is the good organization of the information which will make retrieval faster and easier and, more importantly, brings some relief to the frustrations we experience when looking for information.

- Proximity of information is an illusion -

Ideally we would like to see the evolution of a single information source. A computer, a place, or an institution of some sort, preferably within arm's reach via a terminal or a telephone, where we could, with minimum effort, ask for information or documents, and receive immediate delivery. No doubt, this is an integral part of a librarian's utopian vision and would be a godsend for anyone who has experienced the frustration and often time consuming efforts of information retrieval.

The concept however is still only a vision. We can readily see that the computer and improved telecommunications systems have brought us closer to the information we potentially need. The predictions about the amount of information which can be brought into the home via personal computers, CATV and teletext is mind boggling. Being brought closer to the information is not enough. It is still not in a consumable form. Furthermore, we are indiscriminantly brought closer to more information than we need and individuals are having to do more screening and sorting of information than ever before.

We have the experience of receiving citations from bibliographic databases, and have found that only an abstract exists for the citation (much to the dismay of the user), or that the document represented exists only in a language in which we are not schooled, let alone fluent, or that the document source is incorrect, incomplete or not understandable. To be so close yet so far away. In cases such as these, there is only the illusion that the information is readily accessible. And when a search through union lists does not provide a

North American, let alone local, source for the document, the illusion is quickly broken.

D. ROLE OF AN INFORMATION SPECIALIST

- Necessity of an information specialist -

It is this author's contention and that of many explorationists, that in order to execute the tasks for which they are responsible, that of minerals exploration and mine-finding, they do not have the time to master the details of information storage and retrieval. Keeping current in their own field is enough, let alone keeping up with trends and developments in the information sciences. It is no longer sufficient to have only a casual knowledge of the information systems available for use and still be able to use them effectively and efficiently. Nor does the explorationist have the time or techniques for the organization of information.

- Primary role -

It has always been considered that one of the roles of the librarian was to bridge the gap between information user and information source. That role of the information specialist, whether librarian or another information scientist, is still very necessary and still evident.

- Traditional role -

Traditionally, we may have said that the librarian's direct participation in the user's search for information exemplified this role. The librarian's participation has taken the form of actively retrieving information for the user, organizing the information through cataloguing and providing the guidance to the user to sift through catalogues and indexes. The librarian has brought to the user the knowledge of library systems and organization. More importantly the librarian provided the user with an overall knowledge and an understanding of resources. Specifically, the librarian could direct the user to the type of resource which could provide the information in a form that was needed; and could direct the user to, or impart an understanding of, the information source whether a commercial publisher or government body, etc. In other words, librarians could make sense out of incomplete or incorrect citations.

This role is even more important now in the face of the information explosion and technological development. With the proliferation of information and its increased availability, the user has a greater need for an intermediary if for no other reason than for sheer volume. With the information explosion comes a proliferation of information specialists clearly showing that there is still a need for the intermediary despite the fact that technological development has brought the information closer to the user.

- An expanding role -

Given the wide breadth of and the variations in the information base necessary for explorationists, we see the developments of their needs demanding an expanding role of an information specialist. There are many information systems which an explorationist now needs to use. When a person uses only one or two systems frequently, there is a lot that can be done independently since familiarity is primary to efficient use. But when explorationists, like most users, have limited exposure to, or need for, specific systems, familiarity is lost between one time of use and another. With the current pace of development, especially technological, the ability to be familiar with the various systems available becomes more difficult to master, let alone use them all.

- Definition of an information specialist -

John L. Bennett (1977) has referred to the information specialist as an "information transfer specialist" and further defines the specialist as an "integrating agent" who is 1) expert in system use, 2) experienced in problem analysis and solution synthesis, 3) experienced in interpreting data, 4) keenly perceptive of user needs and 5) willing to serve as a critic and devil's advocate in leading the user to examine the role of the system in the user's own work.

- Responsibilities of an information specialist -

The information specialist in minerals exploration is responsible for the storage and retrieval of information whether through filing systems, library systems or computer systems. The specialist must be aware of systems such as Georef, Geoarchive, Geoscan, Resors, Minsys, Canmindex and so on; have a knowledge of the system's coverage, applicability to user applications and know how to gain access to the systems. Then the specialist needs to be aware of data processing developments and applications in exploration work to assist explorationists to choose or develop data processing systems applicable to their needs and capabilities.

It is the responsibility of the information specialist to keep abreast of systems development; in other words keeping current in the information sciences. Then based on an insight into the needs of a particular user group and an insight into the design concepts of an information system, Bennett further describes the specialist as being capable of:

1. translating the system into terms the user can understand and illustrating a system's usefulness in terms of the users applications;
2. helping the user overcome misconceptions and fear;
3. helping the user see the benefits of a system;
4. instilling the confidence needed to survive system failures;
5. pointing out useful patterns of commands;
6. motivating users on the basis of their skills and interests;
7. helping the user break free of former constrained information use patterns;
8. helping the user develop skills in the potential for problem finding and problem solving made possible by the system.

E. IMPLICATIONS FOR EDUCATION

So far we've looked at the information needs of the explorationist, talked about information management, and the role of the information specialist. Through it all, the focal points are the need for information and the need for good organization. At this time our attention will be turned to the implications of the information needs of explorationists on their education.

Most university students receive library instruction. The campus library remains an important information tool in the student's education and it is just that, only one of the student's information tools. The library cannot and does not meet all information needs in any setting. Unfortunately, library instruction is usually the only form of information instruction which a student receives.

If education is to prepare students for a career, in our case as an explorationist, then some effort must be made to provide them with a more complete perception of information needs and use. Objectively, the perception of information includes 1) an overview of information processes, 2) the availability of information and the information explosion, 3) the need for information, 4) the right to information, 5) the use of information and 6) the value of information. Subjectively, the student must be helped to understand and recognize 1) their individual capacities for information, 2) the ways they receive information, 3) how they screen information and 4) how they put information to use.

The next step for the student is to learn about information handling and techniques, including 1) ways of gathering information, 2) ways of managing or organizing personal information collections for efficient use and future access, 3) information resources and when and how to make use of them, and 4) the role of information specialists and how best to use their services.

F. CONCLUSION

To conclude the discussion, let us observe that the need for the services of an information specialist in minerals exploration is evident in the explorationist's need for information from the very broad fields of the geosciences, law, office systems and field operations. Furthermore, the information explosion has created a greater need for efficient information handling techniques requiring greater expertise. Finally, the rapid developments in technology and their varied applications in exploration require that the explorationist capitalizes on the expertise of an information specialist, who understands both their needs and the technology, and who would help them choose and apply wisely the technology best suited to their applications.

A great deal of pressure is brought to bear on the explorationist by the need for a variety of information in minerals exploration. Day to day operations require that the explorationist encounters many types of information resources. With an understanding of information processes, information management, and the role of the information specialist, the explorationist can be relieved of this pressure.

The information specialist can streamline the explorationist's information gathering techniques and assure the explorationist of accurate retrieval of pertinent information. The information specialist can create systems to improve the flow of information and can assist in the efficient application of systems to the explorationist's problems or needs.

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USER EDUCATION IN GEOSCIENCE: PROBLEMS AND PROSPECTS

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Abstract: Educating the library's clientele has been a topic of considerable interest in recent years, particularly in academic institutions. Levels of instruction have ranged, in general, along a continuum of: (1) simple orientation to the physical facilities with minimal introduction to sources, enabling beginners to cope with limited library assignments; (2) instructional periods or sessions to acquaint users with the general body of literature and appropriate search strategies in their fields; and (3) sophisticated bibliographic guidance and instruction directed toward graduate students. Operating on these three levels, geoscience librarians have employed library tours, printed handouts, audiovisual aids, classroom presentations, point-of-use instruction, and credit and noncredit courses. In some cases this instruction has been offered separate from the curriculum, whereas in others it has been integrated into a variety of geology courses. This paper reports on a survey of user education, as conducted in selected geoscience libraries in the United States and Canada, with the purposes of identifying the levels of instruction, methodologies employed, factors affecting success, and achievements of the programs. Of particular interest are geoscience librarians' attitudes toward user education and their perceptions of the problems and barriers in this area.

Introduction

The instruction of library users, particularly those in academic institutions, has been an important and vital concern to librarians in recent years. This concern has been evidenced in the burgeoning literature on this topic, by a number of workshops and conferences devoted to the subject, and by the many programs in libraries aimed at educating the clientele of the institution. As information sources become more complex and encompass a wider variety of formats and as the sheer volume of information becomes almost overwhelming in many disciplines, the value of teaching users some degree of retrieval skill seems evident to most information specialists.

Several years ago Diane Parker (1979) surveyed a number of universities to find out how they went about geoscience user education. The present investigation describes progress made since Parker's survey and provides an overview of the state of geoscience user education in 1983. Based on the response from requests to selected college and university libraries in the United States and Canada, this report describes the types of user education in the geosciences which exist currently, factors which influence this service in the college and university environment, and, perhaps most interesting, problems and barriers which librarians feel may have an adverse effect on geoscience user education.

Methodology

This study investigates only geoscience library instruction programs in colleges and universities. Although such programs appear to a limited extent in some special libraries in government and industry, the vast majority have been implemented in higher education.

A total of 159 college and university libraries in the United States and Canada received a letter which requested: (a) information on any user education programs which they offered in the geosciences, and (b) comments on problems or barriers affecting such a service.

The 159 institutions surveyed were:

1) Institutions of GIS members in colleges and universities or
2) Selected institutions from the American Library Directory with emphasis on those having separate geoscience or science collections and those which included on their staffs a science bibliographer or librarian for user education or instruction.

The point was not to examine a random sample of colleges and universities but rather to choose those institutions most likely to have a program in user education in the geosciences. Further, the attempt was to define a representative group of libraries in terms of size, geographical location, and level of geology instruction, in order to give us a snapshot look at programs and services in the United States and Canada.

Responses from 114 libraries (a 72% return) revealed that 89 institutions had some form of user education specifically for geoscience, other than one-on-one instruction, library tours on request for single individuals, or assistance to users on an ad hoc basis within the context of regular reference work. This type of assistance is invaluable, of course, and may be one of the most effective forms of user education. However, this report focuses on more formal approaches. Also, general user education programs by the central library which might or might not "mention" geoscience material were excluded, as were the occasional user education programs available in the geosciences but never taken advantage of by library clientele. Also omitted from consideration in this report are geological literature orientations conducted exclusively by geology faculty.

The many detailed, helpful responses provided valuable and thoughtful insight into the current programs, attitudes, and problems of user education in the geosciences today. Selected telephone follow-up of the original responses undertook to obtain further details of a program or to request permission to mention specific institutions by name.

Results

Goggin (1974) has suggested three general levels of instruction within user education:

1) orientation to the physical library, its environs and how to use its services, plus a modicum of library instruction needed by beginning freshmen to cope with limited assignments involving the library
2) for students who have selected a major and are enrolled in courses requiring research or term papers, an instructional period or several sessions to acquaint them with the general body of literature in the field and with appropriate search strategies
3) more sophisticated bibliographic guidance and instruction directed toward graduate students.

Thus, we could say that we introduce freshmen and sophomores to the library and instruct upper classmen and graduate students when they need it. These levels are evident in the programs offered by respondents in the present study.

Topics in User Education

Before proceeding to the methodologies used in geoscience user education, let us examine briefly the wide variety of topics covered in these programs.

A major emphasis is on printed bibliographic tools and how to use them, particularly in the context of a paper or laboratory assignment. Hands-on examination and use are often preceded by discussion in lecture, frequently accompanied by audiovisual aids and printed handouts. Along with bibliographic sources, many librarians offer instruction on techniques of search strategy and related advice, for example, hints on writing term papers, and instruction on special formats or types of material such as maps or government documents.

Orientation to the library typically includes library policies, organization, and procedures; several librarians mentioned their emphasis on the importance of preservation and care of materials, which seems to be particularly applicable these days to maps and difficult-to-replace state and local materials. And no pilfering!

Demonstrations of computer-based retrieval usually include GeoRef and other international data bases as well as instruction on applicable networks such as the Washington Library Network or OCLC. Local systems such as the library's online catalog may also be introduced.

Instructional Patterns

The bar graph in Fig. 1 illustrates patterns of geoscience user education revealed by responses to the letter. Many libraries, of course, offer several types, thus the percentages do not total 100. Furthermore, the categories are not mutually exclusive as, for example, in the very common case of a lecture accompanied by a demonstration of GeoRef. Some comment on details of some of these types is appropriate.

Lectures. Lectures within geology courses are often at the junior or senior level and focus on specific information needs of that course. A typical lecture might include discussion and a handout on bibliographic tools, incorporating those that the professor and/or librarian felt were particularly relevant for that class; a GeoRef demonstration or at least an invitation to come by for a demonstration; a general introduction to the library itself, explaining organization, policies, and procedures; and comment on useful search strategies. In addition, the lecture might, of course, provide specific information for that class, such as the difficulty, effort, and expense of geology mapping in a field geology class.

At Dalhousie University the aim is to reach as many second year students as possible, and a required course for all geology majors incorporates a one-

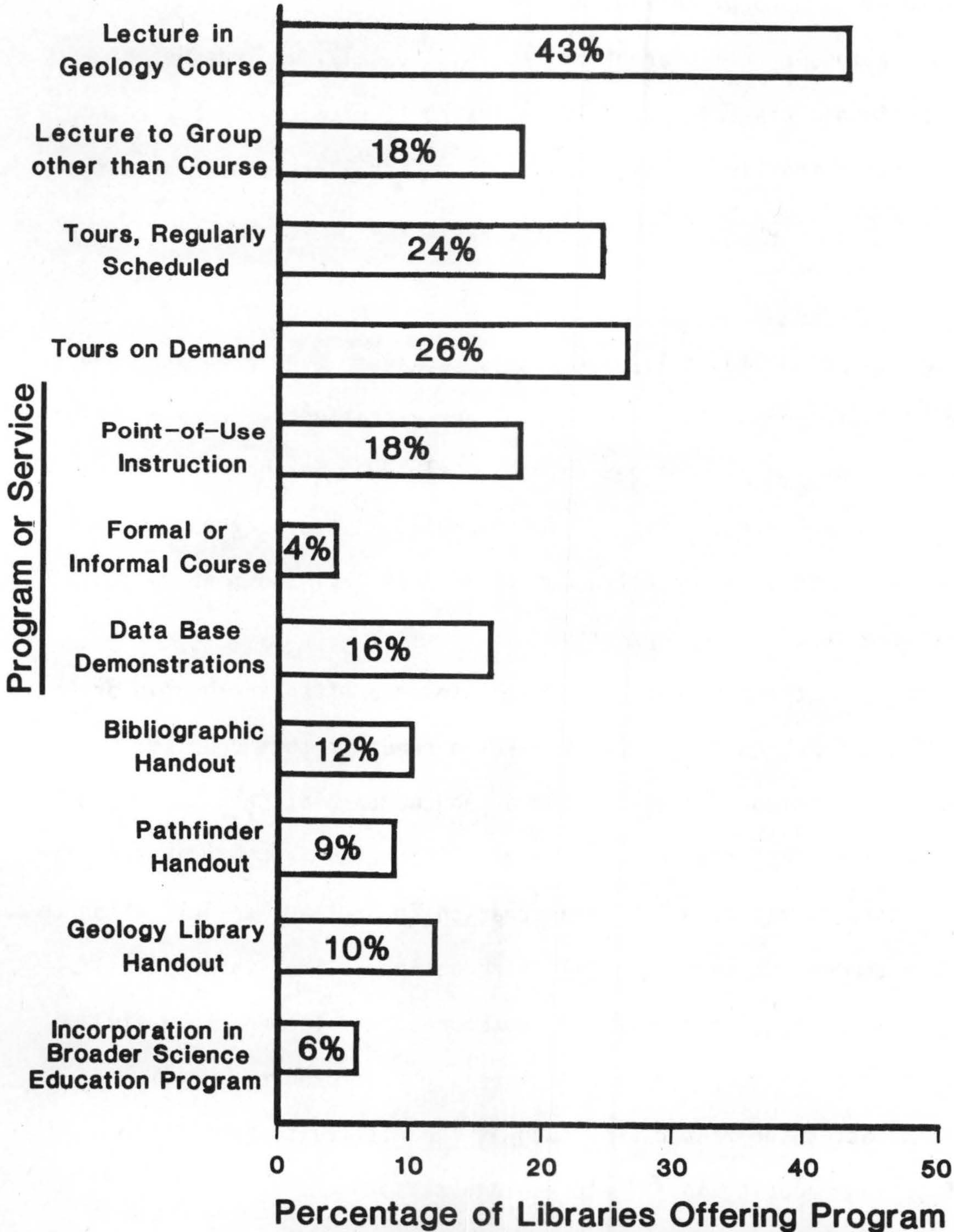

Fig. 1. Types of Geoscience User Education in 114 Libraries

hour workshop in library instruction. An accompanying library assignment includes questions which, for example, require the student to provide bibliographic information on a published paper, given the subject and year; determine local holdings for specific geoscience journals; find the author of a particular government document; and define geological terms. A similar assignment at the University of Illinois requires the use of a variety of printed bibliographic tools, including encyclopedias, indexes, and dictionaries. At many institutions the geology faculty member grades assignments made in connection with this type of integrated instruction; at others the librarian is responsible for grading.

At The University of Calgary the librarian teaches instruction sessions in several undergraduate courses. Figure 2 lists some of the topics and assignments in these courses.

The University of Calgary

Instruction Sessions for Geology Courses

Topics:

A. Methods of Research
B. Major Reference Tools (with emphasis on sources specific to that particular course)
C. Location of Materials in the University Library
D. Interlibrary Loan

Assignments:

A. Term Papers
B. Reference Questions Based on Tools Covered in Lecture

Fig. 2. Library instruction sessions at The University of Calgary within geology courses

Respondents mentioned several courses appropriate for this kind of presentation, including stratigraphy, field geology, paleontology, geophysics, structural geology, mineralogy, physical geology for science majors, coastal plain geology, geochemistry, igneous petrology, plate tectonics, and geomorphology. Thus, this approach is applicable to many areas and, of course, requires the cooperation of geology faculty.

Librarians also offer similar instruction sessions other than through the structure of geology courses. Usually attended on a voluntary basis, they may be aimed at junior or senior level geology majors, graduate students (often new graduate students), or to special groups such as a student organization. For example, a one-hour seminar on geoscience information sources at the University of Wyoming includes a description of the geology library and its services, other libraries on campus, computer searching, using the card catalog and map card indexes, a sample search of a topic in geoscience, whom to contact for further help, and general library handouts.

Courses. Formal courses for user instruction in the geosciences are much less common than other types of education. Several people observed that courses require a lot of preparation time and reach relatively few students. As one librarian stated:

> In the past I have taught mini-courses on the literature of the sciences and research methodology. With our present staffing we feel that these classes are inefficient and expensive. We would rather spend our time and energy trying to reach more students through classroom lectures and tours.

When time and resources permit, however, courses are a valuable and thorough method for instructing interested students. Oregon State University offers one such course pass-fail for one credit. It meets once a week during the semester. The course is practical in nature and introduces students to the several topics shown in the outline in Figure 3.

Oregon State University

"Library Resources in Geology"

I. Becoming Familiar with the Library
   A. Introduction
   B. Tour of Science-Technology Reference Area (Library Files and General Reference Sources)

II. The Geologic Literature
   A. GeoRef
   B. Indexes and Abstracts

III. Other Scientific Literature
   A. Sources and Forms
   B. Serials
   C. Zoological Record and Biological Abstracts
   D. Government Documents
   E. Maps

IV. The Literature Explosion

Assignments: Students compile two research bibliographies and conduct a computer search.

Fig. 3. Formal course taught at Oregon State University

The University of Iowa requires a shorter one credit course for all new graduate students in geology. Louise Zipp comments:

> During one three-hour session each fall, I explain how the library is laid out, how it functions, how it relates to students' needs, and I close with a work session. The latter involves their attempts to answer simple reference questions using my lecture and our card catalog. . . . the session exposes students to basic sources not always available in an undergraduate setting. It encourages them to perceive me as a person whose knowledge is necessary for the efficient use of library materials. Finally, after we share answers and search strategy, I can pinpoint those students who will need more help than others to become self-sufficient.

Her statement certainly provides a convincing argument for supporting this type of librarian-user interaction.

Data base demonstrations. Data base demonstrations are an important part of many user education programs in the geosciences. They may be incorporated within a presentation to a class, held as part of a library tour, or offered at a separate time when interested students and faculty may attend.

A number of respondents mentioned the disadvantage of the cost of these services, particularly in institutions where no subsidy is available. Others pointed out the effect which data base searches have had on interlibrary loan, an effect which may explain the incorporation of "interlibrary loan" within so many user education agenda. As one librarian commented, "We have to explain to students and faculty that not all the references cited in the printout are on this campus."

Some librarians make handouts available on their data base services. At Indiana State University, for example, the librarian not only provides a short explanation of GeoRef and Geoarchive to users but also includes an actual sample search.

At the University of Wisconsin-Madison, the librarian is in the fortunate position of being able to offer one free GeoRef search to all geology graduate students. The department funds this service; and the librarian considers it an important educational tool, giving her the opportunity to introduce data base searching to the students and to explain the theories behind search strategies, as well as the limitations of automated searching.

Handouts. These sections of Figure 1 refer only to those handouts which "stand alone" as separate entities. They may or may not be used in the context of a class presentation; other written material, geared to the particular purposes of the course, often accompanies lectures to classes.

Librarians frequently provide bibliographic handouts to students and faculty. Typically they might include annotations and library locations of reference sources and, as in the case of the University of North Dakota and the University of California, Davis, may incorporate sample entries photocopied from the work itself, which facilitate explanations of how to use the tool. The geology handout at The University of Utah includes an excellent explanation of the card catalog and its use. Both Indiana State University and the University of California, Los Angeles, provide time scales of major bibliographic tools to help students understand changes in coverage and other aspects over a period of years. Reference sources listed in handouts are not necessarily limited to geology, but may include, as at Laval University, more general tools such as McGraw-Hill Encyclopedia of Science and Technology or Dissertation Abstracts International. Occasionally, a bibliographic handout may be devoted to a single title, such as the Monthly Catalog.

Categories of sources typically include guides to the literature, encyclopedias, guidebooks, reports, dissertations and theses, state publications and other government documents, dictionaries, handbooks and manuals, indexes and abstracting services, periodicals, annuals and yearbooks, and data bases. The excellent handout at California State University, Sacramento, also has a section on geologic maps and atlases and a description of the map room and topographic maps. And at the University of California, Riverside, the librarian has incorporated a useful list of important organizations in geology with major serial titles currently received from each.

Some bibliographic handouts include general information on search strategy, often by means of a diagram or flow chart. And for classes such as sedimentology at Ohio State University, the librarian provides details of a specific search which requires several bibliographic sources.

We may think of pathfinders as handouts geared toward a more narrow area within geology such as mineralogy, seismology, paleontology, or coastal processes. They commonly include textbooks, treatises, and classic monographs, as well as specialized dictionaries, indexes, encyclopedias, and other reference tools in the categories mentioned previously. In addition, pathfinders may offer advice on search strategy applicable to that specialty or provide examples of typical queries or topics and how to approach them through the literature. "Mining and Mineral Industries" from the University of North Dakota is a good example of a pathfinder. A specific format or type of literature, such as maps or field trip guidebooks, may also be emphasized. "Finding a Geologic Map in Lindgren Library" from Massachusetts Institute of Technology includes instructions on how to use the map card catalog, index maps and aids, lists, indexes and bibliographies which cover maps, other reference aids useful for maps, and a floor plan of the map room.

Many geoscience librarians provide geology library handouts to their clientele. These are guides to the library itself and typically cover these topics:

1) Policies (hours open; circulation; reserves)
2) Staff
3) Organization (floor plans; location of specific types of materials such as current journals or state survey publications)
4) Collection (books; serials; government publications; maps; reference material such as indexes and bibliographies; theses and dissertations)
5) Services (photocopies; microform reader/printers; interlibrary loan; data base searching)

Some excellent examples of geology library handouts are those at the University of Minnesota, The University of Iowa, and the University of California, Los Angeles.

Problems and Barriers

Faculty attitudes. Perhaps one of the most interesting findings of this investigation was the perception, on the part of geoscience librarians, of the attitudes of geoscience faculty and students toward user education. Some selected quotations will illustrate this perception:

> Geologists are the least frequent library users (biologists and chemists make far greater use of our library), and geology graduate students express the least interest in learning about library resources.
>
> [When the faculty were offered class orientation tours or lectures], we had no response from geology. Our most committed customers are the geography and electrical engineering departments.
>
> It is rare for the geologists to take advantage of tours on request.
>
> In the geosciences our instruction is mostly tours and point-of-use instruction. There is not the same in-depth instruction that I do, for instance, for the chemistry faculty and students, who are avid consumers of our services of this nature.
>
> Our science-technology staff does prepare special subject handouts and present subject instruction for classes if a faculty member requests these services. Why the geoscience faculty has not requested our help is anyone's guess.
>
> In spite of numerous and sustained efforts, we were unable to persuade our geoscience academic personnel of the necessity of bringing their students to the library for a tour and instruction.
>
> We have established and conducted an "outreach" program designed to encourage faculty to bring in their classes for tours or instruction. We do many such programs with the biology and chemistry classes. To this date, none of the earth science faculty have expressed interest in such a program.
>
> Whether faculty believe--truly believe--that a strong ability to use a library is necessary, I don't honestly know. We have to hustle persistently for the opportunity to spend 40 minutes with a class, and repeats the next quarter seldom are requested.

If these perceptions are correct, negative attitudes on the part of many geology faculty are certainly a serious barrier to effective library instruction to students. Perhaps geologists as a group tend to feel less dependent on literature than do chemists, say, with their long history of complex and complicated published sources. Or perhaps geology faculty feel that their literature, though necessary, is easily mastered and does not require instruction from librarians. In many cases geology professors are probably not opposed to library instruction so long as it does not take any of their class time, particularly when they feel they already have too little time to cover the curriculum.

Support from library administration. Several respondents cited the lack of support from their administrations and the lack of coordination at a university-wide level as major barriers to providing library instruction in the geosciences. Evidence of the administration's attitude is often the lack of funds made available for user education. Several librarians commented on the cost of reproducing materials for distribution, and one mentioned the administration's "cheapskate attitude toward the cost of slides." Materials for effective programs in geoscience user education are indeed expensive. Gillispie (1983) has pointed out the various elements of cost for producing a slide/tape program for maps, illustrating the necessity for financial commitment on the part of the library administration.

Inadequate staff to support library instruction is also evidence of an administration's disinterest. The lack of staff time is a major factor operating against beginning, improving, or expanding user education programs. A few comments will illustrate the frustration that so many librarians feel:

> The handouts that I have done are very homemade and done in spare (ha ha) time.

> Since the staff of the [Geology] Library is small, an expansion of the instruction offered by us cannot be envisioned at this time. Merely running the Library--acquiring material and arranging for its cataloging and preservation, conducting the library correspondence, and managing financial affairs--these matters occupy existing staff time.

> It's hard to worry about hatching alligators when you're hip deep in 'em already!

Perceived lack of need. A few people expressed the opinion that library instruction programs are not needed in geology as much as in other disciplines. Perhaps this reflects the more negative views of the geology faculty in comparison with chemists, biologists, and others. However, in some cases it stems from the notion that geology libraries are smaller and easier to use, generally, and that geology librarians are more accessible to users than others. This point might be strongly debated by other branch librarians!

Conclusions

We may identify a number of factors which are essential for successful programs in library instruction in the geosciences. First of all, proper planning is critical. The librarian must determine target groups and their levels. What do the students need to know? What are the specific goals and objectives of the program? Which instructional method is appropriate for that group? Passarelli and Abell (1974) suggest that in this process one should zero in on those courses which are most literature-oriented. (Does the course require a term paper or other written assignments?)

Secondly, librarians who are experienced in providing user education agree that instruction which is incorporated into the regular academic program, i.e. "integrated instruction," is more successful than voluntary programs or separate courses (Kirk, 1974). Those who responded to the present survey reinforced this view when they commented on the frequent disinterest and apathy on the part of students when participation was not required:

> We offer tours, but they are poorly attended. Preparation is a waste of time.
>
> We spend time and money preparing handouts for a voluntary program and few show up.

Clearly, library instruction should be required and should carry some degree of academic credit. Otherwise, it reaches too few users. And it should be required of all students within a target group such as all graduate students in their first year. Princeton University, for example, requires of all junior geology majors a tour of the geology library, an introduction to regulations and policies, and basic instruction in key bibliographic tools, both online and hard copy.

Obviously, integrated instruction requires the cooperation of geology faculty. They must allow time for library instruction in their classes and ideally should cooperate with the librarian in relating the program to the curriculum and to specific assignments. Certainly their attitudes influence the students, positively or negatively. A strong public relations program is necessary to convince geoscience faculty of the importance of library instruction. Personal contacts are essential in this endeavor, and librarians must take the initiative in making such contacts. One strategy might be to approach first those faculty members who are known to be library-oriented.

Integrated instruction has the advantage of being relevant to the students, a critical ingredient for success. Students faced with writing a research paper are much more interested in what the librarian has to say than if approached in the abstract at the beginning of the semester.

In addition, several geoscience librarians stressed the importance of insuring that students have personal contact (direct exposure) to the librarian. Furthermore, library instruction should not only require actual use of the library, but measurably effective use; and this use should be demanded on a continuing basis over a substantial period of time.

Finally, when we use the word "effective," we are suggesting evaluation of the program. This is possibly the area in which geoscience user education most needs improvement. Librarians place too little emphasis, relatively, on quantitative or even qualitative evaluation, necessary to offer proof of the effects of the instruction on student performance. Such proof would be invaluable in convincing geoscience faculty of the importance of the program and would serve to justify its support and funding by the library administration. For example, the librarian should consider the use of control groups, accompanied by careful analysis of term papers and other assignments written by students who have and have not had library instruction.

In 1979 Parker concluded that librarians do not take enough initiative in promoting library instruction. This is no longer the case; librarians are actively promoting programs of user education. She also pointed out the necessity of cooperation between librarians and geology faculty members; this, of course, continues to be true, and so, unfortunately, does her statement that "geoscience professors do not always recognize a need for information education." Thus, her prediction that "geoscience information education . . . may be a common part of geoscience education in the 1980's" has not yet been achieved. Considering the rapid progress, however, we may still see that happening in this decade.

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USING ONLINE BIBLIOGRAPHIC FILES FOR TEACHING AND LEARNING

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Abstract: Textbooks are better than they used to be in directing their users, teachers as well as students, to the primary geological literature. Nevertheless the typical text still fails to serve as an efficient guidebook to the library, and especially to the current literature. Even a periodical like "Science News" makes little attempt to help its readers find the sources it reviews. On the other hand a striking exception is "Nature", whose essays in the weekly section "News and Views" are admirable models.

I believe that teachers of undergraduates have the responsibility of showing how dynamic the subject of geology is today, and that we can do this best by using the library as a laboratory. I teach a course entitled "Geophysics and Global Tectonics", in which the students learn to use online bibliographic files (especially GeoRef, Science Citation Index and the new GeoSciTech) and become familiar with each printed index and thesaurus.

Geoscience information should play the role of an instructor, destroying the common but misleading illusion that some authority knows all the answers, and showing instead the lively ferment and excitement of current science.

PART 2

TECHNICAL SESSION

MEGATRENDS IN GEOSCIENCE INFORMATION: TRADITIONAL VERSUS SOPHISTICATED TECHNOLOGY

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Abstract: The shift from an industrialized economy to an information society partly resulted from the combined technologies of the telephone, television, and computer which merged to form an integrated information and communication system. A collapsing information float, now reduced from months, weeks, or days to seconds, has increased rapid and accurate communication in the earth sciences. Although many traditional information sources are increasingly taking advantage of sophisticated information technology and even though many professional societies and publishers are offering incentives for geoscientists to apply high-tech information strategies, North American databases remain under used. Much geotechnical data is, for example, only available from proprietary or local sources and is not incorporated in abstracted mainline journals. Geological literature also differs from other sciences in that it is historical, descriptive and voluminous, visual, and has wide subject distribution. Perusal of geoscience literature is further complicated by the fact that nearly half of all publications are in languages other than English.

Serials are still one of the most important forms of geoscience literature. Especially useful are book series that contain state-of-the-art reviews and benchmark volumes that reprint in facsimile form important papers that mark turning points in the development of specialist fields. Encylopedic series in the earth sciences are examples of traditional information centers that continue to provide practical information in the form of paper copy. Information management technology is thus seen as an aid to the preparation of reference handbooks which in themselves constitute cross-referenced mini-databanks in the traditional sense.

Introduction

The past two decades have witnessed several important megatrends that largely stem from shifts associated with the transition from an industrialized economy to an information society (Bell 1979). Information has been called the resource of the 1980's because it is estimated that nearly 80% of the world's population is now involved in the new information industry (Gunn 1982). This trend increasingly supports geology librarians and information specialists, the gatekeepers of geoscience information. Data, the lifeblood of science, are essential to many fields of interest. This key information source is remarkably not only renewable, but self-generating. The North American scientific, technical, and medical communities are, for example, such prolific producers of technical information, writing between 6,000 and 7,000 professional papers each day, that technical information now increases 13 percent each year (Naisbitt 1982). This rate of production means that the data base doubles every 5.5 years. Because more powerful information systems are coming on line, because there is an increasing population of scientists and information managers, and because many professionals make use of personal computers with word processing capabiities to speed preparation of manuscripts, this rate may jump so dramatically that the information base doubles approximately every two years (Porat 1977). Assuming that present trends continue, the volume of information by the mid 1980's will be between four and seven times what it was earlier in the decade. Those geoscientists that recognize the potential impacts of such megatrends and plan for them will reap the rewards of the new information society. Communication in the earth sciences depends on the rapid and accurate acquisition of data from a variety of sources, especially computerized databanks. Outside of the U.S. Defense Department, the petroleum industry is the largest user of computers in the world (Cochran 1983). Basic data on all North American wells, both exploratory and development are, for example, stored in databanks managed by the American Petroleum Institute in Washington, D. C. This information is available to members on a file-fee basis plus computer processing costs (Johnson 1980). Many traditional information sources are increasingly taking advantage of sophisticated information technology and some publishers are additionally offering incentives for geoscientists to avail themselves of high-tech information strategies.

Interspersed among these positive megatrends are negative minitrends where researchers, educators, and librarians are all, to some degree, frustrated by the deluge of information. It is already becoming impossible to handle the flood of geoscience information by conventional means. When information systems fail, become uncontrolled or unorganized, information is no longer a resource but a liability. The technical data in a sense becomes "polluted" making it difficult to evaluate information and to extract valid data from noisy backgrounds. Geoscientists involved with pratical applications of technical data must, in addition to generating their own data, peruse the literature to make use of other relevant information. World data centers and computerized databanks assist in this effort but the task is complicated by several factors that to varying degrees inhibit the dissemination of geoscience information. Dowden *et al* (1979), for example, report that nearly half of all geological literature is published in languages other than English. Geological literature also differs from other sciences' because it is descriptive and voluminous, is visual (relies on maps, photographs, and drawings), and has a wide subject distribution (Dvorzak 1980).

Efforts to overcome these temporary drawbacks associated with a rapidly developing information society now focus on attempts to summarize and organize geoscience information in traditional encyclopedic book form, *e.g.* Lapedes (1974, 1978), Parker (1980, 1981), and Considine (1983), or by facsimile reproduction of papers contributing to advances in knowledge or conceptual turning points as produced in the series "Benchmark Papers in Geology." Although the result of such efforts is paper copy, this sort of information management technology is begining to employ high-tech methods of manuscript preparation and production, especially in the area of computer photocomposition (Bichteler 1981). Eventually it will come to pass, however, that users will decide what they want to read because they will be able to extract only the precise information that they need from information centers and databanks. Readers will thus experience true hegemony over information management by not having to read what editors and authors think they should read. This shift from author (editor) to receiver in "sovereignty over text" (Naisbitt 1982) is a trend that will expand as computerized databases become more widely deployed. Electronic publishing, the integration of electronic printing and computer-generated input to produce documents on demand (Bichteler 1981; Douglas 1983), is an example of another new technology. Although best suited to form-intensive industries, electronic pubishing will also serve the needs of professional geoscience societies by enabling them to provide memberships with customized documents.

Megatrends in Geoscience Information Management

Although trends in geoscience information management operate under their own inertia affecting communication in the earth sciences, they respond to much larger global shifts, megatrends, that depend on complex interactions of use, demand, commercial interests, economic and social forces, governmental policy, and technical considerations (Hecht 1983). Some important megatrends that are especially relevant to geoscience publishing include, for example, a movement from specialists who are soon obsolete (within a generation or two) to generalists who can adapt to new methods and different research thrusts, the increasing use of conceptual space via electronic media in preference to use of physical space as in hard copy, the developing notion that information itself is a commodity, the shift from author to receiver in "sovereignty over text," and perhaps most importantly the collapse of the information float. The impacts of these megatrends are obvious to information managers and are becoming increasingly apparent to aggressive researchers who often find themselves acting in the capacity of editor, author, or personal data manager. Some examples of these megatrends are briefly identified in subsequent sections and evaluated in terms of traditional versus sophisticated technoogy.

Information Centers

The World Data Centers (WDC) system, an outgrowth of the International Geophysical Year (1957-1958), serves the international geoscience community in a variety of disciplines. The United States and the Soviet Union operate WDC's in all major disciplines forming World Data Centers A (WDC-A's) and B (WDC-B's), respectively (Lander 1979). Individual disciplines are covered by other countries for WDC-C's in earth, ocean, atmosphere, solar-terrestrial, and space sciences. WDC information is managed by a panel from the International Council of Scientific Unions (ICSU) which issues a "Guide to International Data Exchange Through WDC's." Members can freely exchange information on a barter system but non-contributors must acquire data on a cost-of-copying basis. All WDC's share a common core collection (Shapley and Hart 1982). These modern data centers provide facilities for duplicating, microfilming, digitizing, computer graphics, and electronic publishing.

These centers provide rapid access to information that is of interest to exploration and development corporations and provide a much needed information exchange from which devloping countries can benefit (Finkl 1983). Traditional library systems probably could not have met such demands as well.

National geological surveys attempt to provide their governments with information on their landmasses and resources. Most modern surveys now meet their mandates by publishing results of their investigations in the form of reports, circulars, bulletins, monographs, books, leaflets, and maps. The increasing volume of such hard copy creates massive problems for production, storage, and distribution. In an attempt to partially alleviate these bottlenecks, the U.S. Geological Survey also maintains "open-file reports." Public use of these reports is encouraged at selected regional depositories. These reports include basic data, field notes, and manuscript copy not available in formal publications. Manual filing methods in many surveys are now augmented by more efficient computer systems. The U.S.G.S.'s CRIB (Computerized Resources Information Bank) file, for example, was designed for the storage of information on metallic and nonmetallic mines and mineral occurrences in the United States. This file uses the GYPSY program (Central Information Processing System), a file-management system, to process data through the computer (Calkins 1983). Another example is described by Day *et al* (1983) for a computer data bank capable of handling geotechnical data derived from site investigation reports. The GEOSHARE system provides an interactive computer service and serves as an analytical tool in the investigation of borehole records. Other examples of specialized computerized information centers are indicated for well information systems (Bullar 1972), site investigation data for tunneling and urban development (Cripps 1979), hydrogeological investigations (Harvey 1973), onshore borehole records (Farmer and Read 1976), and for geological mapping (Berner *et al* 1972).

Professional geoscience societies, in addition to providing a wide range of services to their members, also collect, record, organize, and disseminate information. Some organizations such as the American Geological Institute operate their own databases, e.g. updated versions of GEOREF (McIntyre 1981), that the general scientific community can freely access for moderate user fees. Cooperation between major geoscience organizations, national geological surveys, and the development of World Data Centers has encouraged data sharing schemes with great advances in the dissemination of geoscience information coming from computerized databanks. Bibliographic databases that feature online computer searching are also used in the production of abstracting and indexing journals (Leigh 1981). The exchange of information between GEOREF and PASCAL-GEODE [Bureau de Recherches Geologigues et Minieres (BRGM) and Centre de Documentation Scientifique et Technique (CNRS), Paris], initiated in 1981, produced a joint bilingual global database that greatly expanded thesauri and indexing capabilities of both systems (Rassam and Grevesteijn 1982). Thus, GEOREF will provide citations to North American publications and BRGM-CNRS will supply the European citations (N.B. - West Germany, Spain, Romania, Poland, Czechoslovakia, Hungary, and Finland will provide references to their own literature)(Mulvihill 1981; Riley 1981). Also, according to Leigh (1981), there are more than fifty bibliographic databases in the Science Reference Library of the British Library Reference Division. Although North American geological information systems are only in an early state of development (Bie and Gabert 1981), they show future promise as powerful scientific tools. Use of these systems in the classroom encourages student participation while inculcating increased appreciation and awareness of computer capabilities in the geological sciences (McIntyre 1981). Indeed, there will soon be a whole new generation of geoscientists who will be not only computer-literate but experts at geological data management (Jeffery 1979).

Abstracts and abstracting services are another kind of information center. By grouping reference materials by subject, these services can direct searchers to appropriate sources. Many services support online searches but most rely on published copy that is compiled and updated from computer files and then electronically printed. The number of abstracting services is remarkable, as can be determined, for example, from any recent issue of Ulrich's International Periodicals Directory.

Computerized databanks, in addition to bound and printed abstracts held in libraries and other depositories, provide expanded search capabilities to geoscientists with access to computer terminals. Those with personal computers and a microcoupler or modem telephone line hookup can access most databanks via Telenet, Tymnet, or direct dial in the comfort and convenience of their own office or home. Depending on the databank, retrospective searches may be based on author, title words, institutional affiliations, cited references, journal, year of publication, document type, and language for specified time frames. The following acronyms are names of some databanks that are of interest to geoscientists: AGRICOLA, AQUALINE, BHRA FLUID ENGINEERING, BOOKS IN PRINT, COMPREHENSIVE DISSERTATION INDEX, CONFERENCE PAPERS INDEX, DOE ENERGY, ENVIROLINE, GEOARCHIVE, GEOFILE, GEOREF, GLOBEDATA, OCEANIC ABSTRACTS, OMNISAURUS, WATER RESOURCES ABSTRACTS, WATERLIT, and WATERNET. Such systems offer a wider range of services than traditional card catalogues with the added advantage of the user being able to receive by mail copies of journal articles from remote libraries in a few days.

The Information Systems Field

The design and operation of information systems have traditionally been considered primarily technical activities. In the past two decades much interest has focused on this dynamic activity, including the development of information systems courses and programs (Ashenhurst 1972; McIntyre 1981). After an extensive study of the field involving surveys of over 2000 users and 16 major organizations, Lucas (1975) concluded that many users have become enamored or mesmerized by computer technology and have practically ignored the fact that almost all information systems exist within the context of an organization. Particularly important in the development of successful systems were variables associated with user attitudes and perceptions, the use of systems, and user performance. In this same study, Lucas (1975) categorically states that organizational policies and the technical qualities of systems are associated with favorable user attitudes and perceptions. Likewise, favorable attitudes and perceptions and systems with high technical quality are associated with high levels of use of information systems. And finaly, low performance is associated with high levels of use for problem-finding information while the use of problem-solving information is positively associated with performance (Lucas 1975: 105-106).

These major findings indicate why so many information systems fail. Specific examples include, for example, the facts that many users do not understand much of the output that they receive, there often is duplication in in- and output, and that changes are frequently made in systems without adequate notice to users or provisions for user response to the imposed changes (Lucas 1973). Many users also typically complain of information overload because massive amounts of information can be provided but can not be properly digested by the decisionmaker, <u>i.e.</u> they become confused by the proliferation of data which may be extraneous or superfluous to the problem at hand. Such overkill tends to make the users wary of the information system, possibly even to the point of not trusting the information or simply just not knowing what to do with the information they receive. Finally, there is a cost factor that must be considered at some stage - cost incurred by organizations for developing systems and costs for users.

Librarians were the first information specialists, long before there was an "information society." The conflict between traditional and sophisticated information technologies is perhaps no where better illustrated than where both trends began. For example, in a modern university or public library the old card catalog has been replaced with a computer output microform (COM) catalog. Here book information is recorded on a computer record that can be easily changed and expanded. Some libraries periodically print a copy of the COM catalog on microform while others rely on computer terminals that display the online catalog. Modern libraries also have microcomputers and soft-ware that allows them to hook up to records from the Online Computer Library Center (OCLC) in Columbus, Ohio, or the library of Congress in Washington, D.C., the largest computer network which has more than 9 million records in its data base. Libraries using this service can catalog a book for about one-third what it costs to catalog by hand.

A database is, in a sense, a specialized library. There are now already 1,600 major data bases or online information files nationwide. With more than 3 million personal computers on line and nearly half of American homes with at least one computer, the potential for databases seems evident. The existence of traditional libraries seems to lie in question, however. Databases offered by DIALOG, the largest broker, cost anywhere from $15 to $300 per online hour. The average search costs between $5 and $15, but is likely to be a great deal more if the searcher is unfamiliar or inexperienced with the system. Brokers frequently offer special courses that last a few days to train librarians and other users in the methods of their particular system. Such courses are normally offered at regional centers a few times each year. On the other hand, it must be noted that most databases only provide bibliographic citations for books (hard copies of journal articles can be ordered at the time of the search and posted in the mail) giving the traditional library an advantage in having the full information. There is also an argument in favor of personally browsing the stacks. Sometimes additional or even critical information is obtained by serendipitous discovery when least expected. Databases that access entire documents are, however, on the increase and various organizations are making efforts to develop easier search techniques. GEOREF, produced by the American Geological Institute which draws on the expertise of many organizations but especially the library of the U.S. Geological Survey and available through DIALOG and the System Development Corporation (SDC), is a good example. This database is bibliographic, retrospective, online, international, and medium-sized with one million references. Some 7000 journals are scanned regularly for articles and they comprise more than 70 percent of the database. GEOREF also covers books (and their chapters if individually authored), conference proceedings, theses (mainly Masters and Doctorates), government reports, and even maps. Rassam (1983) reports that while the use of GEOREF in academia is still limited, compared to industry, it is growing because of student interest and familiarity resulting from its use as a teaching tool. Such interest, incidentally, is not limited to professionals and students. Other types of information services such as CompuServe and The Source are bringing the information revolution to home terminals using videotex and teletext technology. According to Chang (1983), by the end of the decade these sorts of systems will be as accepted as the telephone and television and present in at least 10 percent of North American homes.

Increasing use of electronic information systems is, however, not without problems. A recent study by the National Academy of Sciences (NAS) found that between 40 and 80 percent of the 7 million workers using video-display terminals (VDTs) complain of eyestrain and other symptoms of stress (Raloff 1983). The incidence of low-grade visual discomfort and persistent stress-provoking environments was found by NAS to be primarily associated with poor job design and not the VDT's per se. More serious problems focus on electronic piracy, plagiarism, and forgery.

Still other points to consider include the limited capacities of some data systems, the size of the database, and anticipated volume of specialized subscriber groups. It must be recognized that mainline or closely reviewed journals are scanned regularly whereas the proceedings and transactions of commonwealth royal societies and other small groups (e.g. some international commissions, working groups) are normally overlooked. Most databases contain specialized, and sometimes spotty information, for certain fields. Although vital and often hard-to-get information may be accessed by the interested searcher, most databases are not comprehensive by any means. And finally, as Hecht (1983) points out, online data services are likely to find growing markets as personal computers spread out the subscriber base ultimately becomes smaller and smaller. Extension of sophisticated information technology in the geosciences seems assured in the decades to come.

Serial, Library, and Subscriber Trends

Perhaps one of the most ironic trends in the new information society is the proliferation of new journals while subscribers and libraries cut back on their budgets. Library budgets are being cut throughout the world leading to reduced book acquisitions and cancellations of subscriptions to periodicals. Yet, with promises of reduced library acquisitions in the near future, publishers seem to be pushing the reserch journal towards a crisis that could result in the termination of numbers of titles. In a recent review, Campbell (1982) reports that this trend is at least partially explainable on several grounds. A journal with as few as 500 library subscriptions can be economically viable. Journals have also performed well in an inflationary market in terms of price per page in spite of slightly declining numbers of subscribers. Most research journals rely on subscribers for 95 percent of their income. The secondary distribution of papers through interlibrary loans, by electronic mail, or as photocopies by delivery centers reduces income to journal publishers. In 1981 alone, for example, approximately 6.5 million serial interlibrary lending requests were filled by photocopies; academic libraries reported making 24.1 million photocopies in 1981, a 45 percent increase over 1976 (Campbell 1982). There thus exists the possibility of a confrontation between journal publishers and the library community. Nelson (1983), in an encouraging review, reports that ideas about what constitutes "a publication" may have to be rethought. He suggests that in tomorrow's electronic systems there will be no artificial distinction between publisher and consumer because anyone can "publish" or retrive. Professional papers will, however, still be subject to peer review and editing. Before a paper goes online, however, the authors, editors, and reviewers will have corresponded electronically via computer without ever having transferred paper copy. Due to limitations of editorial policy, peer review systems, and the necesity for maintaining quality scientific reporting, 'demand publishing' will only partly replace print publishing,. Such a trend is not difficult to visualize when it is appreciated that nearly a decade ago there was one computer terminal available for every 15 professionals in North America (Baker et al 1977). With the advent of personal computers and greater access to terminals in the workplace, this ratio today has probably dropped to one computer or terminal for every 10 professionals. These future text media systems will include arrangements for automatic payment of royalties to authors. Even if only a portion of work is quoted, the appropriate fraction of the royalty will be automatically passed on. In the interim, there may be some difficult transitions from print to electronic publishing.

Examples of traditional publishing methods that are largely impacted by sophisticated information technology include recent trends toward production of encylopedias in the physical sciences. Notable efforts in this regard include, for example, the Cambridge Encylopedia of Earth Sciences (Smith 1980), Encylopedia of Computer Science and Engineering (Ralston and Reiley 1983), the Scientific Encylopedia (Considine 1983), the Encylopedia of Environmental Science (Lapedes 1974), the McGraw-Hill Encylopedia of Ocean and Atmospheric Sciences (Parker 1980), and the McGraw-Hill Encylopedia of Energy (Parker 1981). Efforts in the geological sciences include the Encylopedia of Geological Sciences (Lapedes 1978) and the multi-volume "Encylopedia of Earth Sciences Series" under the Series Editorship of Dr. Rhodes W. Fairbridge (Columbia University). Published reference works of this sort will no doubt persist for some time but their production is increasingly computerized so that in the geosciences there will be encylopedic works available via remote computer terminals.

The book series "Benchmark Papers in Geology," published by Hutchinson Ross Publishing Company (Stroudsburg, PA), is a similar effort but with several important differences. According to the 'benchmark' concept, direct reprints of salient papers are chosen from the worldwide primary literature and grouped with editorial comments into a single volume. Resulting from the expanding paper explosion, these books cull out the best representatives of work in selected areas and present it in an historical perspective. Although these works are not encylopedic, they provide a useful reference base with a copy of the original landmark work at hand. It is anticipated that works of this sort will become increasingly useful because as the information base grows so will the need for cogent summaries of important advances in knowledge.

In the case of primary journals _per se_ and not reprinted collections as in benchmark reviews, it seems reasonable to anticipate some electronic journals because they will become less expensive and more widely used in the future. They will, however, coexist side by side with journals printed on paper (Bichteler 1981) because this method of transmitting archival information is still most effective, especially when the material requires lengthy study. Traditional books and journals will remain for some time the most acceptable means of packaging geoscience information - at least until most geologists have instant access to computer terminals. The future "paperless society" will in a sense eventually replace todays paper pushers as electronic editing takes off (Senders 1977; O'Connor 1978).

Conclusion

Megatrends in geoscience information point to increasing use of sophisticated technology. The rapidly expanding information base and unwieldy proliferation of printed matter has encouraged information specialists, researchers, and students to look for more effecient methods of data presentation (transmission), storage, and retrival. The shift from old to new technologies is in fact a long term societal trend with a structural challenge, as opposed to frequent short-term fiscal trends. This reorganization of society calls for massive international investment in new technology systems and is already apparent in many fields such as geoscience information. Such changes in the macroeconomy of Western society may have been associated with the start of a "secondary depression" in the late 1970's, as predicted by the so-called "Kondratieff Wave" theory where advancing technologies force the economy from bust to boom in a cyclical manner (Dickson 1983). Whatever the cause or effect, the shift from traditional to sophisticated technologies is clearly underway and information specialists are in the midst of the transitory thrust.

In spite of niggling inconveniences in the work place associated with poor design and VDT-related stress syndromes or the failure of some information systems, the overall trend is toward increased development of computerized databanks. These efforts will partly depend on the incorporation of computers in the classroom at all levels of education (Kearsley and Hunter 1983). Such deployment will inevitably encourage the visual presentation of data and lead to greater use of electronic information systems in the years to come.

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U.S. GEOLOGICAL SURVEY GEOLOGIC INQUIRIES GROUP

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Abstract: The role of the U.S. Geological Survey's Geologic Inquiries Group (GIG) is to respond appropriately to the public's questions about earth science and about the publications and research of the Survey's Geologic Division. GIG is an office of information, not a hazards warning center, press office, library, or publications sales unit.

Each year GIG responds to thousands of inquiries from a broad sector of the public, including engineering, insurance, and consulting firms; Congressional offices and Federal and State agencies; and college students and professors and others. In addition to preparing individualized responses to some inquiries and referring certain others to specialists when that is warranted, GIG prepares simply worded, geologically sound statements about various earth-science subjects and incorporates them in form letters or public information leaflets. GIG's responsibilities to the Nation's public-school teachers include distributing a free Teacher's Packet of Geologic Information and answering many geologic questions from teachers and students. A geologic-map indexing staff is an important part of GIG and can provide interested persons with the latest information about published geologic maps of any area of the United States. As each GIG professional staff member is assigned particular geologic subject areas, the group can provide useful information and lists of references on almost any earth science subject. GIG also responds to many inquiries about availability and price of Survey and other earth-science reports and maps.

In more than 100 years of service to earth science and to this Nation, the U.S. Geological Survey (USGS) early recognized its obligation to inform interested persons of its accomplishments. News of the publication of USGS technical reports and maps reached the earth-science community and the U.S. Congress through the Survey's Annual Report and notices in the press. It soon became apparent that citizens other than geologists were also interested in the work of the USGS. These citizens walked into USGS offices or wrote the

USGS to present their questions, which were answered carefully, courteously, and at considerable length by an appropriate specialist. "Taxpayer" questions were answered in this manner for probably 80 years, until the Survey became so large and earth science so complex that a personal reply by an earth-science specialist to every taxpayer letter was no longer possible. How then, could the Survey respond effectively to burgeoning public interest in earth science?

In 1961, the USGS established the Geologic Inquiries Group (GIG) to respond to the public's questions about earth science. The first task of the original staff of two geologists and a clerk was to appraise a great mass of public inquiries to determine the type and complexity of questions and to learn who the inquirers were. When GIG completed the appraisal, they concluded that most public inquiries were from students and their teachers and that simply worded, geologically sound statements incorporated into letters or general-information leaflets and booklets were an appropriate and economical means of response to a great many public inquiries. USGS leaflets, Volcanoes, San Andreas Fault, and Collecting Rocks were the first to be published in a series of general-interest publications which now numbers more than 100 and to which three Survey divisions regularly contribute new manuscripts. Last year the Survey distributed 829,800 general-interest publications. Many of these can be viewed at the USGS exhibit at this meeting.

Not long after GIG was established, the staff realized that secondary-school science teachers needed more earth-science information than could be enclosed in a letter. The idea of a Teacher's Packet of Geologic Information was thus conceived. Today's teacher's packet includes a variety of lists, general-interest publications, and information sheets. We personalize each packet for the State from which the teacher writes by enclosing the State catalog of USGS technical publications, the State topographic map index, and our list of selected references on the State's geology. As the contents of each teacher's packet are estimated to be worth more than $25.00, we ask that teachers request this packet on their school stationery. In 1982, in response to teacher requests, GIG distributed 1,498 teacher's packets--all free.

GIG is an office of earth-science information, not a hazards warning center, press office, library or publication sales unit. Our proper role is appropriate response to the public's questions about earth science and about the research and publications of the USGS Geologic Division. Each year, besides answering thousands of geologic inquiries, preparing and distributing teacher packets, and contributing to the Survey's general information publication series, GIG provides the following unique products or services.

1. To respond to inquirers' interest, GIG prepares reference lists on earth-science subjects as diverse as earthquakes, volcanoes, rocks and gems, prospecting, geothermal energy, earth-science textbooks, oil and gas maps, and State geologic maps. References cited are mainly recent publications, although some older classic reports may be included. The lists include references for all age levels, from elementary school children to the adult general public. To keep abreast of newly published literature for assigned subject areas, each GIG technical staff member checks the Survey library's new books, maps, and journals; publication announcements and catalogs of commercial organizations, State, and other Federal agencies; as well as new Survey publications. Before citing publications on a reference list, a GIG staff member reviews all publications being considered, for scientific content, appropriateness, and general availability.

2. A GIG staff member also compiles lists of selected references on the geology of each of the 50 States, Puerto Rico, and the District of Columbia. A typical State list cites reports on various aspects of the State's geology: physiography, mineral and energy resources, rocks and gems, geology of parks and other scenic areas, as well as geologic maps of the State. State geologic agency reports are most often cited, but reports of geologic societies, other Federal agencies, and commercial publishers may be listed if they are generally available in public or reference libraries or can be easily obtained at reasonable cost. The Indiana geology list, for example, includes reports on minerals, geologic formations, fossils, caves, and guides to the State parks; it also includes geologic and other maps. Cost and ordering instructions are always given for obtaining the listed publications. The State geology list is popular with tourists, school children, scout troops, and other groups because the references concern their area of interest and are often written in popular style.

A companion to the State geology list is prepared for rock and mineral collectors. This list includes titles of collecting guides, mineral resource reports, and short papers on a specific mineral or on mineral occurrences in the State.

3. GIG provides up-to-date information on the availability of published geologic maps for any area in the United States because the USGS State geologic map indexes are compiled by GIG. Access to current geologic map information for particular geographic areas allows staff members to inform inquirers quickly about published data that are available on the geology, hydrology, or mineral or energy resources for any area of concern.

4. GIG responds to the public's almost hysterical concern about specific geologic phenomena or situations related to earth science, such as the world-

wide oil crisis, deregulation of the price of gold, or the eruptions of Mount St. Helens.

For instance, when the price of gold was deregulated, many former flower children became gold diggers overnight. GIG has received hundreds of inquiries on gold occurrences in every State of the United States, on how to prospect for gold, what equipment to use, how to get grubstake money, where to take samples for identification or assay, where to prospect on Federal land, and how to file a mining claim. We responded to these requests by compiling and making available reference lists on gold occurrences in various regions of the United States or on individual States if the number of references warranted separate lists. GIG is familiar with gold information sources outside the Survey, such as U.S. Bureau of Mines commodity specialists, personnel in State geologic agencies, U.S. Treasury Department, U.S. Bureau of Land Management, and others, and refers to those organizations inquirers whose questions on gold are outside the purview of the Survey.

5. GIG provides custom service. When a personal response to an inquiry is warranted, GIG sends the inquirer a note or letter that precisely addresses his concern, be it how to choose a "safe" place to live, why sink holes occur in certain areas, where to hunt for amethysts in Virginia, emeralds in North Carolina, or sapphires in Montana.

Because staff members have an earth-science background and specific areas of responsibiltiy, we can answer most geologic inquiries. We do refer to technical specialists the inquiries we cannot answer; we realize we would competently serve neither the public nor the Survey if we thought we possessed geologic omniscience! On the other hand, long experience enables us to spot immediately the loaded, politically sensitive, or just plain nutty inquiries. Each of these receives a thoughtful, courteous, but possibly tongue-in-cheek response.

When an inquirer contacts GIG instead of the agency he should have contacted, we can usually refer him to a particular person in that agency, offer a phone number, even cite the title and price of a publication that will be helpful to him. Through years of dealing with the public and with State and Federal earth-science related organizations, GIG has developed an effective information network that benefits the public, other organizations involved, and the U.S. Geological Survey.

GEOSCIENCE INFORMATION RESOURCES

AT THE ONTARIO GEOLOGICAL SURVEY

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Abstract: The Mines Library and the Geoscience Data Centre of the Ontario Geological Survey are complementary sources for geoscience information, and user statistics in both areas have recently soared. During Ontario's latest gold rush the upsurge of claim-staking activity in the Hemlo area was paralleled by a similarly hectic scramble to acquire background information on the Wawa greenstone belt. However prospectors are not the only users of earth science data: land use planners, mineral economists, environmentalists, engineers and community developers also need this input for decision-making. Ease of access by disparate groups is thus a major concern of OGS staff.

The Library is a first encounter point for many public enquiries. It supplies traditional material such as journals, books, maps and published reports and responds to or refers requests for information to other areas of the Survey such as the Geoscience Information Office or the Geoscience Data Centre. The Geoscience Data Centre maintains and provides access to manual and computer based files on mineral deposits of Ontario. It is also a public viewing office for reports submitted by mining companies on exploration activity. The GDC is implementing a province-wide microfilm project for exploration reports and has prepared an index system for drill-core storage libraries.

Both the Mines Library and the Geoscience Data Centre actively seek more effective techniques in managing and updating geoscience information so as to communicate with potential users in addition to the mineral industry.

Introduction

1982 was the third consecutive year in which foreign demand for Canadian minerals fell, and according to all reports it will likely go down as the worst year in the history of mining in 20th century Canada. The new president of the Mining Association of Canada remarked at the Annual General Meeting that when he took over the ship he was not told that the fog was settling in, nor that there were icebergs out there nor that the ship's name was Titanic! Nevertheless, he managed to discern some hopeful indications amidst the gloom.

Ontario, (Figure 1) though deeply affected by dismal economic conditions, nevertheless remains Canada's leading non-fuel mineral producer, and its metallic mineral production continues to be twice that of any other province. It is the world's largest supplier of nickel, and is a major producer of gold, silver, platinum, uranium, zinc, copper and iron. It is an important source of salt, gypsum and nepheline syenite and produces more non-fuel minerals for commercial use in greater volume than any other province or any American state.

One particularly bright spot in the Ontario mining industry these days is gold. The search for gold resulted in promising discoveries followed by several staking rushes, including Hemlo. Indeed, because of the Hemlo find, 1982 claims staked in the Thunder Bay mining division increased by 49%, and reports on exploration activity filed in the Mining Recorder's Office during the first nine months of 1983 exceeded total reports submitted for the last nine years.

Along with the staking rushes there was a run on information. Today's explorationists are well aware of the importance of research and know that many prospects have initially gleamed from the pages of a geological report. For example, the copper-zinc-silver deposit which became the Geco Mine at Manitouwadge was staked by three "week-end" prospectors, but they didn't just trip over it. They chartered a plane and went off to inspect a specific sulphide showing described in a 1932 Ontario Department of Mines report (Thomson 1932). The same report recommended further exploration be carried out northeast of Hemlo. It has taken many years and some modern techniques to uncover what could be the largest gold deposit in Canada's history

(Northern Miner 1983) in the Hemlo area.

Information before exploration is a good adage, and we know that chance favours the prepared mind - but to prepare the mind can be a mind-boggling experience. Where to start, and how to go about acquiring the essential data? Access to information was an early concern to the Ontario Bureau of Mines, as evidenced by the publication of a detailed general index to its first 16 annual reports in 1909. Seventy-five years later we are still looking for better ways to help people find what they need to know.

The Ontario Geological Survey, the modern equivalent of the Geological Branch of the Bureau of Mines, provides two information centres and several other information sources. Figure 2 shows a simplified organizational chart of the OGS and its five sections. Figure 3 indicates types of information available from each unit and some of the main clients.

Mines Library

The Mines Library in Toronto is a first contact point for many enquiries. It is a semi-public facility - though our priority clients are Ministry staff and mining industry personnel, we also supply information for researchers in a variety of fields.

The basic library collection of approximately 1500 texts, 250 journals, about 20,000 maps and an uncounted number of government reports stresses geology and mining in Ontario and other Precambrian Shield areas of the world. As well, we acquire selectively, material on industrial minerals, engineering geology, Quaternary geology, mineral economics and mineral policy, geochemistry and geophysics. The library is the depository for all Ontario Geological Survey publications and is also a depository for publications of the

Canadian and U.S. Geological Surveys and other provincial surveys. Among the special collections are proceedings and guidebooks of International Geological Congresses, Geological Association of Canada proceedings and guidebooks, annual reports of Canadian mining companies, theses and dissertations on geology and mines of Ontario and mining legislation and regulations of all provinces.

A prospector can thus come to the Mines Library and research an area fairly completely as far as published material is concerned. He will most likely be interested in property descriptions and regional geology. Mining company personnel might be looking, in addition, for ore genesis and commodity studies, and often data on other provinces or countries. Library clients come from the universities and technical schools, other government ministries such as Environment and Northern Affairs ... we see land use planners, park planners looking for scenic canoe routes, rock hounds, even a sculptor asking about sources for soapstone. Of course, the perennially popular requests are for "everything about gold" and "everything about diamonds". Ontario is not known for diamonds, but we do have kimberlite, and hope springs eternal. Requests for information follow a seasonal pattern and average about 30-40 a day, almost equally divided between staff and outside users.

Geoscience Data Centre

The Geoscience Data Centre in Toronto organizes and maintains geoscience data depositories such as mining industry exploration reports and mineral deposit files. The Centre indexes all Survey publications and exploration reports for inclusion in GEOSCAN, a national geoscience database. Access is provided to commercial databases such as GeoRef, and data processing expertise is supplied to the rest of the OGS.

The mining industry exploration reports, known as "assessment files" are important sources of information. Under the Mining Act, a holder of a claim must perform a certain amount of exploration work each year to keep the claim in good standing. This might include activities such as trenching, diamond drilling, shaft sinking, or geochemical, geophysical and geological surveys. Reports on this work are kept in the Geoscience Data Centre along with technical reports from various government assisted mineral exploration programs, technical data from company prospectuses filed with the Ontario Securities Commission and voluntary submissions. This represents a formidable amount of unpublished material to access. The problem has been compounded by the existence of more "assessment file" material in the regional geologists' offices (Figure 4). An explorationist in Toronto has never known with certainty that he has seen all the data available on a prospect without also checking the files in the regional office. To remedy the situation, the GDC has undertaken to 1) uniformly file and index the Toronto and regional files 2) to eliminate discrepancies in all file holdings 3) reproduce files on microfiche. The project is well underway, although the first stage took longer to complete than expected. The first office tackled had 40% more files than estimated, so instead of taking two people one year, the job took five people two years. However, the files for the Sault Ste. Marie Resident Geologist's Office are now available - this includes 2594 report fiche, 319 index plan fiche and 7 computer generated index fiche. Benefits of the microfiche project aside from saved travelling time for mining company researchers are 1) standardized filing province-wide 2) reduced purchasing costs 3) ease of mailing and handling 4) compact storage. Reports for the Sudbury area are now available. Those for the Sioux Lookout area will be completed in 1984.

Another time-saver assembled by Geoscience Data Centre staff is the Mineral Deposit Files which have been prepared for nearly 7000 individual deposits. These include information on geology, mineralization, development and ownership. They are filed geographically, colour-coded by commodity and cross-referenced by deposit and company name. Also included are major bibliographical references and clippings. From these Mineral Deposit Files a new database has been prepared - the Mineral Deposit Inventory Record (MDIR). This computerized inventory now contains records on more than 5000 deposits. Retrievals can be made on the basis of name, location, commodities and developmental status.

Drill Core Libraries

New information sources as of this spring are drill core storage facilities at Kirkland Lake, Timmins and Sault Ste. Marie. Additional repositories are planned for the Bancroft-Tweed area, Sudbury, Thunder Bay, Kenora, Red Lake and Sioux Lookout. The aim of the Provincial Core Library Program is to provide access to diamond drill core. Each year approximately 700,000 feet of private sector mineral exploration drilling is carried out in the province at an expenditure of $14 million. Most of this core has previously been discarded or left in the field to deteriorate: a loss of valuable data, especially important in areas of poor surface exposure. Each library will have a core preparation area, cold storage space for about 600,000 linear feet of drill core, and a visitors' examination area with catalogued hand specimens, thin sections and complete drill logs. The Geoscience Data Centre will coordinate and standardize the drill core index which will be on microcomputers and maintained by each library. The index will provide access by township location, company and date drilled.

OGS Geologists

A final geoscience information resource which should be mentioned is Ministry geologists. All geologists are available for consultation and much of their office time is spent in responding to queries. One geologist who works in an area of current interest to prospectors dealt with 136 documented queries during a four month period this Spring. Some of these were five minute telephone conversations, others were three hour discussions. Ministry resident geologists acquire and disseminate geological information at a regional level. They provide advice to government, industry and the public about the geology and mineral deposits of their areas. Each office maintains a file of exploration reports previously mentioned, ministry publications of local interest and a small collection of texts and references supplied by the Mines Library. The Library also provides current awareness of geological literature. Resident geologists may give talks to local groups as well as answer queries from the public. In Toronto, most of these "general interest" speaking assignments are carried out by the Geoscience Information Office. Geoscience Information Officers answer general queries, hold classes in mineral exploration and geoscience topics, prepare brochures and pamphlets, prepare and staff displays and exhibits and provide leaders for field trips.

Conclusion

Geoscience information at OGS is available in a variety of formats, both traditional and innovative (Figure 5). We have now reached the point where a geologist can input field data into a portable computer while on traverse; it is not yet possible to flash these observations directly to a potential user. Given the competitive nature of the exploration industry it is probably just as well. But we are interested in rapid dissemination of information, and the Scientific Review Office, the editing-publishing arm of the Survey, has plans to purchase an automated publishing system which will introduce demand printing, simplify procedures, and reduce costs while increasing productivity.

Thus as the Ontario Geological Survey approaches its centenary in 1991, it continues to carry out its original mandate, "to aid in promoting the mining interests of the Province" (Pye 1983). New demands have been added (Figure 6) and new technologies employed, indeed, nowadays even females are employed. But the basic task remains, the assembling of geoscience information. For this purpose the field crews go out each summer, to contend with black flies, bears, inclement weather and rugged terrain - to look at the rocks and try to decipher their secrets.

Acknowledgements

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ONTARIO
MANITOBA
QUEBEC
NORTH DAKOTA
MINNESOTA
MICHIGAN
SOUTH DAKOTA
WISCONSIN
MICHIGAN
NEW YORK
NEBRASKA
IOWA
PENNSYLVANIA
ILLINOIS
INDIANA
OHIO
Indianopolis
Toronto
MD
MISSOURI
KANSAS
WEST VIRGINIA
VIRGINIA
KENTUCKY

Fig. 1.

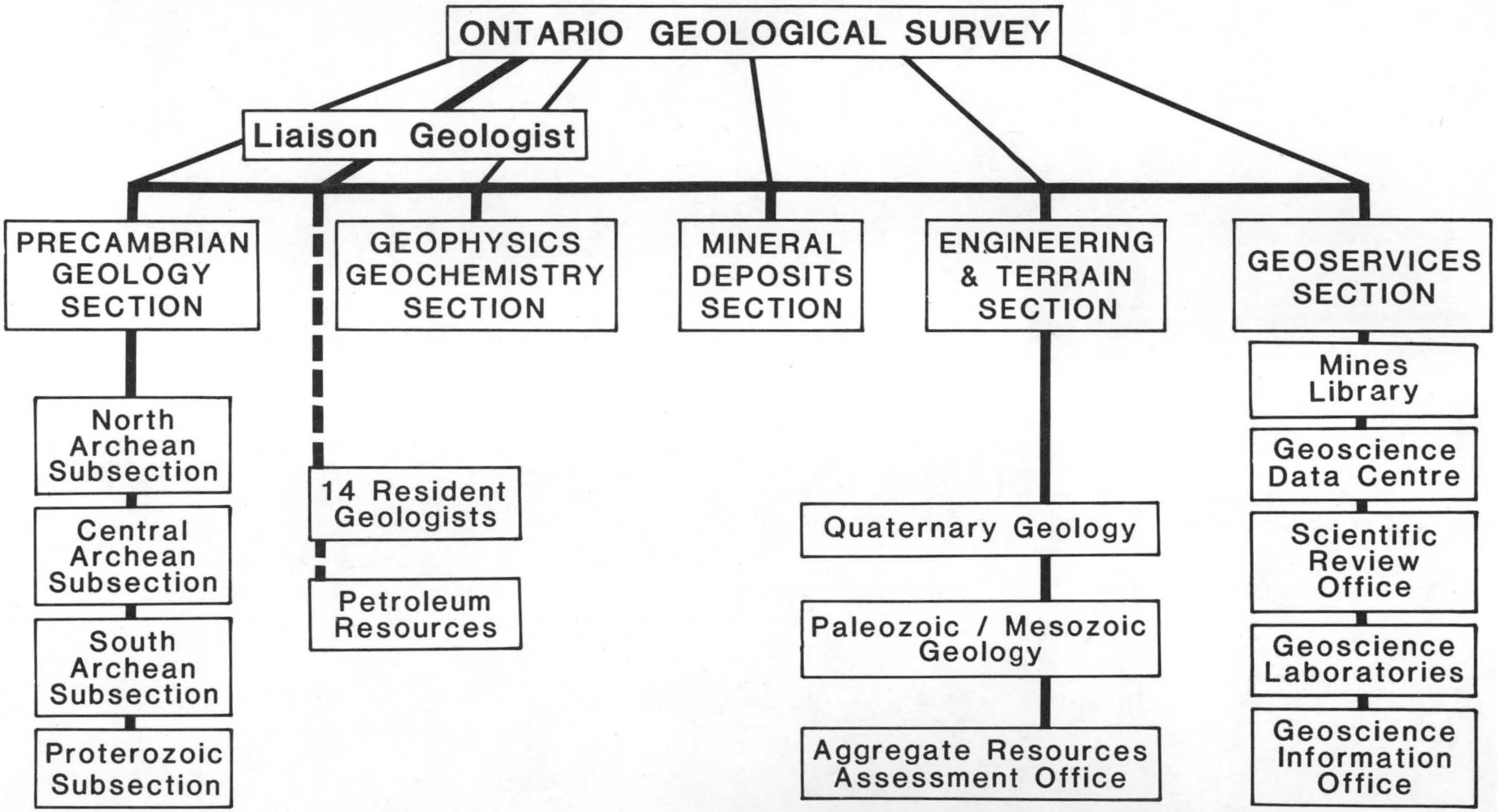

ONTARIO GEOLOGICAL SURVEY
Liaison Geologist
PRECAMBRIAN GEOLOGY SECTION
GEOPHYSICS GEOCHEMISTRY SECTION
MINERAL DEPOSITS SECTION
ENGINEERING & TERRAIN SECTION
GEOSERVICES SECTION
North Archean Subsection
Central Archean Subsection
South Archean Subsection
Proterozoic Subsection
14 Resident Geologists
Petroleum Resources
Quaternary Geology
Paleozoic / Mesozoic Geology
Aggregate Resources Assessment Office
Mines Library
Geoscience Data Centre
Scientific Review Office
Geoscience Laboratories
Geoscience Information Office

Fig. 2.

GEOSCIENCE INFORMATION RESOURCES AT THE ONTARIO GEOLOGICAL SURVEY

GEOLOGISTS (Toronto and Regions)	→	data for reports consultation	→	mining companies public
MINES LIBRARY	→	texts reports maps indices bibliographies	→	ministry geologists mining companies prospectors universities public
GEOSCIENCE DATA CENTRE	→	assessment files mineral dep. files computer files	→	staff geologists mining companies prospectors public
SCIENTIFIC REVIEW OFFICE	→	reports maps	→	public
GEOSCIENCE LABORATORIES	→	mineralogical and chemical analytical services	→	ministry geologists other gov't agencies public
GEOSCIENCE INFORMATION OFFICE	→	exhibits displays brochures lectures field trips	→	schools public

Fig. 3.

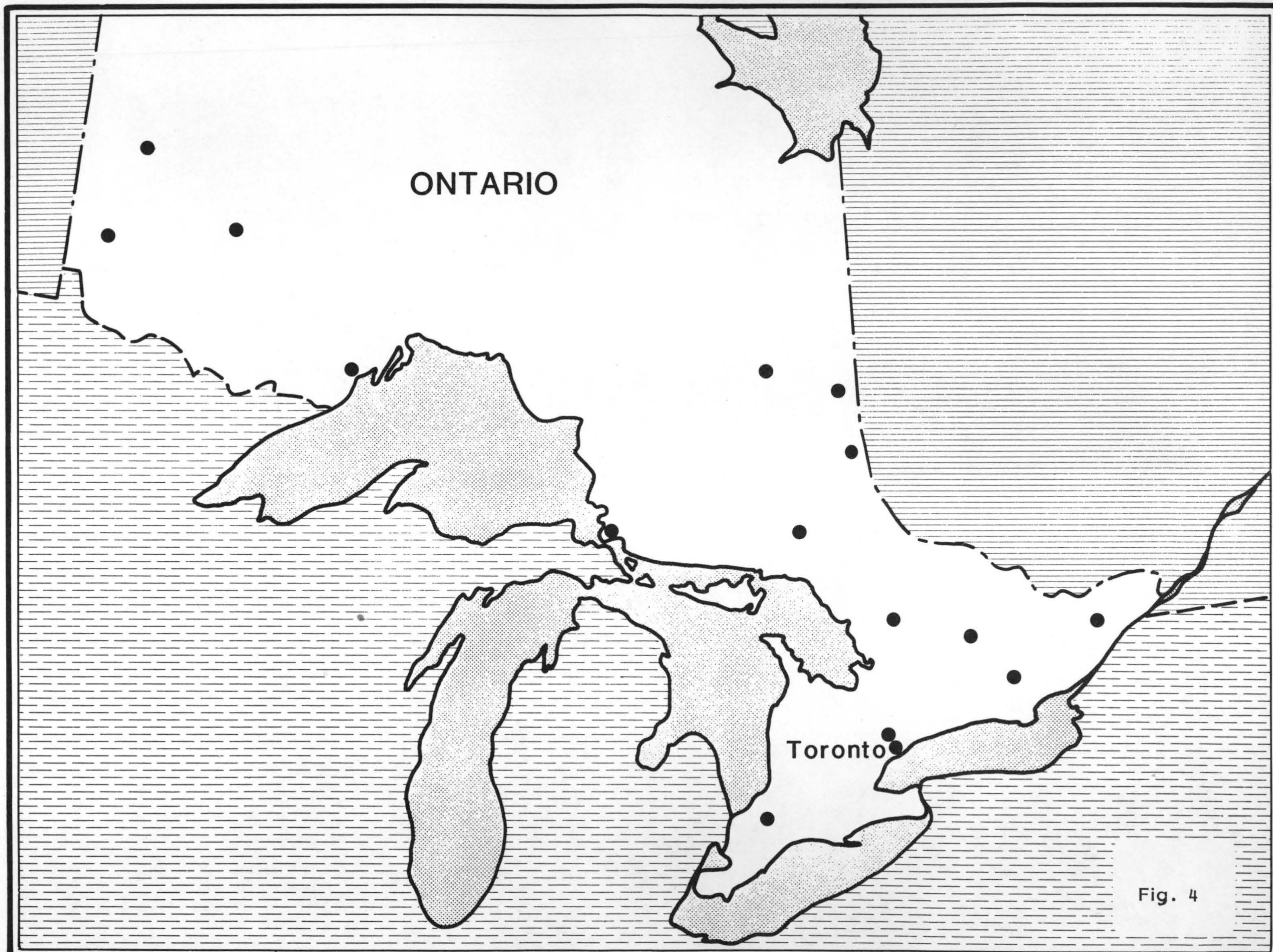


Fig. 4

FLOW OF INFORMATION

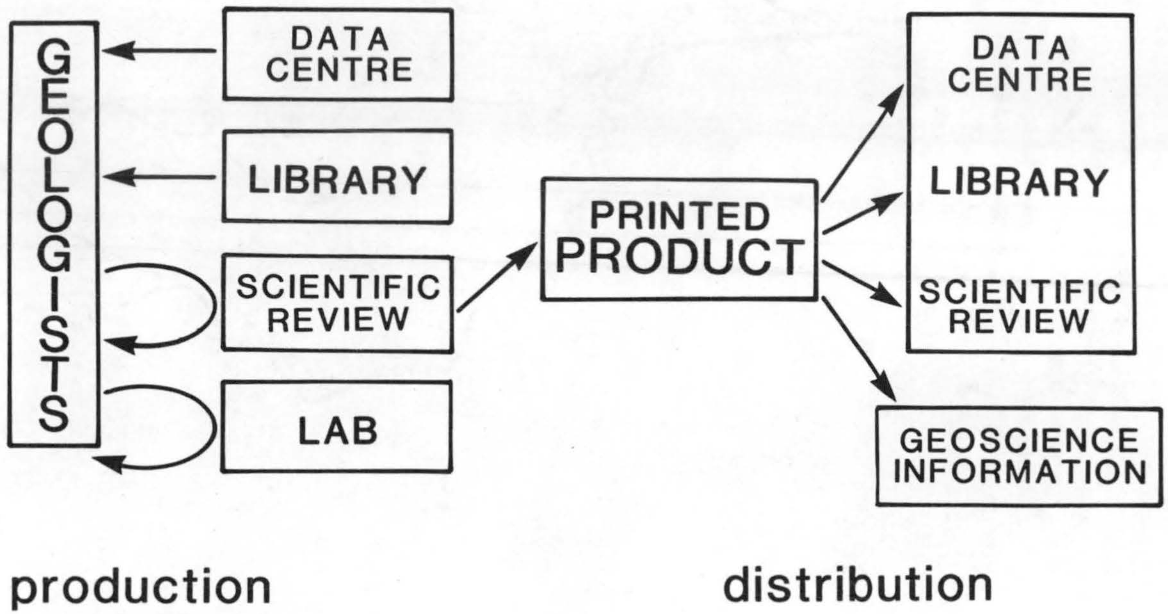
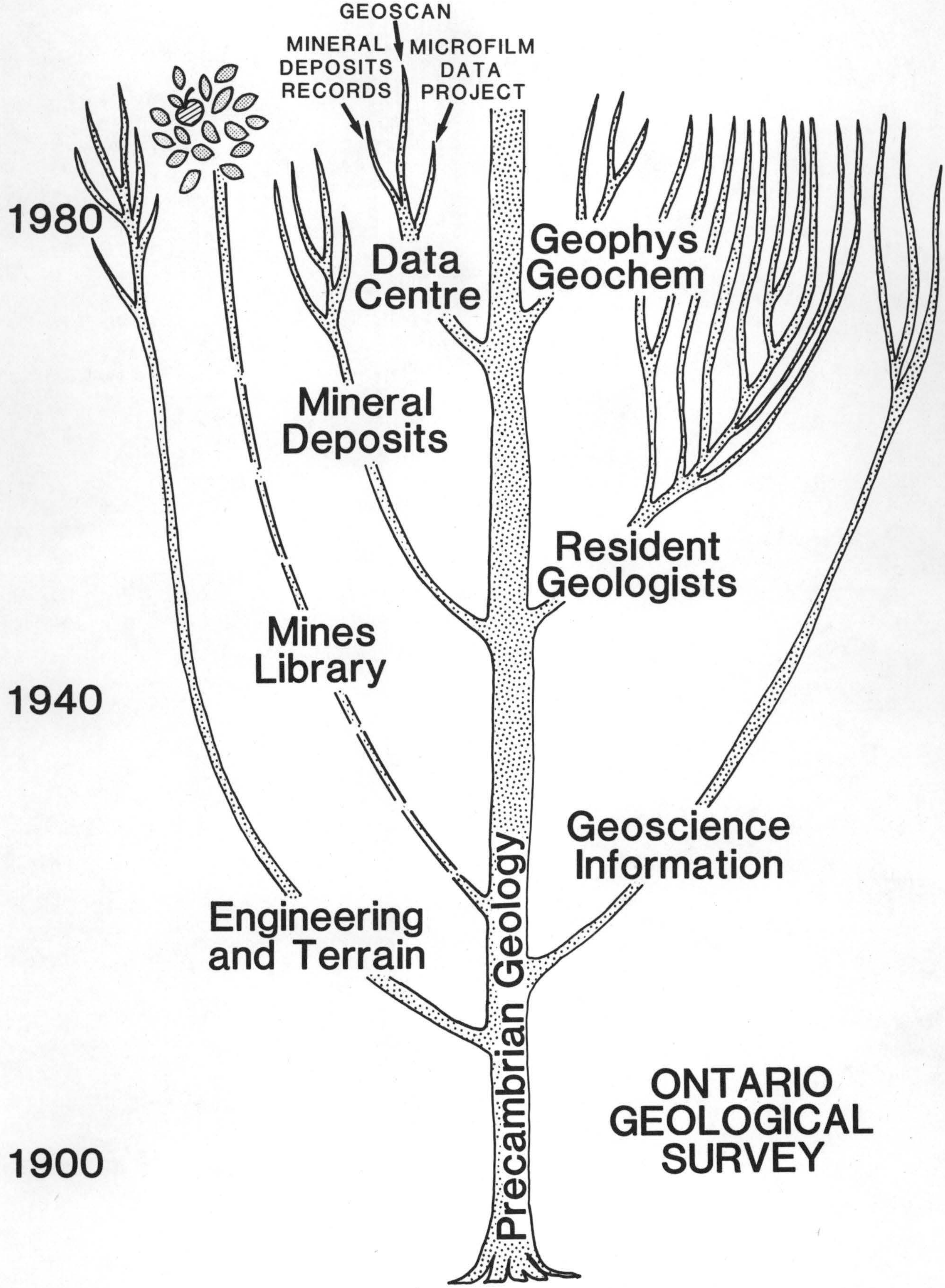


Fig. 5.


GEOSCAN
MINERAL DEPOSITS RECORDS
MICROFILM DATA PROJECT
1980
Data Centre
Geophys Geochem
Mineral Deposits
Resident Geologists
Mines Library
1940
Geoscience Information
Engineering and Terrain
Precambrian Geology
ONTARIO GEOLOGICAL SURVEY
1900

QUEBECS USER-ORIENTED GEOSCIENTIFIC COMPILATION MAP PROGRAM

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ABSTRACT

The practical half-life of most scientific and technical documents resulting from the billions of dollars expended annually in geological research and mineral exploration is measurable in months. . . not years.

In order to capitalize on the immense intrinsic value of this accumulating and largely dormant information, the Québec ministère de l'Énergie et des Ressources has developed a highly successful user-oriented compilation map program which consists of a uniquely complementary document trio:

1) Geoscientific Compilation Maps at a scale of 1 / 10 000 (National Topographic System grid, SI standards) which contain the most pertinent information with respect to mineral exploration and the most up-to-date geological interpretations, based on data extracted, compiled and synthesized from all available assessment files, government publications, university theses and several scientific and technical journals,

2) Geoscientific Work-Location Maps at a scale of 1 / 50 000 (NTS grid, SI standards) which outline the geographic area covered by each known geoscientific document and,

3) corresponding Geoscientific Bibliographies which provide the complete bibliographic reference to each document.

Over 750 Geoscientific Compilation Maps covering the entire Abitibi Mineral Belt (Québec) have been produced during the last five years, while the Geoscientific Work-Location Maps and corresponding Bibliographies have been extended to cover the entire province. Over 50 000 documents were consulted in the process.

Heavy demand for these compilation products has recently required implementation of a systematic up-dating program utilising a MINISIS date base management system and automated cartography.

INTRODUCTION

Before actually presenting our Geoscientific Compilation Map Program, I would like to briefly describe, if I may, the mouvement or flow of geoscience information in the mineral exploration industry.

In addition to competition, a second factor which contributes heavily to the loss of exploration information is the speculative nature of mineral exploration itself. As seen through time, exploration companies, especially the junior companies, come and go and succeed each other continuously as market conditions fluctuate and evolve. The hypothetical but realistic mineral property shown in figure 2 graphically illustrates how in a 60 year period 8 different companies have succeedingly managed to control this one property. Each company will have undertaken different types of surveys,aerially represented in figure 2 by rectangular outlines on three-dimensional timeplanes. The surveys may include trenching, geological mapping, various types of geochemical and geophysical exploration techniques, diamond drilling and so forth. Unfortunately, many of the survey results will invariably have been lost as a result of all the corporate changes which will have occured through time.

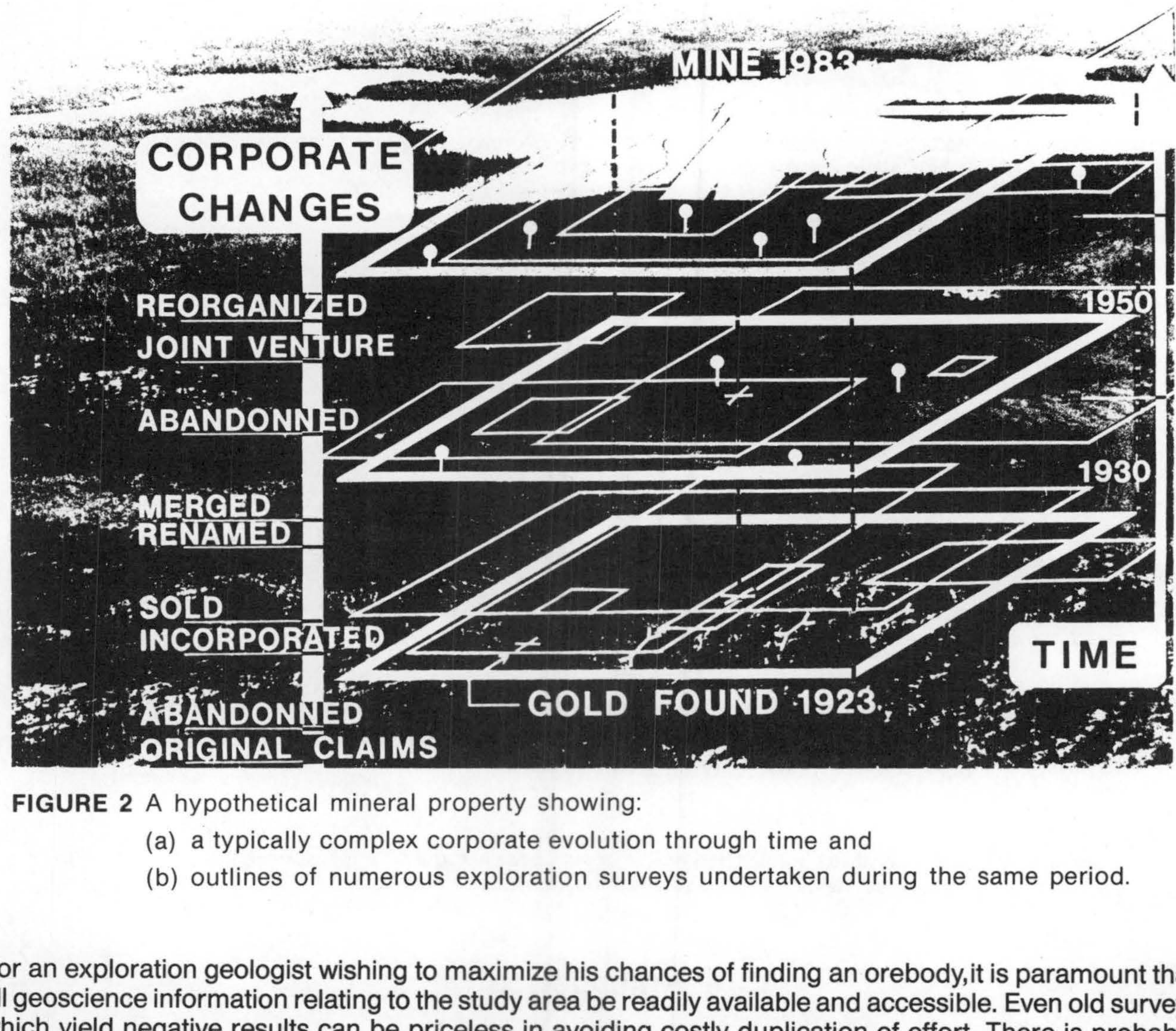

FIGURE 2 A hypothetical mineral property showing:

(a) a typically complex corporate evolution through time and

(b) outlines of numerous exploration surveys undertaken during the same period.

For an exploration geologist wishing to maximize his chances of finding an orebody,it is paramount that all geoscience information relating to the study area be readily available and accessible. Even old surveys which yield negative results can be priceless in avoiding costly duplication of effort. There is probably nothing more frustrating for an exploration geologist drilling a promissing geophysical anomaly to accidentaly stumble over someone elses rusty drill casing. . . and this happens very often.

Notwithstanding the lost information, the sheer volume of available information can still be rather overwhelming. Figure 3 for instance is a composite overlay of a map-area measuring 9km by 10km in a minor mineral belt showing the superimposed outlines of over 150 different surveys. These in turn represent 150 exploration documents containing perhaps over 1 000 technical maps and 100 000 or more observations of all types, ranging from drill logs to magnetometer readings.

The Flow of Geoscience Information in the Mineral Exploration Industry

Quite unlike academic or government-generated geoscience information, which most of you are familiar with, the information generated by the mineral exploration industry is not as freely accessible. Most of the technical documentation resulting from the billions of dollars spent annually in exploration surveys is considered confidential. . ., "for Company eyes only", and therefore remains for all practical purposes relatively uncirculated and unknown. The reason for this secretiveness is, of course, competition.

Some mineral exploration documents do however become publicly available because of laws and regulations which oblige companies to surrender part of their information as assessment files in exchange for mineral rights. We estimate that in Quebec, and Canada generally, as little as 30% of the information generated by large exploration companies becomes publicly available, as opposed to perhaps 60% in the case of junior exploration companies.

In the accompanying network model (figure 1), inspired by Thomas J. Allen (1931), we can see that geoscience information is exchanged freely from one employee to the next within each corporate structure but that very little information is exchanged between exploration companies except in the case of joint ventures, mergers, options, or the sale of mineral properties. The net result of this normal protective business attitude is that much valuable geoscience information is gradually filed-away or stored for safekeeping, only to be eventually forgotten and lost.

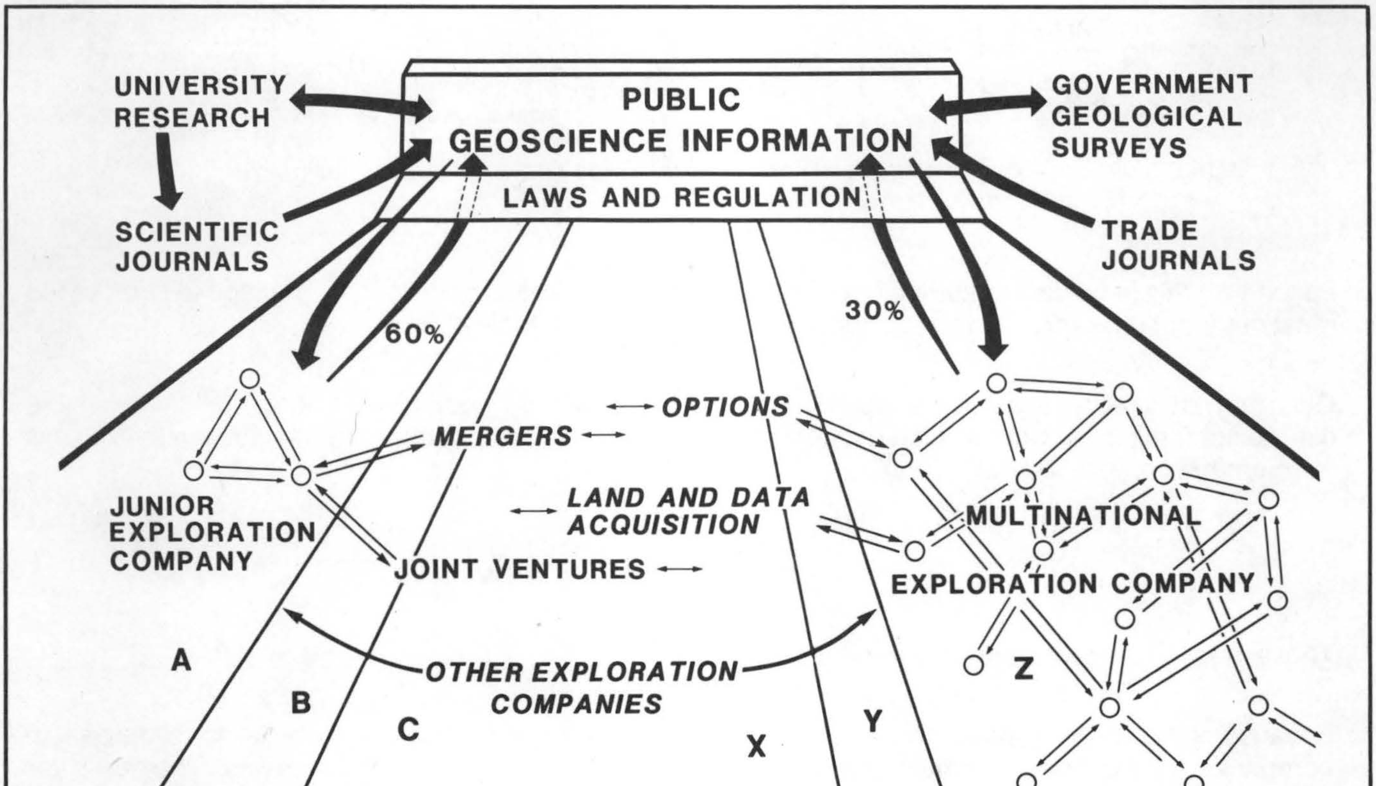

FIGURE 1 The flow of geoscience information in the mineral exploration industry

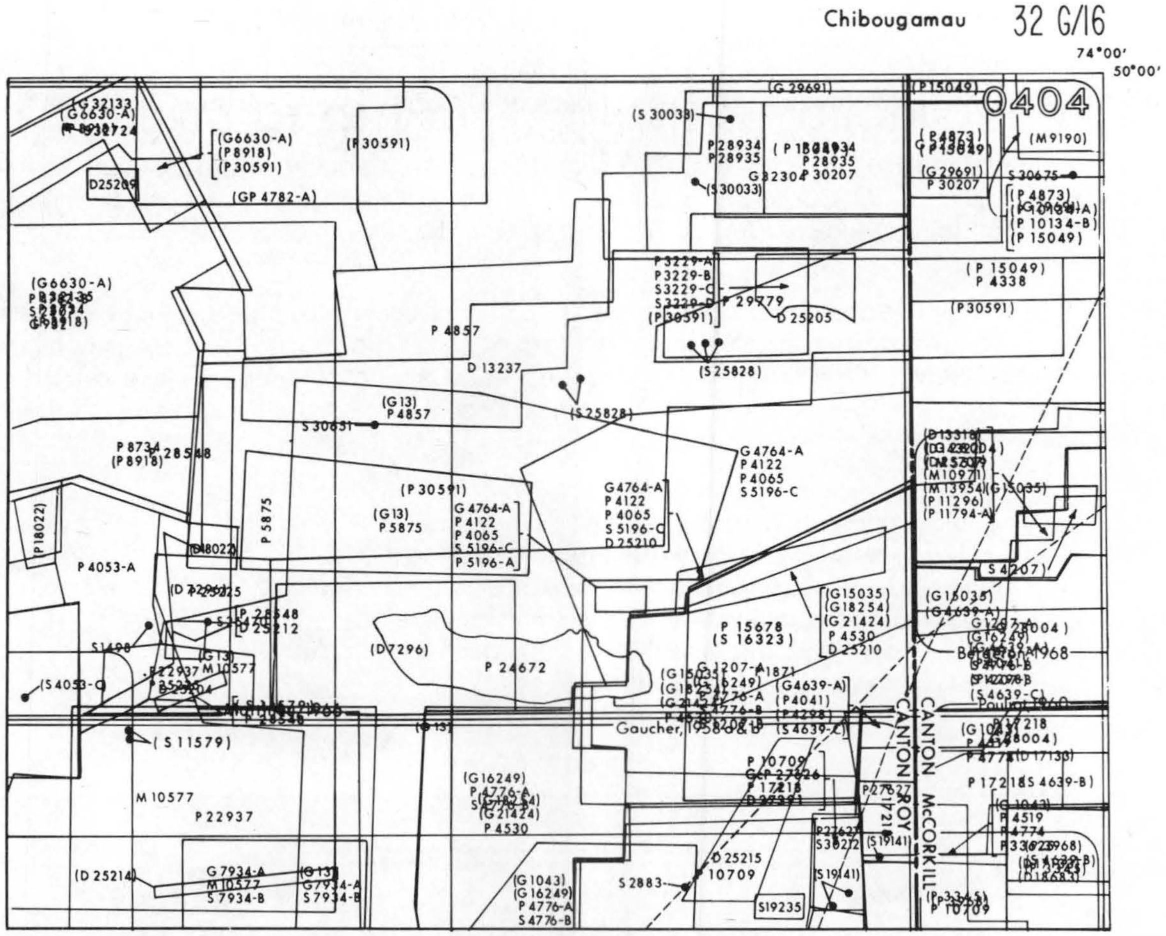

FIGURE 3 A composite overlay of a Work-Location Map showing the outlines of over 150 different exploration and geological surveys.

Faced with this important volume of information, how do exploration companies manage to sort out the most pertinent data and still develop successful exploration strategies?

Generally, they will proceed by assigning a team of experienced geologists to screen all the available data, extract the information which they consider "interesting" and produce what I have deemed to call "homemade compilation maps".

"Homemade Compilation Maps"

These maps present numerous disadvantages (Table 1).

Because of the time and costs involved compilation maps can be produced only by large resource-rich companies and generally remain out-of-reach for the junior exploration companies. They are also confidential and because they are also unpublicised, different companies will often unknowingly duplicate each others efforts in recompiling the same information for the same areas.

The high costs involved in producing such maps encourage cost-cutting procedures, resulting in maps of variable quality which tend to be incomplete or very personalized, reflecting either the compiler's or the company's immediate interests. Nevertheless compilation maps are *indispensable* as an exploration tool. And lest I be misinterpreted, I must add, in all fairness, that some exploration companies do produce excellent compilation maps.

1- PRODUCTION FEASIBILITY IS LIMITED TO LARGE RESOURCE-RICH COMPANIES
2- CONSIDERED CONFIDENTIAL
3- UNPUBLICISED
4- UNKNOWINGLY, THEY ARE OFTEN DUPLICATED
5- QUALITY IS VARIABLE
6- TEND TO BE INCOMPLETE
7- SHORT SHELF HALF-LIFE

TABLE 1 The disadvantages of 'Homemade' exploration company compilation maps.

The Quebec Geoscientific Compilation Map Program

In 1977, we realized that if compilation maps were produced by Government in cooperation with the mineral exploration community, we might not only overcome most of the above mentioned disadvantages, but we would acquire a powerful marketing tool in promoting mineral exploration in Quebec.

Time and space does not permit me to trace in any great detail the different development stages of the Compilation Program itself. Suffice it to say that after having consulted hundreds of geologists and organizations, and after having tried dozens of different cartographic models a three-part document system evolved, consisting of:

Element one : Geoscientific Compilation Maps with an elaborate Legend and Guide,

Element two : Geoscientific Work Location Maps, and

Element three: Corresponding Geoscientific Bibliographies.

Element One

The Geoscientific Compilation Maps are produced at a scale of 1 / 10 000, follow the National Topographic System and cover approximatevely 60km^2 each (at latitude 48°). The maps,as published,consist of 3 combined overlays (Figure 4):

1) A topographic base screened 50%,

2) A lithologic overlay containing the most pertinent information with respect to regional geology, lithology, structural geology, diamond drill holes, mineralizations, ore deposits and mining operations,

3) A third overlay containing the most pertinent geophysical and geochemical exploration information.

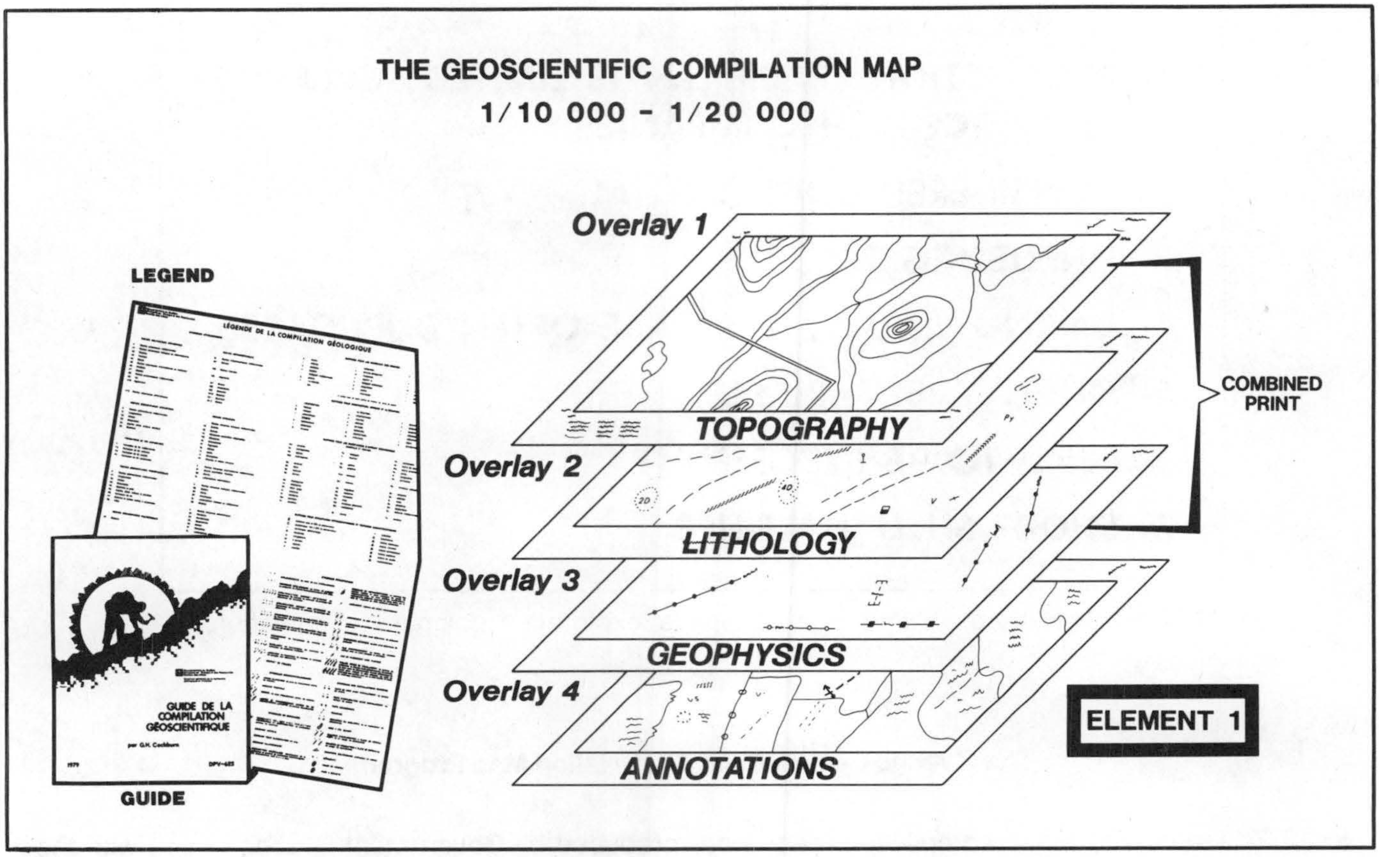

FIGURE 4 The different components of Element 1..

All of the information drafted on overlays 2 and 3 is extracted, synthesized and compiled from all available public geoscience documents, including Exploration and Assessment Files, University Theses, Government Publications as well as several Trade and Scientific Journals.

To better illustrate the map content, I have selected several enlargements (figure 5) taken from a single map sheet from the Chibougamau Mining District (map CG-32G/16-0302).

In addition to outcrop outlines, rock types, alterations, textures, structures and, all ore reserves are clearly indicated on these maps along with mine installations, underground workings, as well as all known mineralizations. Over 300 different map symbols, used alone or in combination, have been defined in the Compilation Legend.

Overlay 4 entitled "Annotations" is available only in manuscript form and is used as a cartographic scratch pad of sorts for indicating differences in geological interpretations, surplus information, errors, suggestions, comments and anything else which can be helpful either to the map-user or for future up-dating.

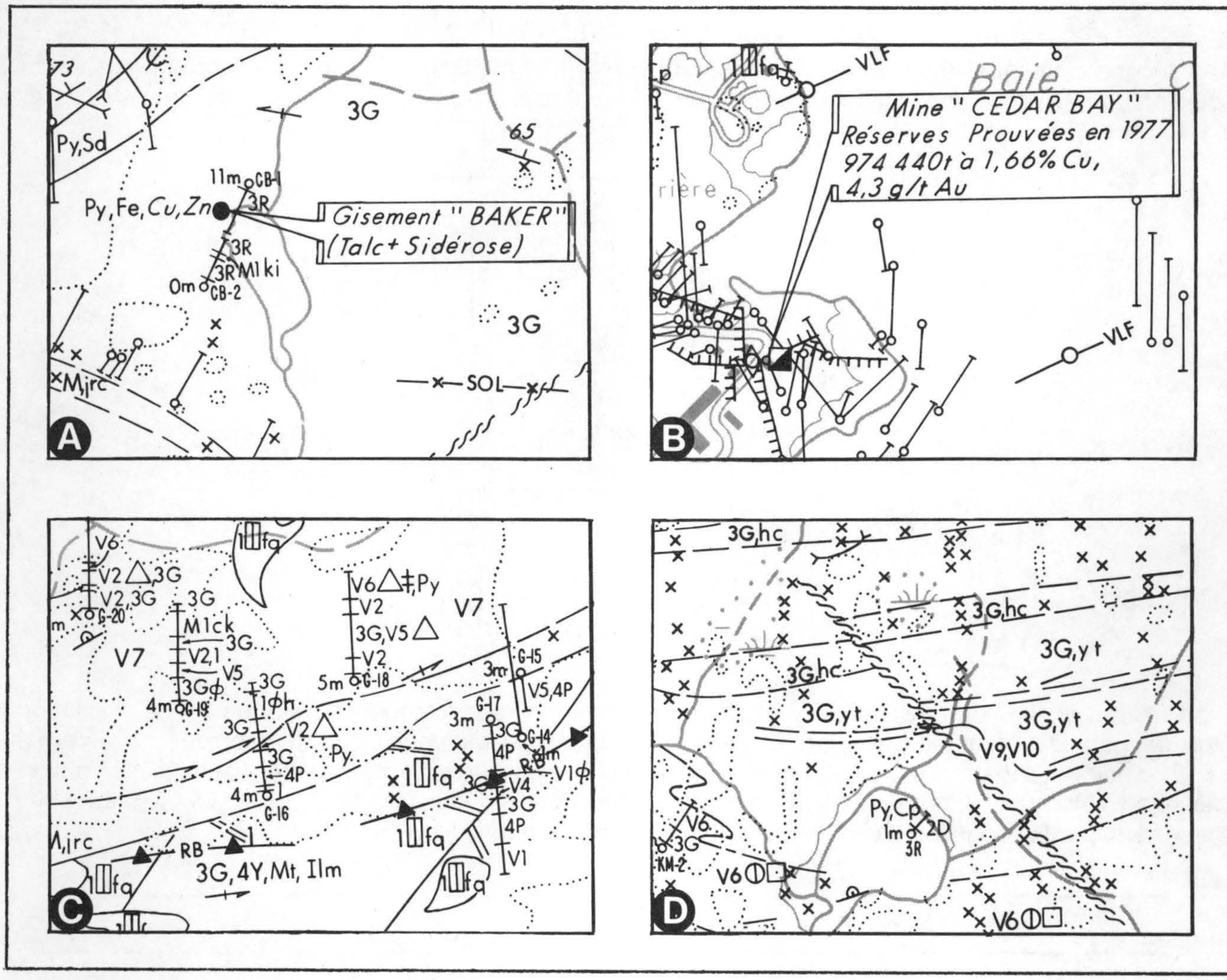

FIGURE 5 Selected segments of a Geoscientific Compilation Map (CG-32G/16-0302) showing:

(a) mineralization, outcrop outlines..., xx
(b) a mine, ore reserves, underground workings (⊤⊤⊤⊤⊤⊤) geophysical conductors (VLF)...
(c) several horizontal projections of diamond drill holes with abbreviated lithology - pyritized gabbro, 3G ϕ ; quartz-feldspar porphyry... 1▯fq
(d) geological contacts, a NW-trending fault with offset...

The Geoscientific Compilation Maps are available on microfiche, on paper or on polyester film at a scale of 1/10 000 or 1/20 000. These maps consist entirely of line-drawings and are produced only in their monochromatic version. Full color maps could easily have been produced; however, in doing so, we would have completely forgotten the user. A monochromatic map is absolutely essential to his needs because he can acquire a copy on polyester film, add his own proprietary or personal information and reproduce the map by conventional means, running-off as many copies as he pleases. The ease by which this type of document can be reproduced is an important consideration. We don't particularly worry about copyright because the name of the game is to promote mineral exploration. . . the more copies are in circulation the better.

Element Two

The second element of the Compilation Program consists of the Geoscientific Work-Location Map at a scale of 1/50 000. It covers exactly the area covered by 16 adjoining Geoscientific Compilation Maps in a 4 x 4 matrix (Figure 6).

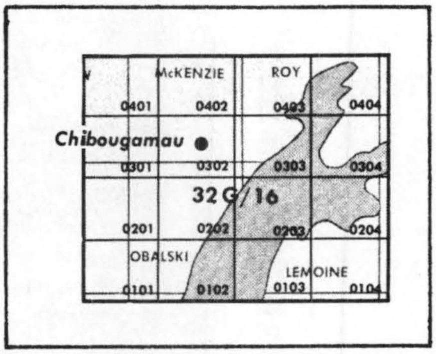

FIGURE 6 The Work-Location Map (CG-32G/16) at a scale of 1/50 000 covers exactly the area of 16 Geoscientific Compilation Maps at a scale of 1/10 000 numbered from 0101 to 0104 (e.g. CG-32G/16-0203)

The limits of the area covered by each geoscience document consulted during the Compilation Program is outlined on the Geoscientific Work-Location Maps and each location map consists of from 2 to 12 coincident sheets or overlays. This is done in order to conserve clarity in sectors or high information density. Exploration documents are identified on the map by registration number (Figure 7a), while theses and publications are identified by author and year of publication (Figure 7b).

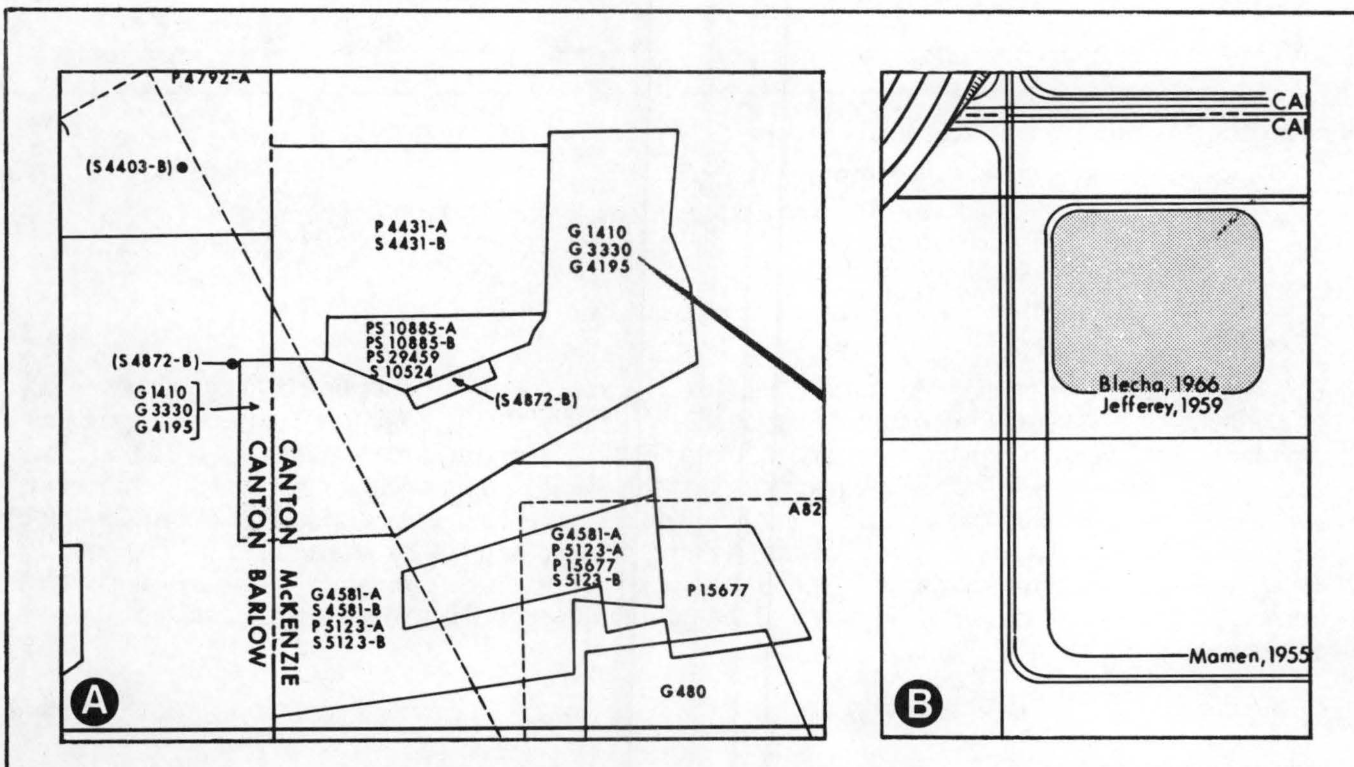

FIGURE 7 Segments of a Geoscientific Work-Location Map showing:

(a) exploration document outlines

(b) thesis and publication outlines

Element Three

The third element is the Geoscientific Bibliography which covers exactly the same geographic limits as the Work Location Map and provides a complete reference to each source document consulted during the compilation and outlined on the Geoscientific Work-Location Map.

Production-wise, all aspects of the Compilation Program, excluding development and quality control, were realized on a contract basis by several senior mineral exploration consultants. The documents produced conform to SI (International Metric Standards), our own ridgid technical standards, and are written in French, the working language of Quebec.

As soon as the first compilation documents were released in January of 1979 we realized that we had a best-seller on our hands, far beyond our most optimistic expectations. Since then, and in response to demand, 750 different compilation maps have been produced covering the entire Abitibi Au-Cu Mineral Belt (Figure 8). New maps are continuously being produced and systematic up-dating will begin this fall.

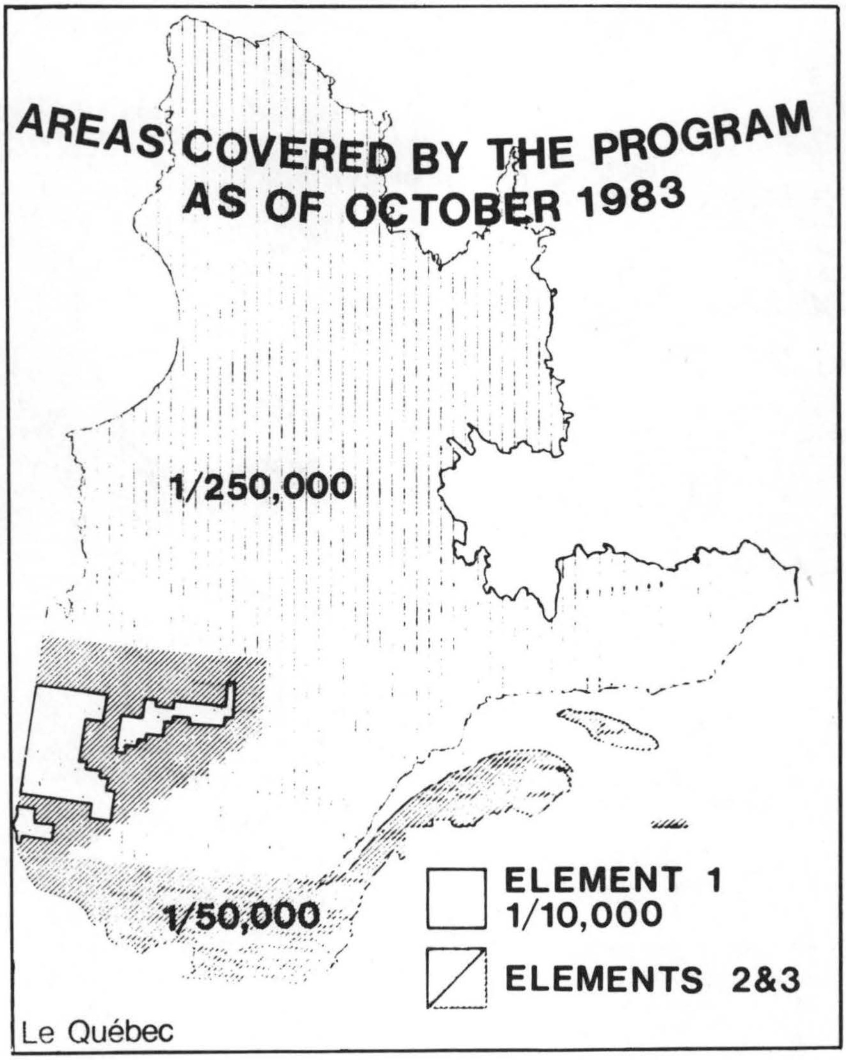

FIGURE 8 The area covered by the Geoscientific Compilation Program as of October 1983.

With respect to the Work-Location Maps and corresponding Bibliographies, elements 2 and 3, there are now 450 at two different scales (1 / 50 000 and 1 / 250 000) and they cover the entire province (Figure 8), respectively outlining and listing over 50 000 different geoscience documents.

The main advantage of the three compilation elements is that they provide a rapid overview of an area's mineral potential and permit the user to rapidly return to the source documents as need be.

Source Document Accessibility

Speaking of the user, once this type of documents are published, it is imperative that his needs not be frustrated. All the source documents mentionned must be easily accessible and available to him. In Quebec, these source documents, all 50 000, are available in our Central Microfiche Library (Figure 9) as well as in 6 Resident Geologist Offices where they can be consulted on large screen viewers, which are essential for working with maps on microfiche.

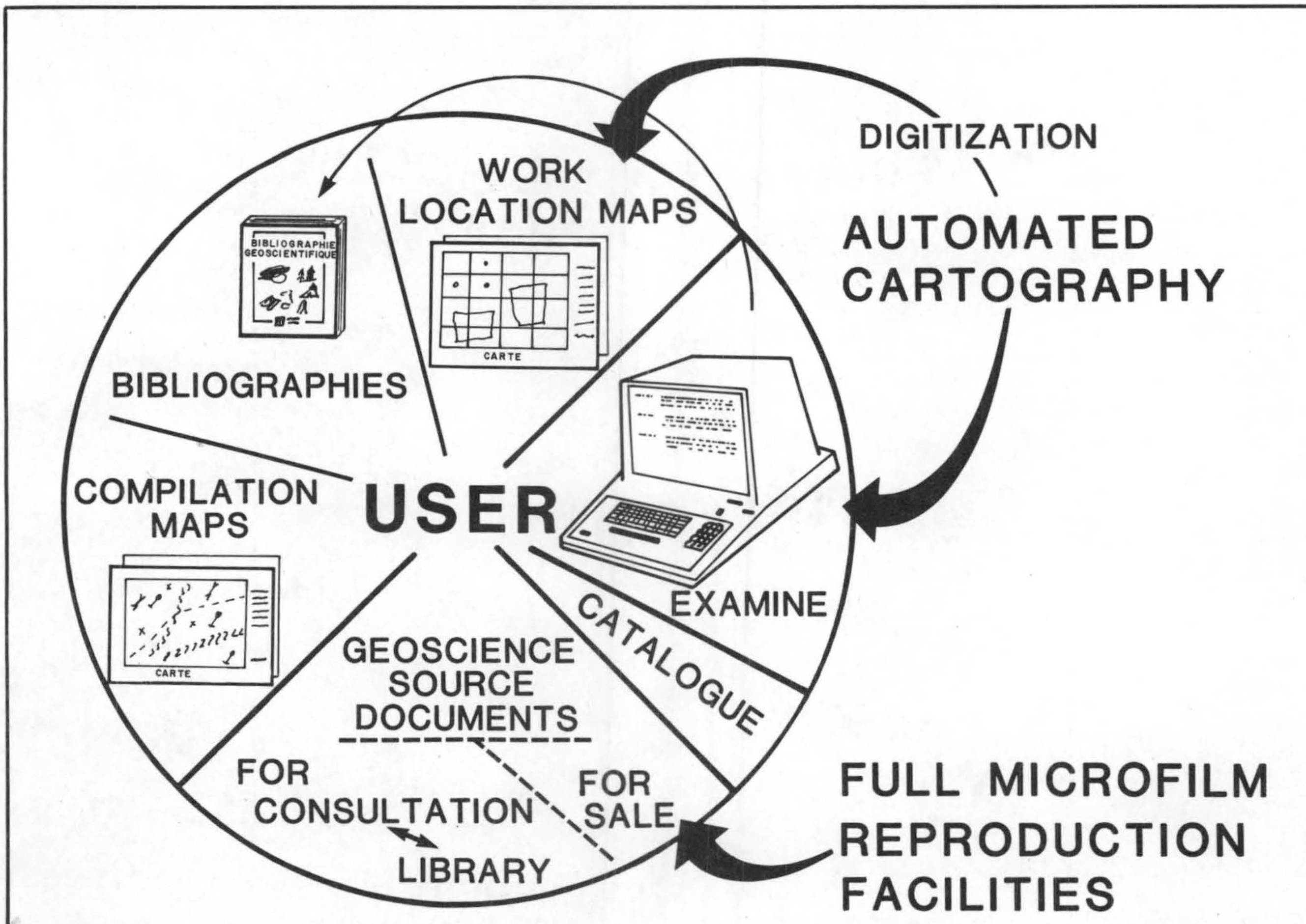

FIGURE 9 Support services available to the user from the *service de la Géoinformation*

Additionnally, if the user wishes to acquire copies of the source documents, we can easily duplicate the microfiche or alternatively enlarge and reproduce the images on paper. Specialized equipment such as an OCÉ-3750 Electrostatic Printer-Enlarger and similar, but smaller, equipment in our regional offices permit us to reproduce on paper most maps either at their original size (max. A0) and scale or, because of a continuous enlargement feature (7,6X to 30X) most any other scale that suits the user within those limits.

Beginning November 1983, a large Minisis data base management system which we call EXAMINE will also be available to the user, greatly improving his search capabilities,as well as providing automatic updating capabilities for the bibliographies.

The next logical step will be to digitize the Work-Location Maps and produce them by automatic cartography.

CONCLUSION

In concluding, I would like to pass on an encouraging observation. Since we started producing the Compilation Maps we have noted that many exploration companies big and small now willingly turn over their older exploration documents though not required by law. Many now admit that in the best interest of all concerned, exploration results should, after a few years, become public geoscience information. Full-disclosure laws, for the sake of information-conservation, may soon be widely accepted in the mineral exploration industry.

Aknowledgements

I would like to thank Paul Brouillette, Robert Carignan and Denis Bergeron the draftsmen who produced the graphic material required for the oral presentation and this paper. My sincere thanks also to Sylvie Vignola and Claire Martel for their assistance and perseverence in typing this paper "en anglais".

Sample Geoscientific Compilation Documents

In consideration of the fact that cartographic documents such as the ones described here cannot be properly rendered or integrated in a volume such as the present Proceedings because of their dimensions, the service de la Géoinformation will provide, upon request, limited sample copies of the Geoscientific Compilation documents. These samples reproduced on paper and microfiche will include an abridged English language description of the different compilation elements as well as the most recent index maps.

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INFORMATION SELECTIVITY APPLIED TO U.S. GEOLOGICAL SURVEY GEOLOGIC MAP INDEXES AND THE GEOINDEX DATA BASE

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Abstract: The selection of useful information from the larger field of available information is part of our responsibilities as information specialists. For example, selection criteria determine which geologic maps appear in the U.S. Geological Survey Geologic Map Indexes (GMI's) and in the GEOINDEX data base. The selection criteria insure that the indexes and data base show only the good original published geologic maps having more than a certain amount of detail.

The term "good" means that a map must have a scale, some form of geographic control, and an adequate explanation. The term "original" means that a map is not modified from or based on a previous map that is already indexed. Only published maps are indexed; we do not index theses, dissertations, or State open-file reports. The term "geologic" means that the map delineates bedrock or surficial units and defines the units in rock and age terms. The amount of detail a map must show is determined by the detail on the State geologic map; maps having less detail are not indexed.

These selection criteria have been used for more than 20 years in producing the GMI's currently available. The process winnows out uncontrolled, illegible, ambiguous, redundant, unavailable, overly general, and (or) other maps inappropriate for these information products. This provides users with the kind and quality of information they expect.

Introduction

As an information specialist I am selective about the information I collect and pass on. Information specialists are all somewhat selective, but as we are faced with more and more information to process, selectivity in information collection can improve the quality of the information we pass on and the effectiveness of our communication.

I compile the U.S. Geological Survey Geologic Map Indexes (GMI's), which are index maps, by State, showing areas covered by published geologic maps. The maps I index are entered in the GEOINDEX data base, which has been developed to facilitate updating, and eventually to permit faster and more specific searching. However, not all geologic maps are indexed. I evaluate all published geologic maps received by the U.S. Geological Survey library and select only good original published geologic maps that show and explain bedrock and(or) surficial geologic units in lithologic and(or) stratigraphic terms in greater detail than the State geologic map. A look at the history of the GMI project will help explain the rationale behind the selection criteria. Then we can look closer at the question, "What constitutes a good geologic map?"

U.S. Geological Survey Geologic Map Indexes (GMI's)

GMI's are index maps that show areas of published geologic maps for the 50 States and the Territories of the United States. First created in the 1940's to facilitate searching for geologic maps, GMI's consisted of (1) a map having colored lines over a screened base map of the State, and (2) a bibliography in the margin (fig.1). Many kinds of maps were indexed on the first GMI's, and some scales were smaller than 1:2,000,000. The GMI's, prepared for all 48 States then in the Union, were well received, although somewhat hard to read and hard to prepare.

In the late 1950's, supplementary GMI's were issued for States that had had the most new geologic maps published. The format was simplified to a blackline map over a green 1:1,000,000 State base map. Different scales were shown by different line widths and type sizes. By this time, problems in producing and using the first GMI's had resulted in greater selectivity in

Figure 1.--Geologic Map Index of Indiana, 1950, showing the format of the first GMI's prepared. Outlines of the areas are in color, indicating different scale ranges.

indexing of subsequent maps. Now maps had to be more detailed than the State geologic map, and they needed to be "geologic." Because these GMI's were supplements, users needed two GMI's to get the whole story. This format was used into the mid 1970's

In the early 1970's, planning started on the computer-generated booklet-format GMI's now available (fig. 2). These newest Geologic Map Indexes supersede the older editions. In fact, all references cited on the first GMI's were evaluated by the more selective criteria we now use; thus, the latest GMI's are the most comprehensive guide available to geologic mapping in the United States. Recently a description was prepared to be distributed with the GMI's to facilitate their use (fig.3). The GEOINDEX data base contains the data used to produce the GMI's.

The preparation of a fourth edition, which should be greatly facilitated by the GEOINDEX capabilities, is just starting. This will yield GMI's that will supersede those now available. The format will remain essentially the same, although several improvements are planned to improve the usefulness of the GMI's. Eventually, after more programming, testing, and debugging, the updated GEOINDEX data base will be accessible to users so that they may search for the maps they need.

What geologic maps are indexed?

This is the main question I need to answer. I mentioned above the "good original published geologic maps that show and explain bedrock and (or) surficial geologic units...." Let us break this down into the salient components.

MAP INDEX INDIANA

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC MAP INDEX OF INDIANA

Compiled by
Willard L. McIntosh and Margaret F. Eister
1977

GENERAL INFORMATION

Geologic map indexes include maps published by the U.S. Geological Survey, State and commercial organizations, universities, and professional societies. Geological Survey open-file reports and maps also are shown, but no attempt is made to include theses or open-file material of other organizations. All maps outlined on the index are at a scale 1:250,000 or larger. All show areal geology in as much detail or more than the State geologic maps.

The formal publications can be consulted in many large public and university libraries. Inquiries about cost and availability of maps not published by the U.S. Geological Survey should be directed to the individual publisher and not to the U.S. Geological Survey.

The map areas on this index are keyed to one or more bibliographic citations. Some map areas may refer to geologic reports containing one or more areal maps and several very large-scale locality maps, of which only the areal coverage is outlined; reference is made to the locality maps in the citation. The index is separated into three scale ranges. Map outlines representative of two or more of these ranges will appear on two or more of the index sheets.

References to open-file reports and maps are followed by letter symbols designating libraries where they can be consulted. All depositories are U.S. Geological Survey offices unless a State Geological Survey or other organization is specifically indicated. The following symbols are used to indicate the major U.S. Geological Survey depositories:

NC Library, 4A100 National Center, 12201 Sunrise Valley Drive, Reston, Virginia 22092.
Da Library, 1526 Cole Blvd. at West Colfax Ave., Golden, Colorado (Mail address: Stop 914, Box 25046, Federal Center, Denver, Colorado 80225.)
Db Public Inquiries Office, 1012 Federal Building, 1961 Stout St., Denver, Colorado 80294.
M Library, 345 Middlefield Road, Menlo Park, California 94025.
S Public Inquiries Office, 678 U.S. Courthouse, West 920 Riverside Ave., Spokane, Washington 99201.
LA Public Inquiries Office, 7638 Federal Bldg., 300 North Los Angeles St., Los Angeles, California 90012.
SF Public Inquiries Office, 504 Customhouse, 555 Battery St., San Francisco, California 94111.
T Public Inquiries Office, 1C45 Federal Bldg., 1100 Commerce St., Dallas, Texas 75242.
U Public Inquiries Office, 8105 Federal Building, 125 South State St., Salt Lake City, Utah 84138.

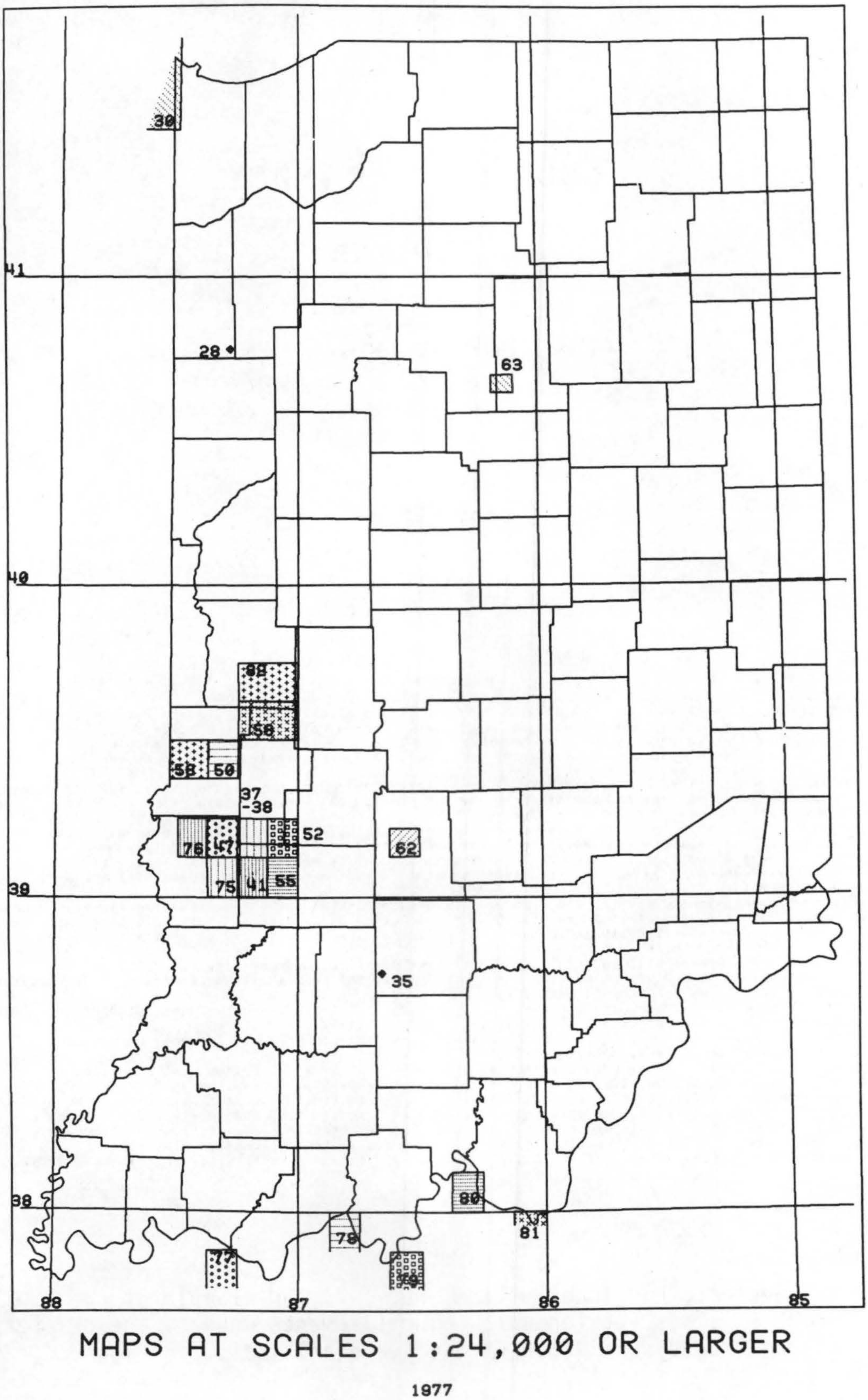
Data used in the preparation of this index are printed directly from the Geomap Index file of the U.S. Geological Survey. Ensuing editions of the index will include omissions, corrections, and future additions.

Correspondence pertaining to possible omissions or errors in the contents of this index should be addressed to the Geologic Inquiries Group, U.S. Geological Survey, 907 National Center, Reston, Virginia 22092.

Figure 2.--Geologic Map Index of Indiana, 1977, an example of the booklet format GMI. Except for a few embellishments made by the printer, this was produced by the GEOINDEX data base and its supporting programs.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

INDIANA

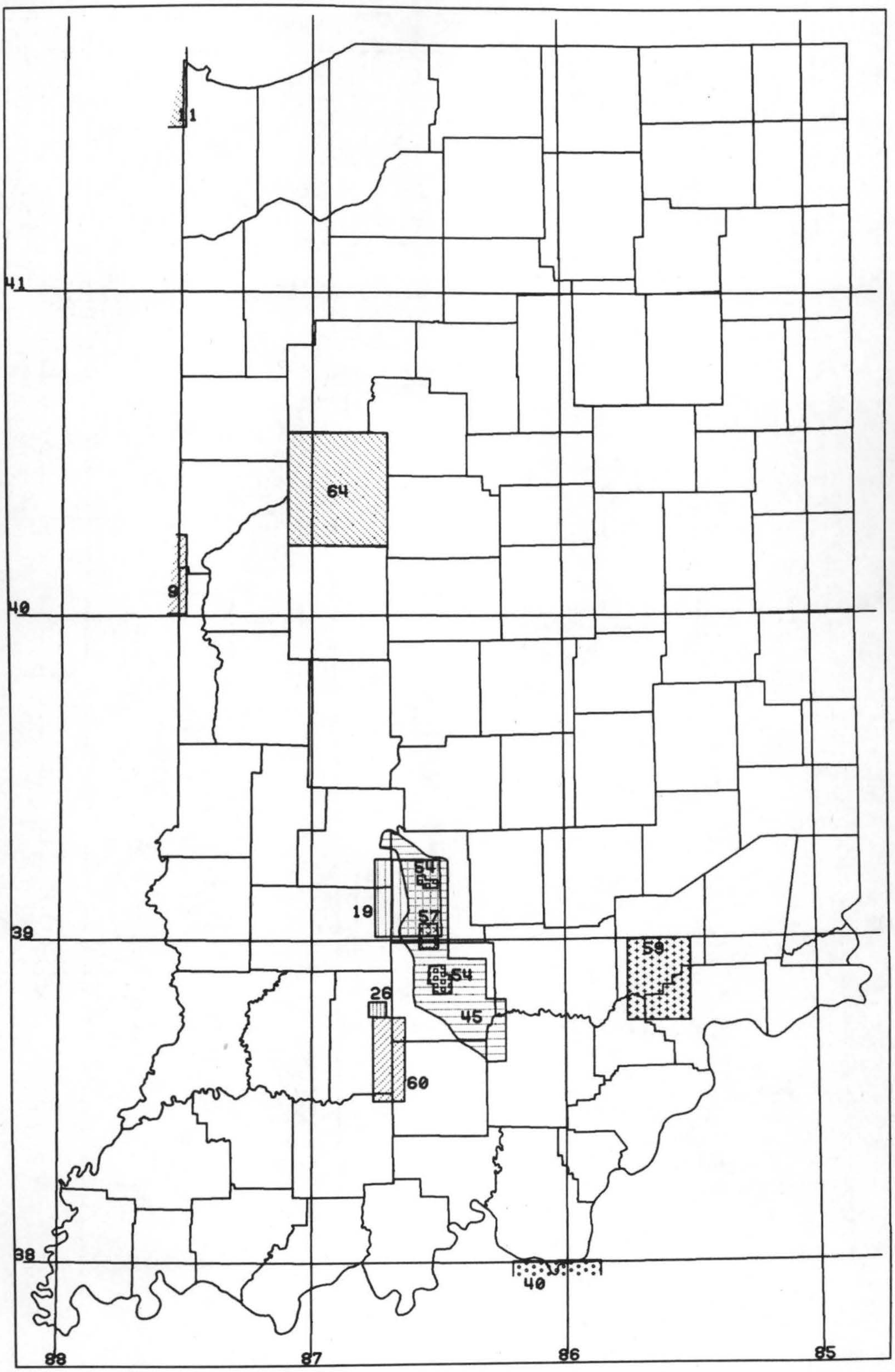


MAPS AT SCALES 1:24,000 OR LARGER

1977

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

INDIANA

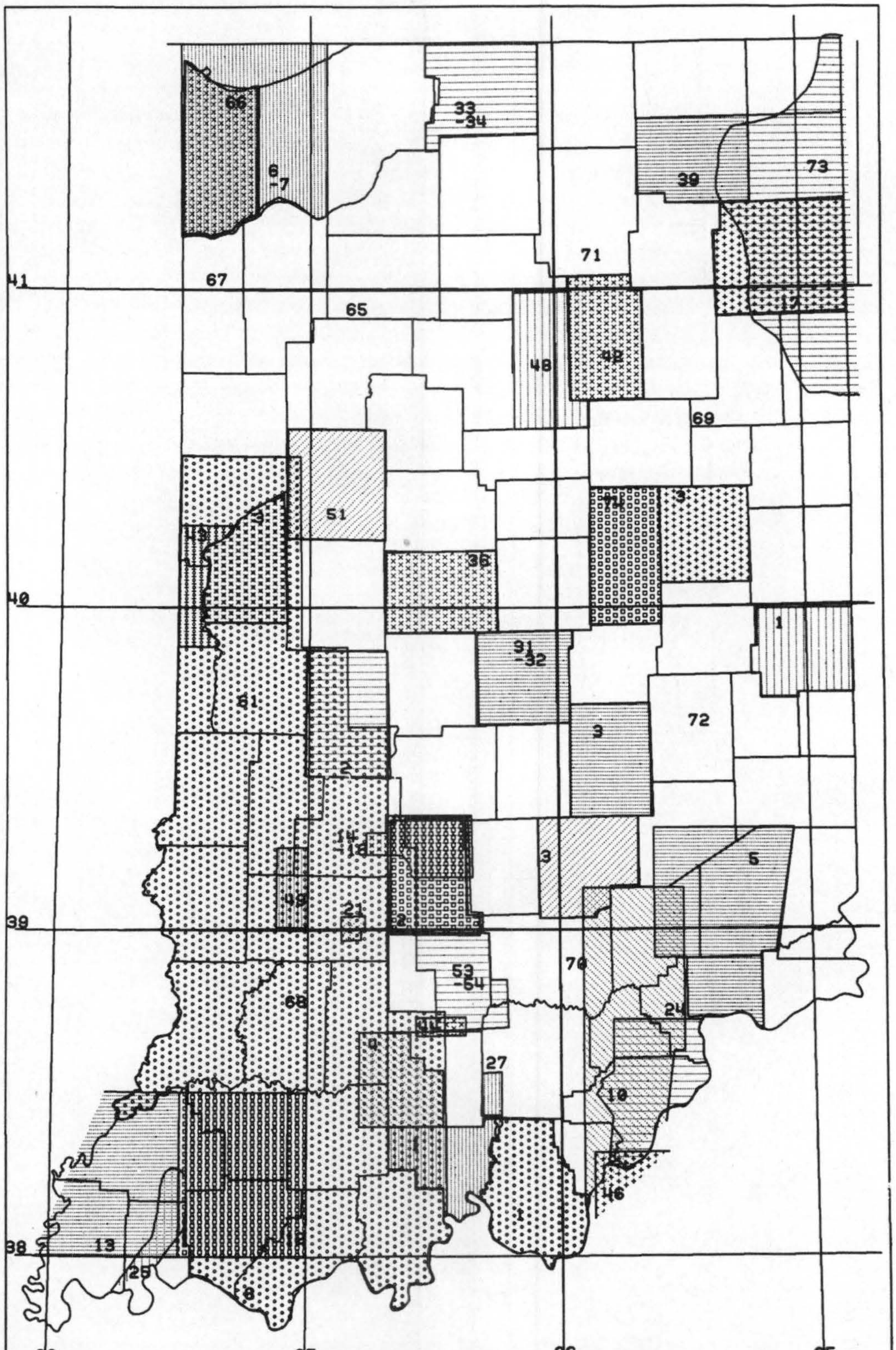


MAPS FROM SCALE 1:24,000 THROUGH 1:63,360

1977

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

INDIANA



MAPS FROM SCALE 1:63,360 THROUGH 1:250,000

1977

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Description of U.S. Geological Survey Geologic Map Indexes

What maps are indexed

Geologic Map Indexes (GMI's), available by State, show outlines of all published geologic maps more detailed than the State geologic maps. Geologic maps from the 1800's to about 1978 have been indexed; publishers include U.S. Geological Survey, other Federal agencies, State geologic agencies, universities, professional societies, and other organizations. Theses, dissertations, and State open-file reports are not indexed.

Information about very recent geologic maps is available from Geologic Inquiries Group, 907 National Center, Reston, VA 22092; phone (703) 860-6517. New map outlines will be added to GMI's when they are updated.

How to use the Geologic Map Index

GMI's consist of two parts: (1) index maps organized by scale range and (2) a bibliography organized by number. To find the geologic maps you want, follow these steps:

Find the index maps of the appropriate scale range.

Identify your area of interest (using the latitude and longitude lines, and State and County boundaries for control).

Note the numbers of any patterned areas in your area of interest. (Patterns show the extent of map areas; they do not represent different kinds of maps.)

Look in the bibliography for the numbers you just noted.

Also in the bibliography, check all entries that have asterisks; these reports are not outlined on the index maps, but they have important general information on topics or regions.

How to obtain the maps you want

Contact the map's publisher (shown immediately after the colon in the reference list) for current price and ordering information. If you cannot reach the publisher, contact Geologic Inquiries Group for assistance.

Most U.S. Geological Survey reports are available from the appropriate Branch of Distribution (see addresses below). U.S. Geological Survey Open-File Reports are available from Open-File Services Section, Box 25425, Federal Center, Denver, CO 80225, phone (303) 234-5888.

Out-of-print reports should be available in large public or university libraries; any library can usually borrow a report for you on interlibrary loan from a large library.

What to do when you don't find a map of your area of interest

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USGS Branches of Distribution

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(703) 756-6141

Residents of Alaska may order USGS Alaska maps from:
Alaska Distribution Section,
New Federal Building,
101 12th Avenue, Box 12,
Fairbanks, AK 99701
(907) 456-7535

Figure 3.--Description page recently prepared for distribution with GMI's to facilitate their use.

Geologic maps. Most geologists would probably agree that a geologic map shows bedrock and(or) surficial deposits and explains the map units in lithologic and(or) stratigraphic terms. Unfortunately, I have found that most laymen consider structure contour maps, geophysical maps, geochemical maps, geomorphic maps, hydrologic maps, and others also to be geologic maps. Perhaps in a broad sense they are correct. GMI's, however, include only the bedrock and surficial geologic maps that have an adequate explanation of the lithologic and(or) stratigraphic characteristics of the units portrayed.

Published geologic maps. GMI's include maps published by U.S. Geological Survey, State and other Federal agencies, universities, professional societies, and other organizations. They do not include theses, dissertations, or other unpublished maps. USGS Open-File Reports are indexed, but other open-file reports are not. Although this policy seems arbitrary, it results from a logistical problem: The USGS library is where new geologic maps are screened before inclusion in the GEOINDEX data base, and many open-file reports from outside USGS never are sent to the library.

Original geologic maps. To eliminate redundancy I do not index maps "from, modified from, after, etc." already published maps. However, if the original map cited on the new map is a thesis, dissertation, or some other form of unpublished report, I will index the new map because it is the first published version.

Good geologic maps. A good geologic map must have several components or features. These include the following:

(1) Publication information, including author's name(s), publication date, title, and publisher.

(2) Scale (preferably a bar scale).

(3) Geographic control, either a base map, latitude-longitude or township-range grid, or other recognizable geographic control.

(4) A geologic credit or index map giving sources of geologic data ("from, modified from, or after" important earlier reports).

(5) Reference information that includes the reports cited in the geologic credit or index of sources.

Maps in greater detail than the State geologic map. This qualification is a logistical and design consideration. By design, GMI's include only original, detailed maps, not small-scale generalized maps or regional compilations. The State geologic map scale was selected to separate original and detailed maps from generalized maps and regional compilations. Logistically, this qualification eliminates the problem of showing on the GMI maps that cover all or very large parts of States.

Selectivity is a must

I believe that the screening of information collected for inclusion in the GMI's and the GEOINDEX data base is a major responsibility I have to users of this information. Selectivity helps me maintain comparability and minimum quality among the entries. GMI users include professionals and laymen, geologists and nongeologists, American citizens and people from many other nations; by being selective when compiling the GMI's, I save all users the time and effort of deciding what maps would serve their diverse needs and what would be too general, inappropriate, or not useful for other reasons.

Computer search capabilities have led me to reconsider this position. However, although computer searches can be conducted rapidly and on a complex set of conditions, selectivity should be exercised to eliminate redundancy and maintain quality control among the data. Elimination of redundancy has important benefits aside from simplifying the user's selection of a map. It eliminates excessive clutter from the GMI's, which improves legibility and facilitates GMI production. It directs the user to the original work, which most commonly has the best explanation of the geologic data. Elimination of redundant maps also saves on computer processing, storage, and search costs.

In my opinion the kind of selectivity I have described is a responsibility that we information specialists have to our clients. They count on us for accurate, useful information, and by being selective about the information we communicate, we serve them better.

COMPUTER CLASSIFICATION OF DEEP SEA SEDIMENTS

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Abstract: In order to prepare any meaningful synthesis or compilation concerning sediment data, it is imperative that the data be collected systematically and uniformly. This problem of maintaining standards was particularly critical to the Deep Sea Drilling Project due to the diversity of scientists involved in sediment descriptions.

In 1974 (when the sediment collection was considerably smaller than it is now) we began devising a scheme which would examine the data collected and, utilizing a computer "screening" method, would re-name a sediment using specified criteria.

The system, with modifications, is still operative, and is not only important as a sediment classification tool which has now resulted in a comprehensive sediment log of the Pacific Deep Sea Drilling sites, but whose basic data serves as a retrieval source for specific data elements.

Introduction

Of all the data collected by the Deep Sea Drilling Project, the data concerning sediment description is the most subjective.

Basically, the information consists of descriptions of cores and sediment smear slides. It also includes information concerning both macro and microscopic aspects of a core. The reason for creating a database for this information is so it can be used for data searches as well as preparation of syntheses on both a regional and global scale.

Any synthesis effort requires that data be gathered systematically using a uniform system of nomenclature. Many scientists with diverse backgrounds have participated in the cruises of the M/V Glomar Challenger. Despite efforts to encourage them to adhere to uniform standards, there has resulted a considerable variability in lithologic nomenclature. This problem of uniformity is particularly true of narrative, nonquantitative data which are not collected or calibrated by machine but rely on a trained observer to visually describe what he sees. It can now be easily understood why the data vary not only from cruise to cruise but from scientist to scientist on even a single cruise.

Over the years, major improvements have been made in equipment used to collect and process numerical data. However, the visual descriptions, so dependent on human observation, are subject to as much variability on Leg 96 as they were on Leg 1.

The two types of narrative data we are now concerned with are the visual core descriptions and the smear slide descriptions (Fig. 1). As you can see, the data are hand written (often with not much concern about legibility). The visual core descriptions consist of a graphic representation of the core sketched by the observer to show structures (such as layering, burrows, or mottles), unusual occurrences (such as macrofossils, nodules, and unusual mineral concentrations) and any other noteworthy features observed in a split section of core. The area to the right of the graphic representation is reserved for a written description of the core. This should include, among other information, the rock name, color, and degree of hardness. A suite of components is described on the smear slide form as a result of microscopic examination of the sediment smear slide. The components and their abundances are matched with a classification system and a name is given to the material. The amount of subjectivity is enormous. We must assume that a scientist is consistent in mineral identification and quantitative determinations. However, the classification system used to determine a lithologic name may vary considerably. A multitude of classifications exist, and their variation is based on differences in philosophy of their creators. Although an official DSDP sediment classification scheme exists (Fig. 2, van Andel et al), we have had little success in maintaining it as a standard on board ship. Consequently the compatibility of this data can be assured to the component/abundance stage and no further. Thus our aim in creating a sediment database is primarily to make our lithologic data compatible from cruise to cruise.

One approach to this problem would be to have a single observer redescribe all of these cores and their associated amount of material involved.

A second, more feasible approach is to utilize the existing body of observational data and, by using computer processing techniques, reclassify the sediments using some chosen classification scheme.

Encoding Data for JOIDESSCREEN

The format used to encode visual core descriptions and smear slides is rather simple. The label is fixed field data and agrees in format with all other DSDP data. It occupies the first 26 positions of the record and contains information about site, hole, core, section, and the interval described. Following this are the initials of the describer and a record sequence number. Following this is an open field where each specified characteristic being discussed is grouped into sections and labeled with a letter designator. In the case of visual core descriptions, there are ten sections: lithology, color, structures, deformation, unusual occurrences, minerals, paleontology, hardness, and remarks. For smear slides there are three categories: mineralogy, paleontology, remarks. A new set of records is created for each new lithologic layer as well as the beginning of each new section of core.

The terms used to describe the cores were selected from GEOREF glossary. We originally included all observations mentioned by the describer and although the database was thorough it was almost unmanageable.

Sediment Classification Scheme

Sediments are divided into pelagic and non-pelagic groups and those which are transitional between the two groups. The biogenous and transitional sediments are classified on the basis of the principal fossil groups present and the terrigenous and volcanogenic sediments on the basis of texture. The classification philosophy we have used is illustrated in Figure 3. Sediments are initially separated into those that are dominantly biogenous in composition and those that are not. Biogenous sediments are defined as those in which either the siliceous or calcareous fossil content exceeds 30% or in which the total biogenous components exceed 50%. Biogenous sediments in which the total biogenous component exceeds 70% are considered pure biogenous sediments; those with less than 70% are considered transitional biogenous sediments. The dividing points at 30 and 70% are selected as being readily recognized by comparatively unskilled observers. They also reflect the fact that deep sea sediments appear to be either strongly biogenous in composition or almost devoid of a fossil component. The classification divides the biogenous sediments into those which are primarily calcareous and those which are siliceous. Both pure and transitional biogenous sediments are then further subdivided into monogenous and heterogenous groups and finally classified on the basis of major biogenous component. Monogenous calcareous sediments contain more than 60% carbonate; monogenous siliceous sediments more than 50% siliceous fossils. Dolomites (greater than 70% dolomite) and shallow water carbonates (greater than 30% shallow water indicators) are separated as special groups.

The non-biogenous sediments are divided, on the basis of the presence or absence of more than 10% slow sediment indicators, into pelagic and non-pelagic groups. Slow sediment indicators include authigenic components (zeolites, iron manganese micronodules, etc.), fish debris and other indicators of very slow sediment accumulation. Evaporites and volcanogenic sediments (greater than 80% volcanogenic material) are recognized as special groups of non-biogenous sediments. Terrigenous and volcanogenic sediments are classified on the basis of texture using the scheme proposed by Wentworth (1922). Finally, in all sediment groups, by taking account of induration, soft sediments and their lithified equivalents are distinguished.

JOIDESSCREEN

JOIDESSCREEN essentially takes the sediment description I've just discussed and converts it to a computerized classification program.

The classification process comprises the following steps:

1. Gather composition and induration data from the resource files.
2. Converts abundances to screen classes.
3. If more than one sample is taken from the interval, check for inconsistencies and, if present, choose the most representative sample.
4. Evaluate the data according to the classification scheme and assign component qualifiers if warranted.

Each of the steps is an independent program module with a minimum of interdependence on other modules, making it easy to change any one step without affecting other portions of the program.

Assembly of essential data. All resource files are sorted to guarantee that they are in order by DSDP site number and, within each site, by subbottom depth, enabling us to process them as coordinated files and expeditiously retrieve the data for all samples taken from the layer under construction.

When there is no lab measurement of carbonate or grain size, as is often the case, the visual estimates from the smear slide observations are automatically substituted. The smear slide file supplies the majority of the key data items used in the classification process: the sums of the abundances of siliceous fossil material, calcareous fossil materials, slow sediment indicators, shallow water indicators, volcanic material, evaporites, and dolomite. Since it is quite possible that more than one smear slide sample may be taken from a sediment layer, intersample consistency checks are made. It is also possible that, in the case of complex layers, some of the samples might have been taken from minor lithologies which are not truly representative of the major unit we are trying to name. If this situation cannot be resolved by the program, it is assumed an error condition exists.

Each of the key smear slide summary totals and the laboratory grain size and carbonate data records are checked to see if the screen classes which have been assigned disagree. If this is the case, a major error flag is set indicating conflicting data which would have caused a disagreement as to the path choice at some node in the naming logic. If no major disagreements are found, the data are further checked to see if the actual percentage abundances disagree by more than 10%. If so, a warning message is issued. These warnings do not stop the classification process. When major errors occur the process proceeds until a decision node which references the data item which caused the error message is encountered. When a major error is encountered, or when the availabile data are inadequate, classification of the layer is terminated and a "data snapshot" showing the total data environment at the time of classification attempts were complete.

Only components that occur in quantities greater than 10% are appended to the basic lithology. A maximum of three qualifiers per lithology is allowed.

JOIDESSCREEN results. Table 1 compares some original sediment names with the final JOIDESSCREEN name given after machine classification. The consistency introduced by the JOIDESSCREEN program is evident. The reduction in the number of lithologic names required is striking.

The worst problem we have in trying to classify a layer is inadequate data, either as a result of a lack of smear slides for the layer because the information was incorrectly recorded by the observer (cases where the total components were less than 80% or greater than 120%). Some of our sediment layers are artificial in that the largest length a layer can be is defined as one section of core (approximately 150 cm). This was part of the original plan to ensure that each section of description was accounted for. It is possible to classify these artificial layers in two ways. One is to allow the JOIDESSCREEN program to infer a lithology by comparing the name of a layer above an unclassified layer with one below. If the names match, it is given to the unclassified layer which lies between them. The second method requires that a stratigrapher compare the information from core summaries prepared from the shipboard data and, in the case of homogenous layer, insert screen labels manually. Both these methods have been used with great success. In only about 5% of our attempts at automated classification are we still hampered by inaccurate recording of original data by the shipboard observer.

Uses

The basic data encoded for use in the screen program has, in itself, become an invaluable data base. These data are used for both simple and complex searches for particular minerals and suites of components.

Our other important achievement is the preparation of automatically produced stratigraphic sections (Fig. 4). These compare age of a layer, sediment type and graphically show trends in carbonate and siliceous component content as well as bulk density.

It has been proposed to use the screen results and the raw data to produce regional maps as parts of global syntheses.

Conclusion

The system of automated sediment classification described here has been designed to increase availability and usefulness of the DSDP data to interested researchers. I hope this goal will be achieved. I must stress that the purpose of this paper is not to advocate any particular classification scheme, but rather to illustrate that useful information can be obtained from an existing body of highly variable Deep Sea Drilling observational data. The choice of sediment classification scheme in this case is dictated largely by circumstances. The screen system is a flexible one and changes can be readily incorporated at any level subject only to the limitations posed by the data given.

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TABLE 1.—*Examples of operation of SCREEN*

Observed Composition (%)	Observer's Name	SCREEN Name
Nannofossils 90, Forams 10	Foram nanno chalk ooze	Nannofossil chalk
Clay mins. 6, Glass 2, Nannofossils 88, Forams 3, Rads 1, Sponge Spicules 1	Clay bearing nanno ooze	Nannofossil chalk
Nannofossils 84, Forams 10, Rads 3, Sponge Spicules 3	Nanno ooze	Nannofossil chalk
Glass 2, Nannofossils 90, Forams 5, Rads 1, Sponge Spicules 1	Glass shard and foram bearing nanno ooze	Nannofossil ooze
Glass 4, Nannofossils 70, Forams 24, Rads 1, Sponge Spicules 1	Glass shard and foram bearing nanno ooze	Foram rich nannofossil ooze
Quartz 10, Feldspar 5, Amphibole 2, Nannofossils 2, Forams 10, Sponge Spicules 1, Indet. carbonate 68	Glauconite bearing siltstone or fine-grained sandstone	Indurated carbonate chalk

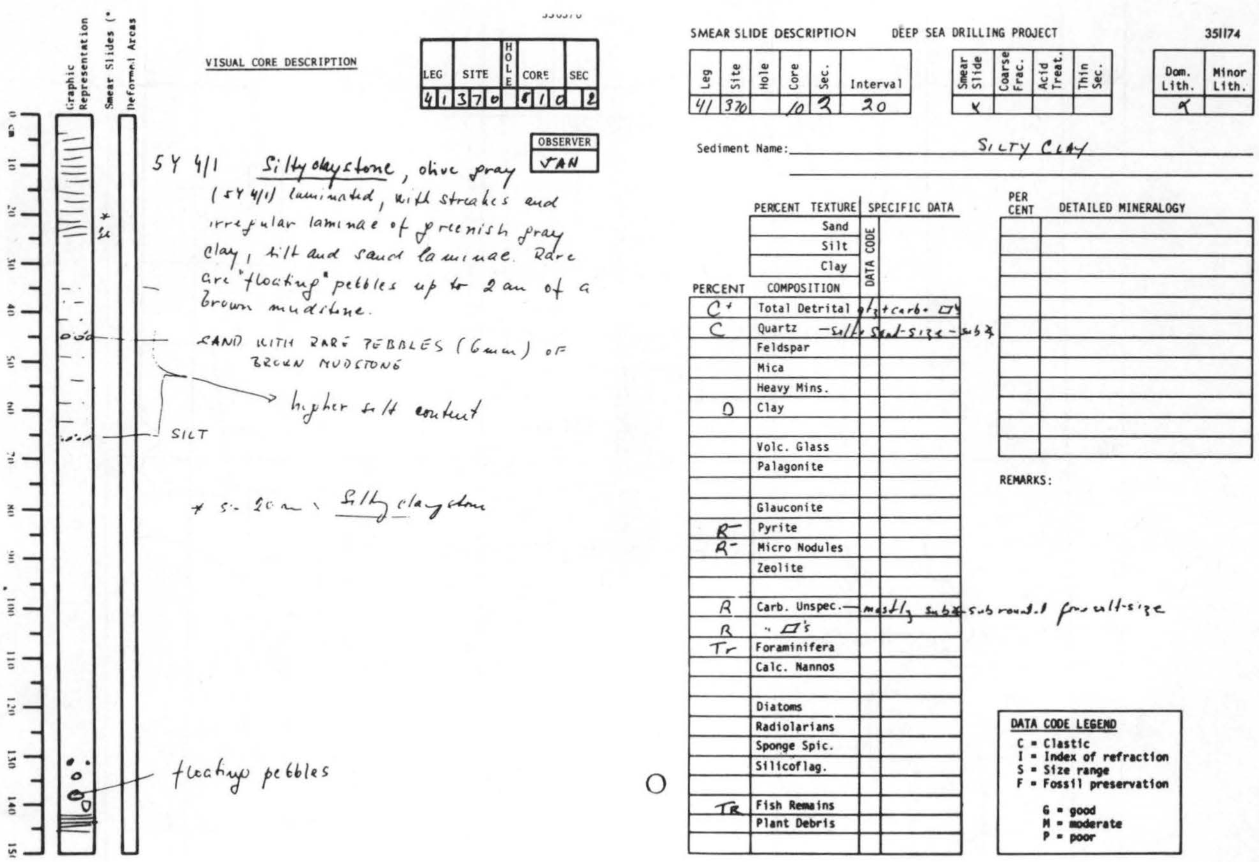

Fig. 1 Examples of shipboard visual core description and smear slide forms.

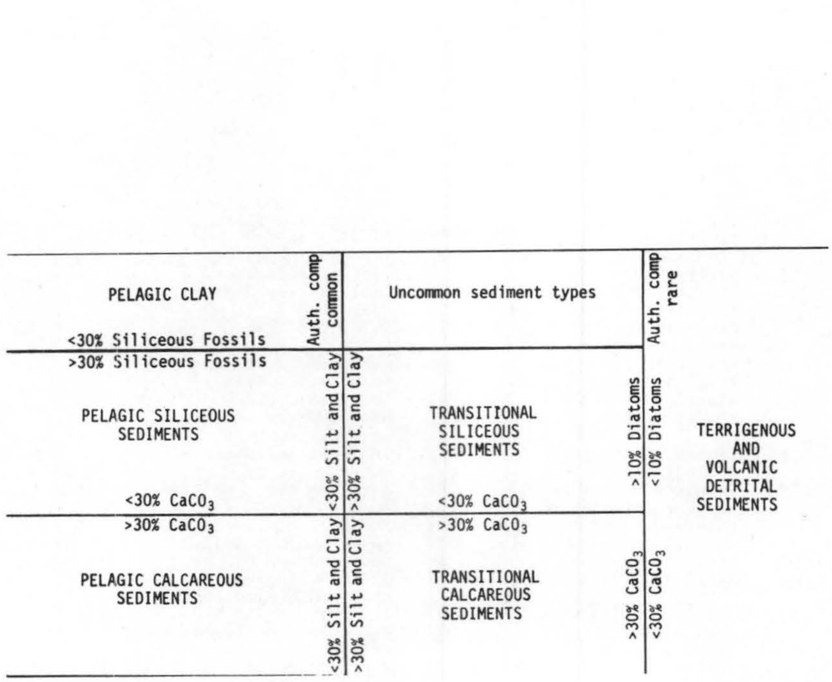

Fig. 2 Sediment classification scheme (van Andel et al, 1973)

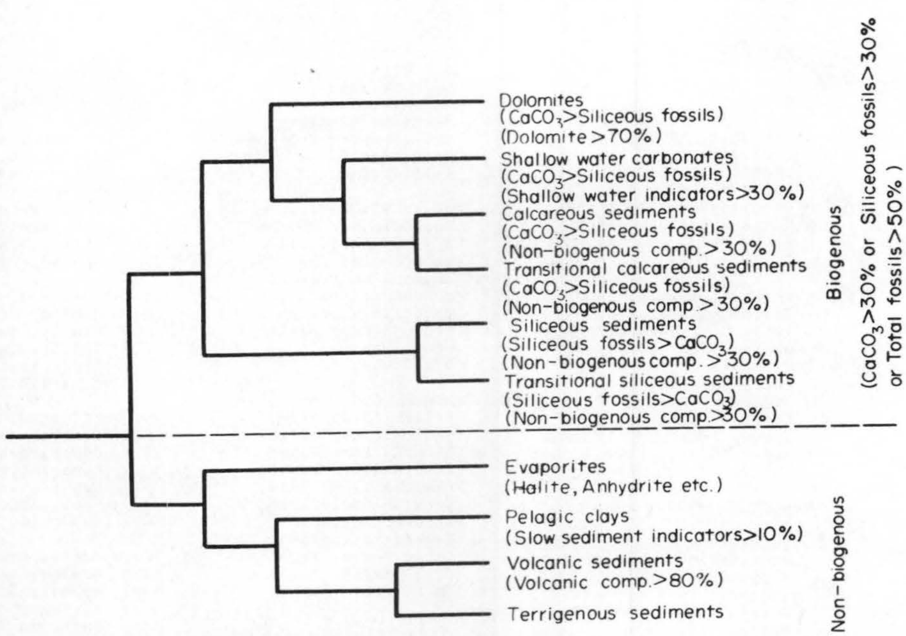

Fig. 3 JOIDESSCREEN classification methodology

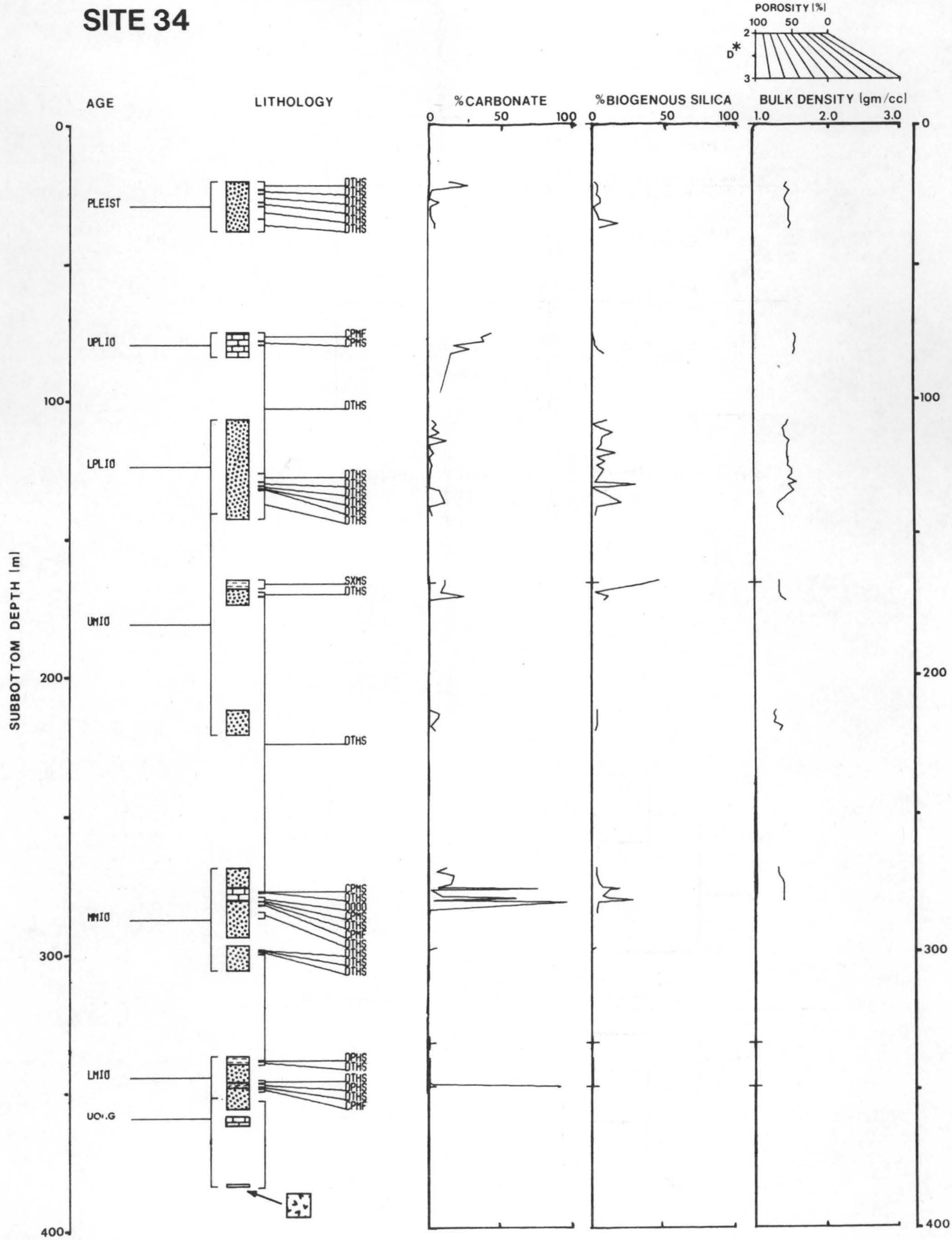

Fig. 4 Computer-generated stratigraphic sections

THE CONTINENTAL SCIENTIFIC DRILLING PROGRAM DATA BASE - 1983*

by

Gayle A. Pawloski and Nancy W. Howard

ABSTRACT

The Continental Scientific Drilling Program data base is a central repository cataloguing information on over 2000 government funded and scientifically interesting drill holes in the United States. Utilization of the data base can help reduce drilling costs and help maximize scientific value of drilling efforts by government agencies and industry.

Continental Scientific Drilling Program (CSDP) was established in 1979 by the National Academy of Sciences as part of an effort to maximize continental drilling investments (National Academy of Sciences, 1979). Our current economy requires that, now more than ever, scientific projects maximize funds invested. CSDP data base is maintained at Lawrence Livermore National Laboratory as part of the CSDP data management program (Howard, 1979). It is important that scientific data retain its value by being efficiently stored and then available for future distribution as required. CSDP data base, funded by the Office of Basic Energy Sciences of the Department of Energy, is a well managed data base that acts as a central repository, cataloguing information on United States drill holes. The data base currently consists of approximately 2000 holes funded by government agencies (at federal and/or state levels) and also scientifically interesting commercially funded drill holes. "Scientifically interesting" holes are those which are drilled in an area that has little or no previous information, holes reaching geologic basement, record setting holes, and other selected holes. Through the unrestricted use of this data base, it is possible to reduce drilling costs and maximize the scientific value of current and planned efforts of government agencies and industry by (1) offering the opportunity to add-on experiments in proposed or currently drilling drill holes, (2) offering opportunities to run tests in existing drill holes, and (3) supplementing information from existing drill holes included in the data base. An example of an add-on experiment is a proposal by University of California, Riverside, scientists to deepen, run tests and gather core and data from a 3.7 km geothermal well to be drilled in the Salton Sea beginning in late 1983 by Republic Geothermal, Inc. (EOS, 1983). An electromagnetic propagation experiment was carried out by Lawrence Livermore National Laboratory scientists in the Mono Craters-Long Valley Caldera area. Testing was done in commercially funded drill holes found through a search of CSDP data base. We have handled several hundred requests for information on existing drill holes catalogued in CSDP data base. These requests come from researchers in government, industry, and academia, and also from private citizens who have read articles describing the data base.

There are various sources of information for CSDP data base. We obtain information from agencies, reports, newsletters, other data bases, state geologists and members of academia. Any person with information about a drill hole that meets CSDP data base requirements is encouraged to contact us in order that the hole may be included in the data base.

* Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.

There are twenty-four parameters for each drill hole. The information is stored in a relational format using FRAMIS (Jones, et al., 1981). The parameters are:

IDN: Number assigned to the hole by us for record keeping purposes.

Hole Designation: Hole name.

Holes in Group: Other similar nearby holes in a project, entered as a group of drill holes (entered once as a group rather than each hole entered individually).

Purpose: Reason(s) for which the hole was drilled; there are 23 categories:

- C Coal
- CG Coal gasification
- EG Engineering geology
- EQ Earthquake studies
- G Gas
- GE Geologic exploration
- GP Geopressure
- GT Geothermal
- HDR Hot dry rock
- HF Heat flow
- HW Hot water
- MER Methane removal
- MR Mineral resources
- NPR Naval petroleum reserves
- NT Nuclear testing
- NWR Nuclear waste repository
- OG Oil and gas
- OR Oil recovery
- OS Oil shale
- PS Petroleum storage
- RM Radionuclide migration
- U Uranium
- WR Water resources

Site Location: County and state.

Site Coordinates: Latitude-longitude location is necessary for plotting. Township-Range locations are also entered when given.

Surface Elevation: Feet above sea level

Depth: Depth of the hole. If the hole is proposed, the planned depth should be entered.

Start Date: Start date of drilling. If the hole has not been started yet, this should be the proposed start date.

Completion Date: Completion date of drilling.

Status: Current condition of the hole: proposed, injection, observation, plugged, etc.

Geologic Setting: Lithologic description of formations penetrated by the drill hole.

Drilling Stages: Diameters and corresponding depths of the hole.

Casing Stages: Diameters and corresponding depths of casing in the hole.

Samples: Samples taken from the drill hole (note core, sidewall, or cuttings) and corresponding depths.

Geophysical Logs: List of geophysical logs run in the drill hole.

Well Testing: Any tests that have been performed in the hole.

Funding Agency: Any government and/or private agency that paid for drilling the hole. If there is more than one funding agency, list all.

Additional Information: Any necessary or pertinent information for the hole not included in other parameters; examples: project name, publication reference number, KGRA location, specific or multi-purpose of hole.

Total Cost: Total cost of the hole. If the entry is for a group of holes, this value indicates total cost of all holes in the group.

Principal Investigator: Person responsible for the hole. This is the person who may be contacted for further information.

Submitter: Person who submitted, and generally the one who has checked, the information listed for each hole. This person is not necessarily the principal investigator.

Date: Date the information for a hole was first entered into the CSDP data base.

Update: As new information becomes available for a hole, it is entered and the update is shown in addition to the original entry date.

The data base is constantly updated. New holes are added as soon as we receive information on them.

Any of the above parameters can be sorted on and ordered. For example, holes in oil shale, sorted by county and state; holes with temperature logs, sorted by depth; holes in California, drilled between 1970 and 1980, sorted by county; a large number of combinations are possible. Data output is text and graphics. There are two text formats: full-page printouts or tabular listings. Full-page printouts show all information included in the data base about one drill hole (Figure 1). Tabular listings show selected parameters for any number of holes (Figure 2). Graphic output plots drill hole locations on county (counties) (Figure 3), state(s) (Figure 4), United States (Figure 5), or an area bounded by specific latitude-longitude (Figure 6). These plots are generated by the interactive code TALKPLOT (Richardson, 1983) written specifically to plot drill hole locations from CSDP data base.

The data base has been enhanced by adding references to other geologic data bases (Appendix). The references include data base name, type of data stored in the data base, and person to contact for information. Some of these references originally appeared in the AAPG Explorer (Iglehart, 1981).

For output or information about the data base, please call or write:

Gayle Pawloski, L-222
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550

(415) 423-0437
FTS 543-0437

The services of CSDP data base are available to all, and free of charge.

CSDP data base is a well managed data base cataloguing information on government funded and scientifically interesting drill holes in the United States. The data is efficiently stored and available to all persons free of charge. Researchers can gain useful information by utilizing the data base. We are eager to help obtain information which is pertinent to their interests. "Science is the program; the drill is the tool for that program...(there is) the need to maximize the effectiveness of research efforts based on an expensive tool" (National Academy of Sciences, 1979). Continental Scientific Drilling Program data base is attempting to do just that.

REFERENCES

EOS Transactions, American Geophysical Union, Vol. 64, No. 34, August 23, 1983.

Iglehart, C. F., December, 1981 and January, 1982, Computer Applications Committee Cites Sources, in AAPG Explorer, American Association of Petroleum Geologists, Tulsa, OK

Howard, N. W., 1979, Continental Drilling for Scientific Purposes Data Management Program, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-82819.

National Academy of Sciences, 1979, Continental Scientific Drilling Program, Washington, D. C.

Jones, S. E., Ries, D. R., Lyles, L., Dittli, A. L., and Johnson, K. W., 1981, FRAMIS Reference Manual, Lawrence Livermore National Laboratory, Livermore, CA, LCSD-554.

Pawloski, G. A., Howard, N., Hage, G., Higuera, M. L., and Richardson, W., 1982, The Continental Scientific Drilling Program Data Base, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-53284.

Richardson, W. W., 1983, TALKPLOT: An Interactive Code for Plotting Locations of Drill Holes from Continental Scientific Drilling Program Data Base; Lawrence Livermore National Laboratory, Livermore, CA, UCRL-53408.

HOLE DESIGNATION UE20E1

SURFACE ELEVATION 6297 FEET

SITE COORDINATES
37 DEG 19 MIN 01 SEC
116 DEG 27 MIN 25 SEC

START DATE (YR-MO-DA) 64-01-26
COMPLETION DATE 64-03-24

LOGGING (DEPTHS IN FEET)
3D, DENSITY, ELECTRIC, INDUCTION, GAMMA, NEUTRON, TEMPERATURE

DRILLING STAGES
26. 0-50; 17.5 50-701

SAMPLES (DEPTHS IN FEET)
CONVENTIONAL CORE TAKEN 701-TD

FUNDING AGENCY(S)
DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE

PRINCIPAL INVESTIGATOR
NANCY W. HOWARD L-222
GROUP LEADER
GEOLOGY/GEOPHYSICS DATA MANAGEMENT
LAWRENCE LIVERMORE NATIONAL LABORATORY
P. O. BOX 808
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P. O. BOX 808
LIVERMORE, CA 94550
(415) 423-0437
(FTS) 469-0437

ADDITIONAL INFORMATION
NEVADA TEST SITE

SITE NYE CO., NV

DEPTH 2165 FEET

PURPOSE NUCLEAR TESTING
STATUS PLUGGED

GEOLOGIC SETTING
THIRSTY CANYON 0-344; AMMONIA TANKS 344-581; RAINIER MESA 581-1395; TUFFS AND RHYOLITES OF AREA 20 1395-TD

CASING STAGES
20. 0-50; 13.38 0-694

DATE ADDED 83-07-12
UPDATED 83-08-04

RECORD 2360

FIGURE 1. Full page printout showing all information in CSDP data base about one drill hole.

CONTINENTAL SCIENTIFIC DRILLING PROGRAM - SELECTED PARAMETERS

COUNTY	STZ	HOLE DESIGNATION	PURPOSE	DEPTH	HOLES GROUP	RECORD
	CA	FEDERAL-DOE-SPERRY 87-6	GEOTHERMAL	6290	0	1
INYO	CA	CGEH-1	GEOTHERMAL	4845	0	28
IMPERIAL	CA	EMANUELLI 1	GEOTHERMAL	12831	0	60
IMPERIAL	CA	BORCHARD A-2	GEOTHERMAL	11092	0	100
IMPERIAL	CA	BORCHARD A-1	GEOTHERMAL	13404	0	101
LAKE	CA	NORTHEAST GEYSERS UNIT 5	GEOTHERMAL	12000	0	105
LAKE	CA	NORTHEAST GEYSERS UNIT 3	GEOTHERMAL	12000	0	106
LAKE	CA	NORTHEAST GEYSERS UNIT 4	GEOTHERMAL	12000	0	107
KERN	CA	NPR1, CARENEROS WELL	NAVAL PETROLEUM RESERVES	14000	0	108
KERN	CA	NPR1, SHALLOW STEVENS ZONE	NAVAL PETROLEUM RESERVES	8500	67	109
KERN	CA	NPR1, DEEP STEVENS ZONE	NAVAL PETROLEUM RESERVES	10000	24	110
KERN	CA	NPR1, SHALLOW OIL	NAVAL PETROLEUM RESERVES	3000	65	111
KERN	CA	NPR1, DRY GAS	NAVAL PETROLEUM RESERVES	2000	6	112
LAKE	CA	ROBBINS 1	GEOTHERMAL	11995	0	117
LAKE	CA	ROBBINS 2	GEOTHERMAL	11995	0	128
LAKE	CA	ROBBINS 3	GEOTHERMAL	11995	0	129
LAKE	CA	ROBBINS 4	GEOTHERMAL	11995	0	130
LAKE	CA	ROBBINS 5	GEOTHERMAL	11995	0	131
LAKE	CA	ROBBINS 6	GEOTHERMAL	11995	0	132
SONOMA	CA	AIDLIN 1	GEOTHERMAL	8629	0	133
SONOMA	CA	SULPHUR BANK 3	GEOTHERMAL	5507	0	250
LAKE	CA	WILSON 1	GEOTHERMAL	10001	0	251
LAKE	CA	WILSON 2	GEOTHERMAL	10001	0	252
LAKE	CA	AUDREY 1 A	GEOTHERMAL	10042	0	272
SAN BENITO	CA	CV-1	EARTHQUAKE STUDIES	2000	0	285
SONOMA	CA	DX STATE 4596 42	GEOTHERMAL	10000	0	288
SONOMA	CA	L.F. STATE 4597 28	GEOTHERMAL	10000	0	289
SONOMA	CA	L.F. STATE 4597 29	GEOTHERMAL	10000	0	291
SONOMA	CA	PRATI STATE 1	GEOTHERMAL	8199	0	292
HUMBOLDT	CA	GBL	HEAT FLOW	540	0	294
IMPERIAL	CA	KERSHAW 1-3	GEOTHERMAL	12000	0	295
IMPERIAL	CA	S.H. ELMORE 1	GEOTHERMAL	12000	0	296
KERN	CA	CIN	HEAT FLOW	568	7	297
IMPERIAL	CA	HOLLY SUGAR-DOE 44P	GEOTHERMAL	10000	0	298
IMPERIAL	CA	BORCHARD A-3	GEOTHERMAL	12888	0	299
LAKE	CA	TELLYER 1-24	GEOTHERMAL	12192	0	303
MENDOCINO	CA	NOY	HEAT FLOW	652	0	308
SONOMA	CA	SEA	HEAT FLOW	694	0	317
SAN BERNARDINO	CA	DMD	HEAT FLOW	335	0	330
RIVERSIDE	CA	CXS	HEAT FLOW	225	0	331
SAN BERNARDINO	CA	BOR	HEAT FLOW	335	0	332
KERN	CA	CQU	HEAT FLOW	422	0	333
SAN BERNARDINO	CA	FIC	HEAT FLOW	305	0	334
KERN	CA	TEH	HEAT FLOW	335	0	335
PLUMAS	CA	LSNH	HEAT FLOW	610	0	336
PLUMAS	CA	LSNL	HEAT FLOW	310	0	337
PLUMAS	CA	LSNG	HEAT FLOW	565	0	338
SAN BENITO	CA	LKA	HEAT FLOW	720	0	339
SAN BENITO	CA	LKB	HEAT FLOW	685	0	340
SAN BENITO	CA	LKC	HEAT FLOW	696	0	341
MONTEREY	CA	LKD	HEAT FLOW	717	0	342
MONO	CA	COS	HEAT FLOW	505	0	343
MONO	CA	GAS	HEAT FLOW	365	0	344
MONO	CA	GTM	HEAT FLOW	505	0	345
MONO	CA	IND	HEAT FLOW	505	0	346

FIGURE 2. Tabular listing output of some drill holes in California included in CSDP data base. Listing shows county, state abbreviation, hole designation, purpose, depth, holes in group, and record number. Listing is sorted by record number.

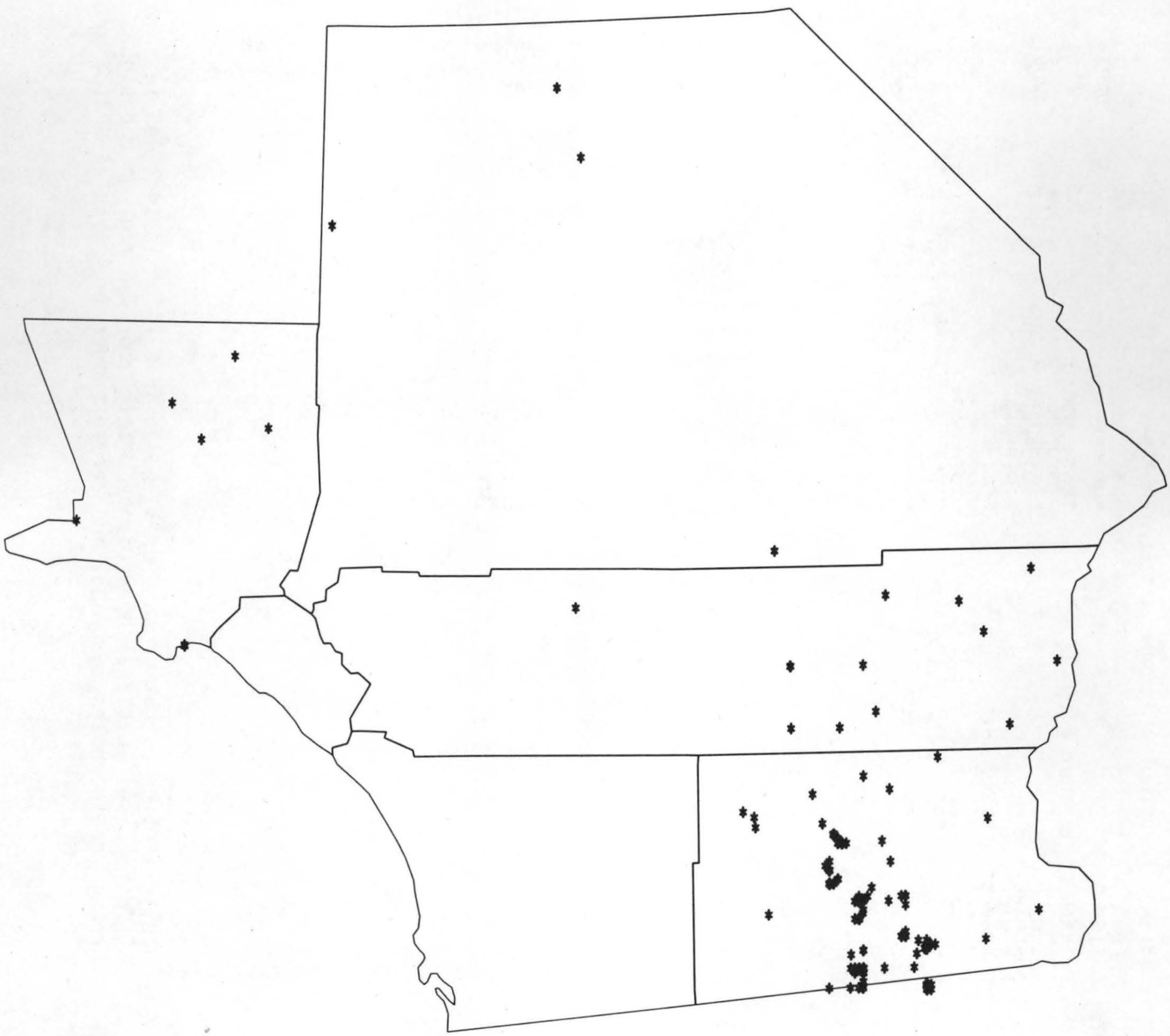

FIGURE 3. Plot of drill holes from CSDP data base located in Los Angeles, San Bernardino, Orange, Riverside, San Diego, and Imperial counties, California.

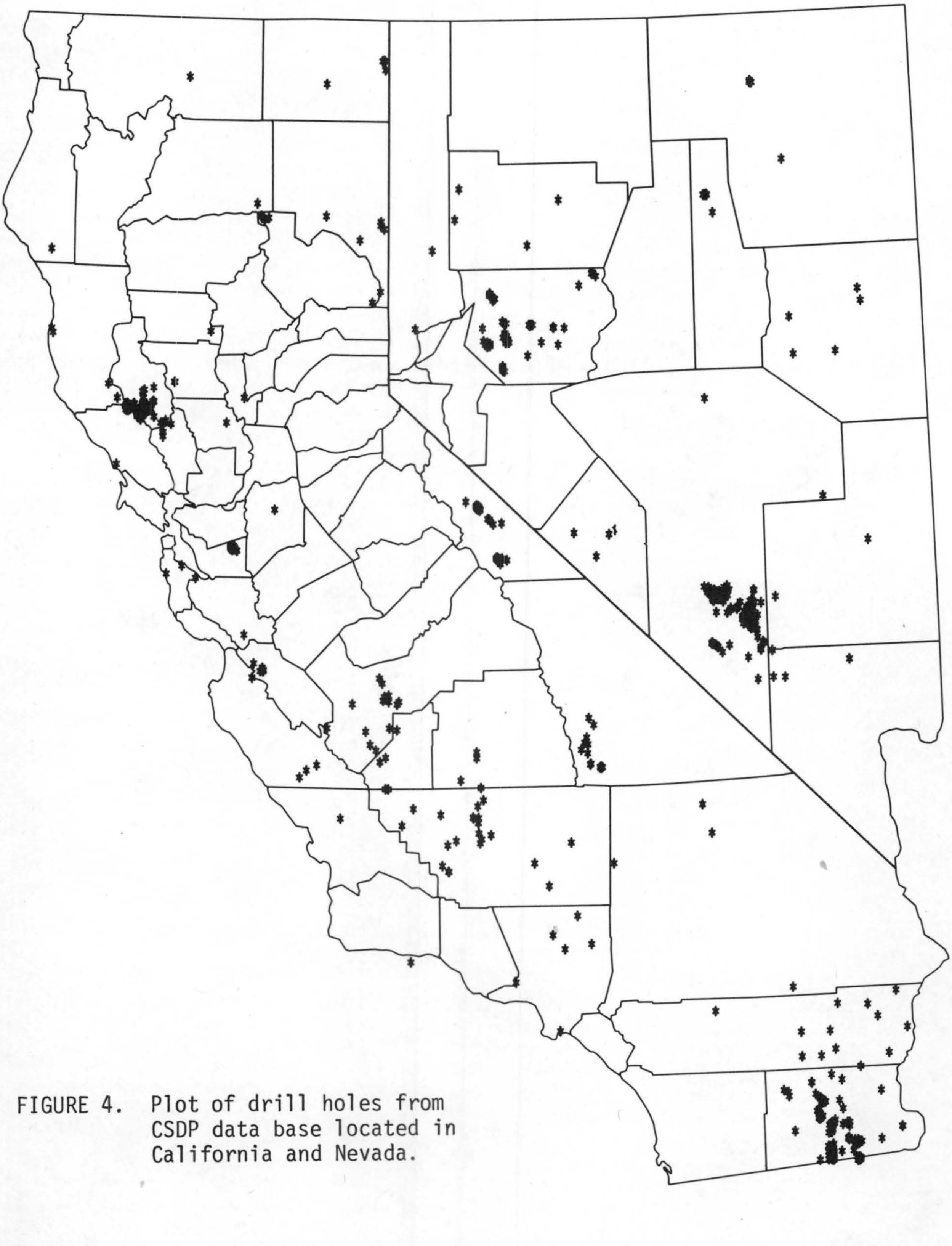

FIGURE 4. Plot of drill holes from CSDP data base located in California and Nevada.

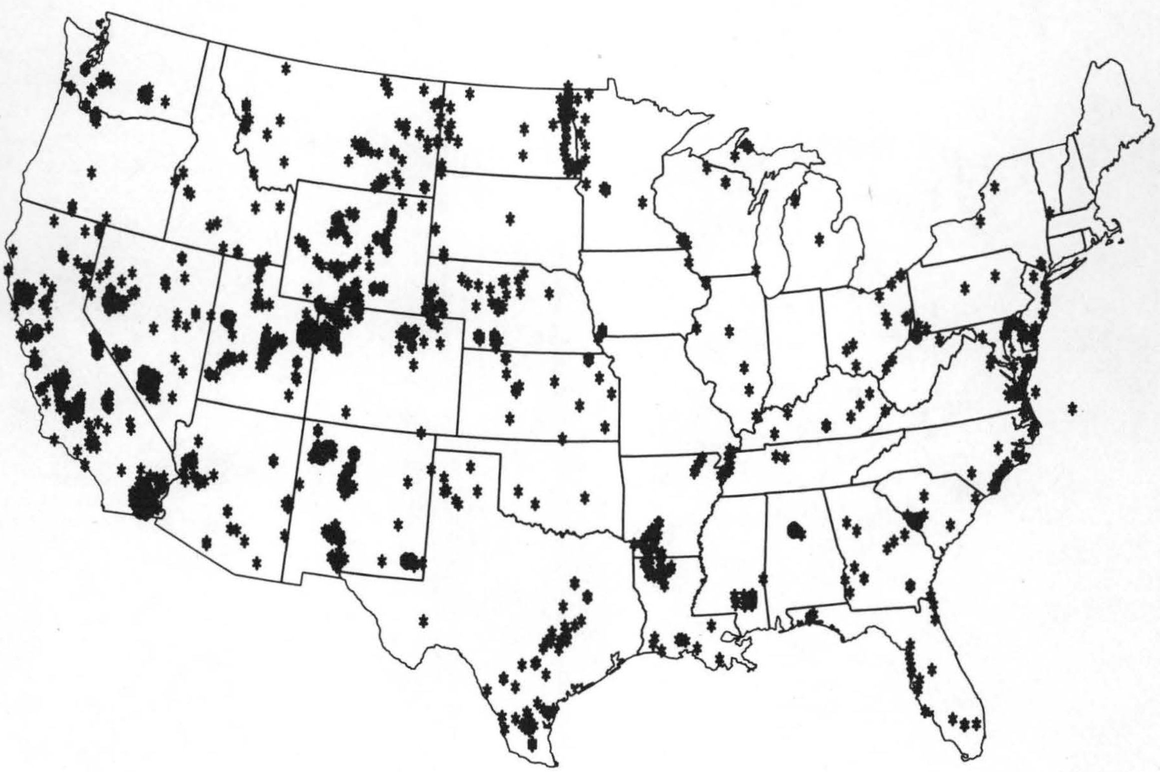

FIGURE 5. Plot of drill holes from CSDP data base on a United States base map.

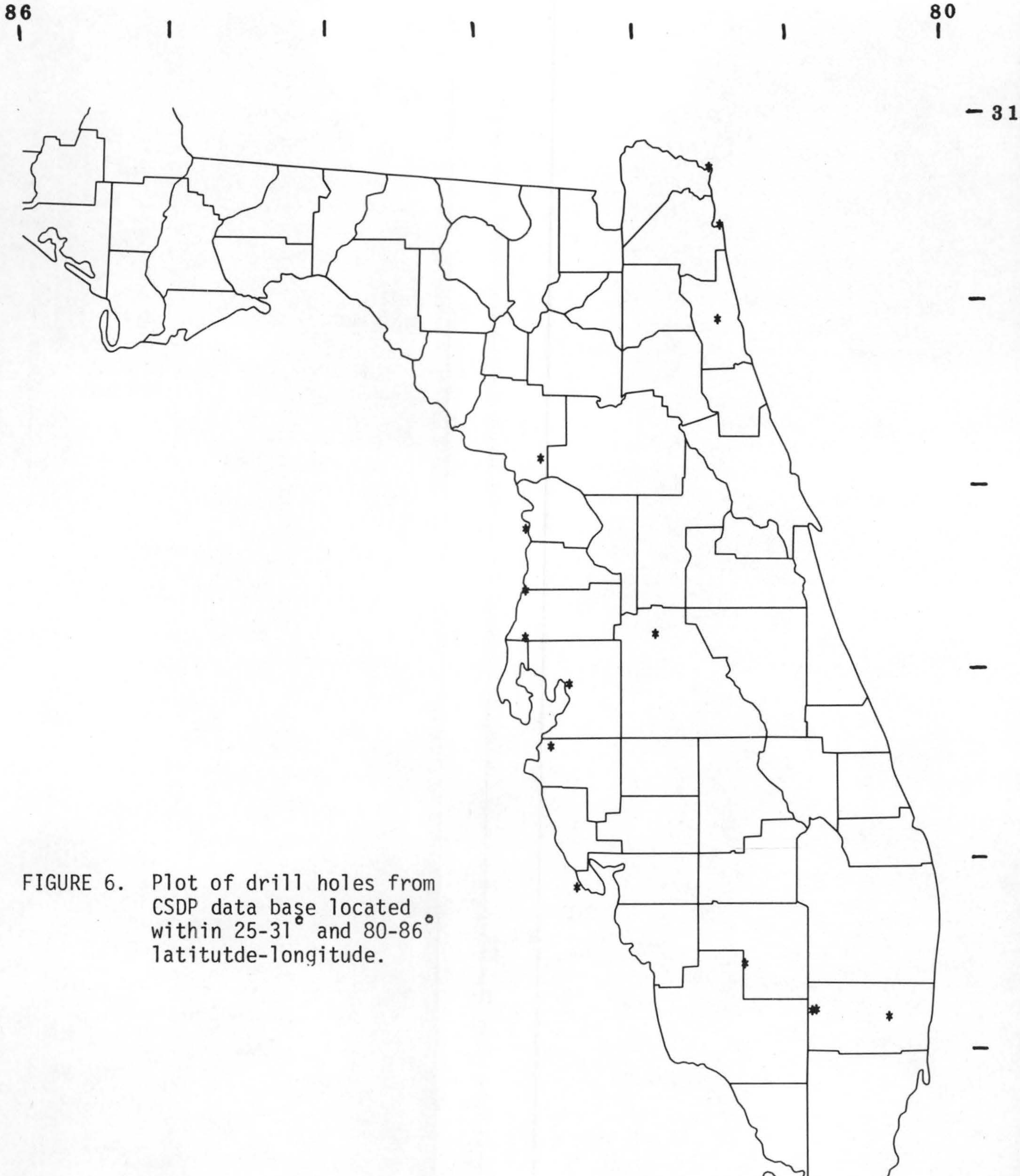

FIGURE 6. Plot of drill holes from CSDP data base located within 25-31° and 80-86° latitutde-longitude.

APPENDIX

REFERENCES TO OTHER GEOLOGIC DATA BASES

SYSTEM	TYPE OF DATA
PETROLEUM INFORMATION CORP. CONTACT: PAUL A. SLATTERY 4100 E. DRY CREEK ROAD LITTLETON, CO 80122 P. O. BOX 2612 DENVER, CO 80201 (303) 740-7100	WELL DATA, SCOUT DATA, AND DRILLING HISTORY OF HISTORIC AND CURRENT WELLS (1200000 WELLS)
PERMIAN BASIN WELL DATA SYSTEM CONTACT: DICK TEAL AMOCO PRODUCTION COMPANY P. O. BOX 3092 HOUSTON, TX 77001 (713) 652-4265	WELL DATA SYSTEM OF HISTORIC WELLS (1900-1964) IN THE PERMIAN AND DELAWARE BASINS OF WEST TEXAS AND NEW MEXICO, INCLUDES DRILLING HISTORIES, GEOLOGIC TOPS (165000 WELLS)
TOBIN RESEARCH, INC. CONTACT: C. R. BROWN, PRESIDENT P. O. BOX 2101 SAN ANTONIO, TX 28297 (512) 223-6203	WELL DATA (1900 TO PRESENT) IN TEXAS COAST, LOUISIANA COAST, ARKANSAS, MISSISSIPPI, ALABAMA, AND FLORIDA, WELL LOCATION, COMPLETION STATUS (430000 WELLS)
API-AAPG COMMITTTEE ON DRILLING STATISTICS (CSD) ANNUAL WELL TAPES CONTACT: AMERICAN PETROLEUM INSTITUTE 2101 L STREET, NW WASHINGTON, D. C. 22037 MS. REGINA ROSEN (202) 457-7148 AAPG P. O. BOX 979 TULSA, OK 74101 TED BEAUMONT (918) 584-2555	ANNUAL DRILLING DATA 1966-1980
GEOLOGICAL COMPUTING SERVICE (GCS) CONTACT: J. WILLIAM VINEYARD 8204 WESTGLEN HOUSTON, TX 77063 (713) 785-900	DESIGNED PRIMARILY TO SUPPLY PROPRIETARY GEOLOGICAL CORRELATIVE TOPS FOR COMPUTER MAPPING-TEXAS COAST, LOUISIANA, MISSISSIPPI, ALABAMA, AND FLORIDA (31000 WELLS)
GEOMAP/PEPPARD-SOUDER CONTACT: DAVE EGGLESTON 6001 SAVOY HOUSTON, TX 77036 (713) 785-7900 FRED REED 802 THREE PARK CENTRAL 1515 ARAPAHO STREET DENVER, CO 80202 (303) 893-5858	ABBREVIATED WELL HISTORIES WITH PROPRIETARY TOPS IN ROCKY MOUNTAINS, WEST TEXAS, AND TEXAS-LOUISIANA GOLF COAST (43000 WELLS)

References to other Geologic Data Bases

SYSTEM	TYPE OF DATA
HOTLINE ENERGY REPORTS CONTACT: JOHN L. PATE 70 WEST 6TH AVE., SUITE 415 DENVER, CO 80204 (303) 623-7130	WELL DATA FOR WEST COAST AND ROCKY MOUNTAINS, HISTORIC AND CURRENT (ROCKY MOUNTAINS 189000 WELLS, WEST COAST 121000 WELLS)
TENROC CORP CONTACT: DAVID DOMINEY 9015 MAIN NEEDVILLE, TX 77461 P. O. BOX 467 (713) 793-4416 - ROSENBERG (713) 342-8641 - HOUSTON	ABBREVIATED WELL HISTORIES, GEOLOGIC DATA ON TERTIARY ROCKS OF GULF OF MEXICO, PROPRIETARY GEOLOGIC TOPS, SAND COUNTS, SHALE DATA (27000 WELLS)
EXPLORATION GRAPHICS, INC. CONTACT: JAMIE THOMPSON 1700 NORTH BIG SPRINGS P. O. DRAWER 2478 MIDLAND, TX 79701 (915) 683-4771	INFORMATION ON WELLS IN THE PERMIAN AND DELAWARE BASINS OF WEST TEXAS AND NEW MEXICO. PROPRIETARY GEOLOGIC TOPS (24000 WELLS)
OFFSHORE OIL SCOUT ASSOCIATION P. O. BOX 6946 METAIRIE, LA 77009 (504) 454-9843 OR N. W. BAIRD, CONOCO NEW ORLEANS, LA (504) 523-3151	WELL DATA FOR ALL OFFSHORE WELLS IN GULF OF MEXICO AND ATLANTIC COAST. AVAILABLE ONLY TO ACTIVE MEMBERS OF OFFSHORE SCOUT CHECK (25000 WELLS)
GEOMASTERS, INC. CONTACT: GERALD C. GLASER AND ANDREW C. JURASIN NORTHWEST ATRIUM II 7878 GROW LANE, SUITE 22 HOUSTON, TX 77040 (713) 939-1166	MICROPALEO DATA FOR OFFSHORE GULF OF MEXICO (1500 WELLS)
PERMIAN BASIN SAMPLE LABORATORY CONTACT: R. KEN CARPENTER BUSINESS MANAGER 401 N. COLORADO MIDLAND, TX 79701 (915) 683-3363	LITHOLOGY DATA FILES WITH PROPRIETARY TOPS IN THE PERMIAN AND DELAWARE BASINS OF WEST TEXAS AND NEW MEXICO (6500 WELLS)
AMERICAN STRATIGRAPHIC COMPANY (AMSTRAT) CONTACT: DICK ANDERSON VICE PRESIDENT 6280 E. 39TH AVENUE DENVER, CO 80207 (303) 399-2746	LITHOLOGY DATA FILES WITH PREPRIETARY TOPS MAINLY IN WILLISTON BASIN OF MONTANA AND NORTH DAKOTA (4000 WELLS)
NATIONAL COAL RESOURCES DATA SYSTEMS (NCRDS) CONTACT: KATHLEEN KROHN MS-956 U.S. GEOLOGICAL SURVEY NATIONAL CENTER RESTON, VA 22092 (703) 860-7464	TONNAGE, GENERAL QUALITY, STRATIGRAPHIC, GEOCHEMICAL, ANALYTICAL AND PETROGRAPHIC DATA FOR COAL (8 MAJOR DATA BASE FILES)

SYSTEM	TYPE OF DATA
CONTAINMENT PROGRAM NUCLEAR TEST EFFECTS AND GEOLOGICAL DATA BASE CONTACT: NANCY HOWARD L-222 LAWRENCE LIVERMORE NATL. LAB P. O. BOX 808 LIVERMORE, CA 94550 (415) 422-6491	GEOLOGY AND NUCLEAR TESTING DATA FROM NEVADA TEST SITE (4950 WELLS)
GEOPHYSICAL DATA SYSTEM (GEODAS) CONTACT: ALLEN HITTLEMAN NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER EDIS/NOAA D-62 325 BROADWAY BOULDER, CO 80303 (303) 499-1000, EXT 6338	MARINE GEOPHYSICAL DATA
EASTERN-GAS-SHALES-PROJECT (EGSP) DATA SYSTEM CONTACT: TED S. DYMAN, MS-971 U.S. GEOLOGICAL SURVEY P. O. BOX 25046 DENVER, CO 80225 (303) 234-6115	GEOLOGICAL, GEOCHEMICAL, GEOPHYSICAL, AND ENGINEERING DATA FROM DEVONIAN SHALE SAMPLES OF APPALACHIAN BASIN (6000 WELLS)
GEOTHERMAL RESOURCES (GEOTHERM) CONTACT: JAMES BLISS MS-84 U. S. GEOLOGICAL SURVEY 345 MIDDLEFIELD ROAD MENLO PARK, CA 94025	PHYSICAL AND CHEMICAL PROPERITIES OF SAMPLES FROM GEOTHERMAL WELLS (8000 RECORDS)
AUTOMATED BASE MAPS (BASEMAP) CONTACT: JIM EBERHARDT U.S. GEOLOGICAL SURVEY 1340 W. SIXTH ST. ROOM 160 LOS ANGELES, CA 90012 (213) 688-5780	CARTOGRAPHIC DATA BASE AND MAPPING SYSTEM, INCLUDING GEOLOGIC AND GEOPHYSICAL DATA
BOREHOLE AND COMPLETION FILE - GULF OF MEXICO AND OCS (BHCP) CONTACT: JOSEPH J. CHEDOTAL U.S. GEOLOGICAL SURVEY P. O. BOX 7944 METAIRIE, LA 70010 (504) 837-4720	BOREHOLE AND COMPLETION INFORMATION (40000 RECORDS)
GENERALIZED SAMPLE DATA SYSTEM (GSDS) CONTACT: TED S. DYMAN, MS-971 U.S. GEOLOGICAL SURVEY BRANCH OF OIL AND GAS RESOURCES P. O. BOX 25046 DENVER, CO 80225 (303) 234-6115	CENTRAL LIST OF FEDERAL, STATE, CANADIAN, AND INDUSTRIAL REPOSITORIES THAT HOLD WELL SAMPLES, CORES, LOGS, AND OTHER DATA FOR WELLS DRILLED FOR OIL, GAS, MINING WATER, CONSTRUCTION, WASTE DISPOSAL (5000 SAMPLES)

SYSTEM	TYPE OF DATA
CORE LIBRARY DATA FILE (CLDF) CONTACT: CHARLES W. SPENCER, MS-940 U.S. GEOLOGICAL SURVEY BRANCH OF OIL AND GAS RESOURCES P. O. BOX 25046 DENVER, CO 80225 (303) 234-4750	LOCATION, IDENTIFICATION OF CORES, STRATIGRAPHY OF DRILL CORE IN USGS CORE LIBRARY (1250 CORES)
PERMIAN BASIN WELL AND RESERVE FILE (PBW/RF) CONTACT: LAWRENCE J. DREW, MS-920 U.S. GEOLOGICAL SURVEY OFFICE OF RESOURCE ANALYSIS RESTON, VA 22092 (803) 860-6446	49 VARIABLES FOR EACH DRILL HOLE (208000 WELLS)
MASTER WATER DATA INDEX (MWDI) CONTACT: OWEN O. WILLIAMS, MS-421 U.S. GEOLOGICAL SURVEY WATER RESOURCES DIVISION RESTON, VA 22092 (703) 860-6031	IDENTIFICATION OF HYDROLOGICAL SITES FOR WHICH WATER DATA IS AVAILABLE, DETAILED DESCRIPTION OF SITES AVAILABLE (269400 SITES)
DEEP SEA DRILLING PROJECT DATA FILES CONTACT: MS. BARBARA LONG DEEP SEA DRILLING PROJECT A-031 SCRIPPS INSTITUTE OF OCEANOGRAPHY LA JOLLA, CA 92093	GEOLOGICAL AND GEOPHYSICAL DATA GATHERED ON THE R/V GLOMAR CHALLENGER
WELLS ADJACENT TO ACTIVE FAULTS IN CALIFORNIA CONTACT: R. S. YEATS OREGON STATE UNIVERSITY DEPARTMENT OF GEOLOGY CORVALLIS, OR 97331 (503) 754-2484	WELL LOGS, LITHOLOGIC AND PALEONTOLOGIC DESCRIPTIONS (3000 WELLS)
CALIFORNIA WELL SAMPLE REPOSITORY CONTACT: J. R. COASH OR J. TUCKER CALIFORNIA STATE COLLEGE BAKERSFIELD 9001 STOCKDALE HIGHWAY BAKERSFIELD, CA 93309 (805) 833-2324	ROCK SAMPLES REPRESENTATIVE OF GEOLOGIC HISTORY, STRATIGRAPHY, ROCK PROPERTIES, AND MINERAL RESOURCES OF CALIFORNIA (2200 WELLS)
NOAA WORLD DATA CENTER A FOR SOLID EARTH GEOPHYSICS CONTACT: W. A. RINEHARD BOULDER, CO 80303 (303) 499-1000, EXT. 6591	SEISMIC, HEAT FLOW, THERMAL GRADIENT, AND VOLCANIC DATA
PETROLEUM DATA SYSTEM (PDS) CONTACT: UNIVERSITY OF OKLAHOMA INFORMATION SYSTEMS PROGRAMS ENERGY RESOURCES CENTER P. O. BOX 3030 NORMAN, OK 73070 (405) 325-1702	IDENTIFICATION OF FIELDS, GEOLOGIC AND FLUID DATA (SEVERAL DATA BASES)

SYSTEM	TYPE OF DATA
CONTINENTAL SCIENTIFIC DRILLING PROGRAM (CSDP) DATA BASE CONTACT: GAYLE PAWLOSKI, L-222 LAWRENCE LIVERMORE NATL. LAB P. O. BOX 808 LIVERMORE, CA 94550 (415) 423-0437	26 PARAMETERS THAT CATALOG DATA FROM GOVERNMENT FUNDED AND SCIENTIFICALLY INTERESTING DRILL HOLES IN THE U. S. (1920 WELLS)

USING RLIN TO LOCATE EARTH SCIENCE INFORMATION

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Abstract: RLIN is the database containing the records of books, journals, maps and other materials held in the library collections of the member libraries. The coverage of the file does not include individual journal articles nor single papers from conference proceedings, but it does contain individual professional papers, memoirs, occasional papers, special publications, and other types of publications. It is especially helpful for tracking down proceedings of particular conferences. It does not take the place of GeoRef or GeoArchive, both of which contain more geological references as well as indexing separate journal articles, but it has the significant advantage of showing possible locations from which to borrow the material. It does not contain as many citations as OCLC on which are loaded the tapes from the U.S.G.S. Library at Reston; however, the ability to search by subject on RLIN means that retrieval of information available is much more complete. It is possible to obtain search-only or inter-library loan accounts for the RLIN database.

I have found one of the most valuable tools for geological reference to be the Research Libraries Information Network or RLIN database composed of the holdings of the member libraries of the Research Libraries Group and of the other shared-cataloging members. The database was begun in 1973 and contains holdings of the original members from that time. As of October 1983 there were a total of ten million, nine hundred thousand titles in the Books file, one million, two hundred sixty-six thousand records in the Serials file, and eighty-eight thousand records in the Maps file. The Machine-Readable Cataloging or MARC records of the Library of Congress date from 1968. The dates of the holdings of the other members are staggered depending on their entry dates into the system. Obviously, the holdings are not limited to post-1973 imprints as records are added to the file when older materials are purchased or when retrospective conversion projects occur. The database only contains entries that one would expect to find in a card catalog and each entry contains the same information as would appear on a catalog card.

One should not plan to use the database for locating or verifying journal articles, individual papers presented at a symposium or a conference, or individual chapters in a multi-authored work. For this, of course, one would choose to use GeoRef or GeoArchive or another of the many journal, technical reports or conference indexes available. Since many titles of individual professional papers, conference proceedings, and books on the earth sciences also appear in the aforementioned indexes, why would one also find the RLIN database useful?

The RLIN database not only contains the citations for these monographic works but also indicates which library or libraries own the title, so that it can be borrowed for a client. For searchers from the member libraries it is also a much cheaper system to search. The charge is only thirteen cents per CPU second. As an example of the cost, a recent intensive, two and one-half hour search session cost $8.35. Even for non-member searchers the costs are somewhat cheaper than going through DIALOG or some other service to access GeoRef, GeoArchive, etc., as search-only accounts are assessed a fee of $60 per connect hour plus TYMNET charges of $15.50 per hour.

What are the features of the RLIN system that make it a particularly useful tool for the retrieval of earth sciences literature? Since a significant percentage of the geological literature is published in series or serial form by government agencies or societies, library cataloging departments often find it too expensive to enter the individual authors and titles plus subject headings for each item in each of its series either cataloged separately or analyzed. However, either the Library of Congress or one of the member libraries has probably analyzed or treated separately the title or author that you need.

Once you have located a citation for the material that you are looking for you can examine the list of holding libraries to see from where the item can be borrowed. I usually take the further step of searching in the serials file for the series title in which I have ascertained that the material desired has been issued, to determine which libraries hold the series, as they may be closer than the library which analyzed the pieces separately; it may even be that the series is held elsewhere on campus. (See fig. one.) I have also found citations for individual titles in series that are not listed elsewhere in any other index, either manual or on-line.

One can search the system with any of the information available: the author's name, with or without the first or middle name or the initials, any of the words of the title, any of the words of the conference title, or any combination of the above. Serials can also be searched for related titles. One can search the system using the boolean operators "and", "or", and "and not". Neither proximity searching nor linked field searching is available. Phrase searching is, however, available; that is, if the exact words of the title, or the series, or the exact name of the corporate author, such as Geological Society of America, are known they can be searched as one entity, with right-hand truncation, if desired. This last feature is especially helpful when searching for titles with only very common words (see fig. two) or for publications by geological surveys. One can truncate the corporate name "California. Division of Mines". This can be combined with a subject term to produce a bibliography of that subject by the division (see fig. three). From the information available it is most efficient in CPU seconds to choose one or two terms on which to search and then refine the search as needed until the results are of a manageable size. Since there are no online print charges it doesn't hurt to print extra citations. The system cannot, however, search for combinations shorter than three letters or three numbers. This is unfortunate because one cannot search for GSA Memoir 32 just by the number "32". However, when searching for the Geological Survey of Canada's memoir 157, it is possible to search under just the title word 157, plus the title word "memoir" (fig. four).

Sample studies on patron requests received in the Branner Library has yielded results ranging from 7% to 25%, depending on the topic, for retrieval rates for Stanford-held material on subject searches in the card catalog as compared to searching the RLIN system. This is due to the following: only some of our 700 series such as professional papers, bulletins, etc. are analyzed or cataloged separately; the retrieval rate using the card catalog is much lower due to the relatively few entry points in any manual catalog; and, for items acquired before 1970; the Branner catalog does not provide any subject access. For author searches, if the author desired has written many works published by state geological surveys or as guidebooks, memoirs, etc., retrieval rate has been found to be much higher, even for local authors, using RLIN rather than using the card catalog. (Fig. five)

The database is very up-to-date. Since the MARC tapes contain some prepublication cataloging, since some of the shared cataloging members, such as the Shell Library in Houston, seem to collect many titles as soon as they are available, since several libraries input their orders on the system, and since even the large, slow-to-catalog research libraries do priority cataloging for reserves and for patron-requested materials, a significant number of the new publications can be found on the system as soon as they are available. For example most U.S.G.S. publications can be found on the system by the time we receive them on depository.

Guidebooks and conference proceedings are very easy to locate on the system, given its great flexibility. Not only can one search by editor or compiler's name, sponsoring agency, and title, as well as subtitle, but also by location and/or date of the conference. (See fig. six.)

Maps can be found in either the books file or the maps file; map series may be entered into either the serials or the map file. They can be searched using any of the indexes that apply to either books or serials, such as compiler, "author", title, subtitle, series title, or subject. They can also be searched for by an index called the geographic code, which is composed of the number from the G schedule appropriate for a map of a particular area minus the letter "G". It is possible to truncate the geographic code, so that one can search for all of the maps of a particular area at once. For example, maps of the state of Indiana can be retrieved by searching for geographic code "409" plus the truncation symbol. This search would, of course, retrieve maps of all types, not just geological maps, as the database covers all fields. We have found that it works best to combine geographic code with one or more subject terms when searching for maps of a large area or one that has been heavily mapped. (See fig. seven.) Not all maps have been assigned geographic codes, so it is wise to also search for maps using subject terms or words from the title. A few book publications have also been assigned geographic codes.

In addition to reference searching I also use the system heavily for collection development purposes. Before sending an order to the Acquisitions Department we verify the citation. Since the Serials Department will not claim nor order any irregular serial without proof that the item in question has actually been published, we find it very useful to regularly search the system under the number of the next bulletin or memoir to be published to see if there is any record of it yet. I will usually decide not to buy a title another branch on campus already owns or has ordered; this I can check on-line. For items of marginal interest I check to see if Berkeley or Davis or some other nearby library already owns it. When I have only the publisher's blurb from which to make a decision, it is sometimes helpful to look at the full record and see what subject headings are assigned to the title. Frequently, when checking the title of an item for which I have read a review, I find that the book in question is actually published as one of a series for which I have a standing order, saving us from ordering what would, in fact be a duplicate.

There are several special databases available on RLIN of which two: the Authorities file, and the Conspectus, would also have some application for reference in the Earth Sciences.

While the OCLC database contains a greater number of geological titles than does RLIN, due, in part, to the fact that the U.S. Geological Survey in Reston has loaded its cataloging tapes onto it, RLIN's greater searching flexibility makes it a more effective reference tool.

Although more than 200 libraries catalog on the RLIN system, only seventeen of the libraries listed in the Directory of Geoscience libraries (Walker et al 1974) are shared cataloging members of RLIN; an additional thirty-nine geological libraries belong to institutions that have access to a search-only account. We find the RLIN system so useful, that we generally remain logged onto the system from 2 in the afternoon until the system goes down at 9 pm. It is by no means a complete index but is one more tool to use.

References

Bourne, Jim, 1981-. Searching in RLIN II: User's Manual. Research Libraries Group.

Walker, Richard D., 1974. Directory of Geoscience Libraries, U.S. and Canada/ compiled by Richard D. Walker and Diane Parker. -- 2nd edition --: Geoscience Information Society.

FIN TW MOZAAN - 2 CLUSTERS IN BKS

WATCHORN, M.B.
A REAPPRAISAL OF THE GEOLOGY OF THE WESTERN MOZAAN BASIN / BY M. B. WATCHORN. -- JOHANNESBURG, S.A.: UNIVERSITY OF THE WITWATERSRAND, ECONOMIC GEOLOGY RESEARCH UNIT, 1979.
7 LEAVES : MAPS ; 30 CM. -- (INFORMATION CIRCULAR / ECONOMIC GEOLOGY RESEARCH UNIT, UNIVERSITY OF THE WITWATERSRAND ; N. 141)

UTBG (c-9114 UPB)

FIN TP INFORMATION CIRCULAR# AND CW WITWATERSRAND - 3 RECORDS IN SER

1) JOHANNESBURG (SOUTH AFRICA). UNIVERSITY OF THE WITWATERSRAND. ECONOMIC GEOLOGY RESEARCH UNIT. INFORMATION CIRCULAR. NO.1-; AUG. 1960- (JOHANNESBURG.) c-9665 ILNGAAL8917-S

2) JOHANNESBURG, UNIVERSITY OF THE WITWATERSRAND. ECONOMIC GEOLOGY RESEARCH UNIT INFORMATION CIRCULAR c-9664 CSUP02445001-S

3) UNIVERSITY OF THE WITWATERSRAND. ECONOMIC GEOLOGY RESEARCH UNIT. INFORMATION CIRCULAR
c-9665 CUBG16312909-S QE325.A1J6.I5

FIGURE 1

FIN TP URBAN GEOMORPHOLOGY IN DRYLANDS# - 1 CLUSTER IN BKS

URBAN GEOMORPHOLOGY IN DRYLANDS / R.U. COOKS ... [ET AL.] ;
WITH CONTRIBUTIONS BY J. GRIFFITHS ... [ET AL.] -- NEW YORK :
PUBLISHED ON BEHALF OF THE UNITED NATIONS UNIVERSITY BY OXFORD
UNIVERSITY PRESS, 1982.
XII, 324 P. : ILL., MAPS ; 24 CM.

FIGURE 2

FIN SP FAULTS GEOLOGY# AND CP CALIFORNIA# - 27 CLUSTERS IN BKS

1) CALIFORNIA. DIVISION OF MINES AND GEOLOGY. ACTIVE FAULT MAPPING AND EVALUATION PROGRAM : (SACRAMENTO : THE DIVISION, 1976.)

CTYG (C-9665 CTY)

STREITZ, ROBERT.
STUDIES OF THE SAN ANDREAS FAULT ZONE IN NORTHERN CALIFORNIA /
EDITED BY ROBERT STREITZ AND ROGER SHERBURNE. -- SACRAMENTO CA :
CDMG, 1980. 187 P. -- (SPECIAL REPORT ; 140)

FIN SP FAULTS GEOLOGY# AND CP CALIFORNIA# - NONE IN SER, 16 IN MAP

1) HART, EARL W. PRELIMINARY MAP OF OCTOBER 1979 FAULT RUPTURE, AND BRAWLEY FAULTS, IMPERIAL COUNTY, CALIFORNIA / ([SAN FRANCISCO, CALIF.?] : CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1981.)

FIGURE 3

FIN TW 157 AND TW MEMOIR - 4 CLUSTERS IN BKS

TECTONIC AND STRATIGRAPHIC STUDIES IN THE EASTERN GREAT BASIN / EDITED BY DAVID M. MILLER, VICTORIA R. TODD, KEITH A. HOWARD. -- BOULDER, COLO. : GEOLOGICAL SOCIETY OF AMERICA, 1983.
VI, 327 P. : ILL. ; 29 CM -- (MEMOIR / GEOLOGICAL SOCIETY OF AMERICA ; 157)

EMMONS, RICHARD CONRAD, 1898-
PRELIMINARY REPORT ON WOMAN RIVER AND RIDOUT MAP-AREAS, SUDBURY DISTRICT, ONTARIO, BY R.C. EMMONS AND ELLIS THOMSON. OTTAWA, F. A. ACLAND, PRINTER, 1929.
2 P. 1., 30 P. 2 FOLD. MAPS (IN POCKET) 25 CM. (CANADA. GEOLOGICAL SURVEY. MEMOIR 157)

FIGURE 4

FIN PE COLEMAN, ROBERT GRIFFIN - 6 CLUSTERS IN BKS

COLEMAN, ROBERT GRIFFIN, 1923-
NEW ZEALAND SERPENTINITES AND ASSOCIATED METASOMATIC ROCKS, BY R. G. COLEMAN. [WELLINGTON] DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH, N.Z. GEOLOGICAL SURVEY, 1966.
101 P. ILLUS., MAPS, DIAGRAMS, TABLES. 28 CM. (NEW ZEALAND. GEOLOGICAL SURVEY. BULLETIN N.S. 76)

COLEMAN, ROBERT GRIFFIN, 1923-
JABAL SHA_I_GABBRO IN SOUTHWEST SAUDI ARABIA / BY ROBERT G. COLEMAN, EDWARD D. GHENT, AND ROBERT J. FLECK ; WITH A SECTION ON GEOPHYSICAL STUDIES BY ANDREW GRISCOM. -- JIDDAH : DIRECTORATE GENERAL OF MINERAL RESOURCES, 1977.
VI, 46 P. : ILL., MAPS (1 FOLD. IN POCKET) ; 28 CM. -- MINERAL RESOURCES BULLETIN ; NO. 17)

NORTH AMERICAN OPHIOLITES / EDITED BY R. G. COLEMAN AND W. P. IRWIN. -- PORTLAND : STATE OF ORGEON, DEPT. OF GEOLOGY AND MINERAL INDUSTRIES, 1977. V, 183 P. : ILL. ; 28 CM. -- (BULLETIN - STATE OF OREGON, DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES ; 95)

COLEMAN, ROBERT GRIFFIN, 1923-
THE COLEBROOKE SCHIST OF SOUTHWESTERN OREGON AND ITS RELATIONS TO THE TECTONIC EVOLUTION OF THE REGION, BY R. G. COLEMAN. WASHINGTON, U.S. GOVT. PRINT. OFF., 1972.
10, 61 P. ILLUS., MAP. 24 CM. (GEOLOGICAL SURVEY BULLETIN 1339)

FIGURE 5

FIN CW CYPRUS AND TW 1979 - 5 CLUSTERS IN BKS

3) INTERNATIONAL OPHIOLITE SYMPOSIUM (1979 : NICOSIA, CYPRUS) OPHIOLITES : ([NICOSIA?] : REPUBLIC OF CYPRUS, MINISTRY OF AGRICULTURE AND NATURAL RESOURCES, GEOLOGICAL SURVEY DEPARTMENT, 1980.)
CUBG (c-9114 CU) CTYG (c-9114 CTY) CUDG (c-9114 UC-A) IAUG (c-9114 IAU) MNUG (c-9114 MNU) NJPH (c-9114 NJP) NYCG (A-9114 NNC) NYCX (c-9114 NIC) OKUG (c-9114 UKU) TXSC (c-9114 TXHSOF)

FIGURE 6

FIN GC 409# - 667 RECORDS IN MAP
FIN GC 409# AND SP GEOLOG# - NONE IN SER, 2 RECORDS IN MAP

PURCELL, ROGER L.
MAP OF INDIANA SHOWING BEDROCK GEOLOGY [MAP] / ADAPTED FROM REGIONAL GEOLOGIC MAP SERIES, INDIANA GEOLOGICAL SURVEY. SCALE CA. 1:1,800,000. (W880--W 84045'/N 41045'--N37052'). -- [BLOOMINGTON, IND.] : INDIANA GEOLOGICAL SURVEY, 1970.

FIN GC 409# AND SP GEOLOG# - 2 CLUSTERS IN BKS

2) GUIDEBOOK TO THE GEOLOGY OF SOME ICE AGE FEATURES AND BEDROCK FORMATIONS IN THE FORT WAYNE, INDIANA AREA / PRELIM. [ED.]. (BLOOMINGTON : IND.: 1973.)
IAUG (c-9114 IAU) CTYG (c-9614 CTY)

FIGURE 7

FIN PE COLEMAN, ROBERT GRIFFIN - 6 CLUSTERS IN BKS

COLEMAN, ROBERT GRIFFIN, 1923-
NEW ZEALAND SERPENTINITES AND ASSOCIATED METASOMATIC ROCKS, BY R. G. COLEMAN [WELLINGTON] DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH, N.A. GEOLOGICAL SURVEY, 1966.
101 P. ILLUS., MAPS, DIAGRAMS, TABLES. 28 CM. (NEW ZEALAND. GEOLOGICAL SURVEY. BULLETIN N.S. 76)

COLEMAN, ROBERT GRIFFIN, 1923-
JABAL SHA_I_GABBRO IN SOUTHWEST SAUDI ARABIA / BY ROBERT G. COLEMAN, EDWARD D. GHENT, AND ROBERT J. FLECK ; WITH A SECTION ON GEOPHYSICAL STUDIES BY ANDREW GRISCOM. -- JIDDAH : DIRECTORATE GENERAL OF MINERAL RESOURCES, 1977.
VI, 46 P. : ILL., MAPS (1 FOLD. IN POCKET) ; 28 CM. -- MINERAL RESOURCES BULLETIN ; NO. 17)

NORTH AMERICAN OPHIOLITES / EDITED BY R. G. COLEMAN AND W. P. IRWIN.
-- PORTLAND : STATE OF OREGON, DEPT. OF GEOLOGY AND MINERAL INDUSTRIES, 1977. V, 183 P. : ILL. ; 28 CM. -- (BULLETIN - STATE OF OREGON, DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES ; 95)

COLEMAN, ROBERT GRIFFIN, 1923-
THE COLEBROOKE SCHIST OF SOUTHWESTERN OREGON AND ITS RELATION TO THE TECTONIC EVOLUTION OF THE REGION, BY R. G. COLEMAN. WASHINGTON, U.S. GOVT. PRINT. OFF., 1972.
10, 61 P. ILLUS., MAP. 24 CM. (GEOLOGICAL SURVEY BULLETIN 1339)

FIGURE 5

THE GEONAMES COMPUTER LEXICON OF GEOLOGIC NAMES OF THE UNITED STATES

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Abstract: The GEONAMES data base, an annotated index lexicon of geologic names, was created by the U.S. Geological Survey (USGS) to provide information on the current status of formal stratigraphic nomenclature of the United States and its territories and possessions. GEONAMES is an interactive computerized storage and retrieval system that contains 28,000 records relating to more than 17,000 formal geologic names. Each record contains as many as 132 characters of information in 10 fixed fields: 1. name of the unit; 2. State in which unit occurs; 3. geologic age; 4. USGS usage; 5. geologic province; 6. lithology; 7. thickness at type section; 8. location of type section; 9. lexicon reference; 10. unique identifier. The data base is continually updated by the professional staff using an editing program called LOTUS. The system is accessible through an interactive program called QUERI, which permits users to sort the data by combinations of fields and to obtain printouts of the sorted data. Interested persons may have access to the data by request to the USGS. Copies of the complete data base on magnetic tape may also be obtained. The GEONAMES data base will facilitate the compilation of a printed lexicon containing the complete bibliographic record of the usage of the stratigraphic nomenclature of the United States, similar to lexicons published in 1938 and 1966.

History of Lexicons

Records of the stratigraphic nomenclature of the United States have been kept by the U.S. Geological Survey (USGS) since 1882. The first lexicon, published in 1902, contained separate lists of North American sedimentary and igneous formation names together with their age, geographic location, and most important references. In 1915, M. Grace Wilmarth began compiling a narrative-style lexicon of geologic names of the United States. It contained the original definition of each name including the description at the type locality, lithology, and relationship to adjoining units, and all important revisions of the name. This lexicon, USGS Bulletin 896, was published in 1938 and has become a standard for lexicons of geologic names. Bulletin 1200, published in 1966, was in the same style and updated the records of geologic names through 1960. Lexicons of new names only were published in 1970 and 1981. Lexicons of new names are published at regular intervals, but it may be some time before another narrative-style lexicon updating the status of all names will be published. To fill the need for information on the current status of stratigraphic nomenclature, a computerized index lexicon called GEONAMES, an acronym for Geologic Names, was created. USGS Bulletin 1535 is a printout of the first complete GEONAMES data base and shows the status of geologic names through 1975.

Stratigraphic Information Codes

Work on coding stratigraphic information was begun in 1967 when the Committee on Standard Stratigraphic Coding of the American Association of Petroleum Geologists (Cohee 1967) devised standards for computer-coding basic stratigraphic information that would be adaptable to the entire geologic profession. The codes devised by the committee were based on a study made by the Canadian National Advisory Committee on Research in the Geological Sciences (Robinson 1966). The basic code identifies each rock-stratigraphic unit and gives its age. These codes are used with minor modification in the GEONAMES data base.

Development of the Data Base

The USGS decided in 1970 to explore the possibility of producing a computer list showing the current status of names. This list not only would be of use to geologists, but also would assist in the compilation of future lexicons. Information for the data base was taken from the published lexicons of geologic names, publications in the Geological Survey library, and from the records and files of the Geologic Names Committee of the USGS.

In the first phase of the computerization, the name, State location, age, and unique identifier for each record were recorded on punched cards for entry into the Honeywell Multics computer at the USGS in Reston, Va. The first phase produced about 30,000 records involving 15,000 names. Some names have several records because each name variation and State and age assignment of a name requires a separate record. In the second phase of the computerization, additional data on USGS usage, lithology, thickness at type locality, location of type locality, color, and principal reference were added to the records. The first complete GEONAMES data base contained only information published before the end of 1975. The data base is continually updated from published literature in the Geological Survey library and is now complete through 1980. Data for 1981 and 1982 are now being entered.

Explanation of Fields

In the present format each record contains as many as 132 characters in 10 fixed fields. A printout of part of the data base is shown on Figure 1.

Field 1. Location. The U.S. Postal Service 2-letter abbreviation is used to identify the State, territory, or possession in which the name is located. In the first phase, only names in the 50 States were entered. The territories and possessions of the United States are now included.

Field 2. Geologic Age. The currently accepted geologic age is represented, with minor modifications, by the 3-digit code devised by the Committee on Standard Stratigraphic Coding. In the Phanerozoic, the first digit to the left represents the era; the second, the period; and the third, the epoch. The numbers proceed from youngest to oldest as this provides unlimited numbers for use in the Precambrian as more stratigraphic units are distinguished. We designated informal subdivisions of eras into late, middle, and early by the numbers 01, 04, and 07 added to the era code. These subdivisions are used in cases where the geologic age of rocks is so imprecisely known that they cannot be assigned to any one period.

The provincial series codes apply as follows: 212 and 218 are used in Alabama, Arkansas, western Florida, Louisiana, Mississippi, southern Oklahoma, and Texas; 219 is used in Alabama, Arkansas, Louisiana, Mississippi, and Texas; 312, 313, 318, and 319 are used in New Mexico and Texas; 322, 323, 325, 326, and 328 are used in Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, and Oklahoma; 332, 333, 338, and 339 are used in Illinois, Indiana, Iowa, western Kentucky, Missouri, and western Tennessee (Fig. 2).

In adapting to recently established subdivisions of the Precambrian, the number 401 designates the Proterozoic, 404 designates the Archean, and 407 designates the pre-Archean (Fig. 3).

Ages are listed in ascending order, and a (+) following the first age indicates that the unit has additional ages.

Field 3. Name of Unit. The geologic name consists of a geographic name combined with a rank or descriptive term. Sorting is performed on the geographic term, which is separated by a comma. If a unit is part of a higher ranking unit, the name of that unit follows in parentheses. A slash (/) preceding a name indicates a violation of the North American Stratigraphic Code. A name may have been used previously in the same area, or a rank term may have been used improperly or may have been omitted. Suggested corrections of improper usage are enclosed in brackets ([ ]) (Fig. 1).

Field 4. U.S. Geological Survey Usage. A "U" is entered in this field if the name has been used in reports of the USGS. This information is primarily to guide geologists of the USGS in the usage of geologic names (Fig. 1).

Field 5. Lithology. The principal lithology of a unit at the type section is entered here. Abbreviations of common lithologies have been devised for this data base (Fig. 1).

Field 6. Geologic Province. A 3-digit geologic province code and map for use with automatic data processing were devised in 1970 by the Committee on Statistics of Drilling of the American Association of Petroleum Geologists (Meyer 1970). The geologic province code is intended to emphasize geologic provinces that have petroleum or other mineral resource potential or development, and to discriminate between geologic positive and negative elements and segregate these from purely physiographic features. Color was originally entered in this field, but we felt that the geologic province was more useful.

Field 7. Thickness. This field shows the maximum thickness at the type locality, in meters, rounded to the second significant figure.

Field 8. Type Locality. The part of the State in which the type section, locality, or area of a unit is located is entered in this field. Each State is divided into nine parts determined by dividing its maximum latitudinal and longitudinal dimensions by three. These parts are designated by the abbreviations NW, NC, NE, WC, C, EC, SW, SC, SE. Irregularly shaped States do not contain all nine parts (Fig. 4). Names originating in Canada or Mexico which have been extended to the United States are identified by the abbreviations CAN or MEX.

Field 9. Reference. Each of the letters A through E refers to a volume of the Lexicon of Geologic Names in which a name was first described.

Field 10. Unique Identifier. A unique identifier consisting of a 4-letter mnemonic plus a 2-digit number is assigned to each record. This is essential for recalling records for updating and for creating new records. The mnemonic is derived from the geographic name using a method devised by the American Association of Petroleum Geologists Committee on Standard Stratigraphic Coding. English articles and prepositions are deleted first; those in foreign languages are retained. The first letter of each remaining word is retained. Names beginning with Mc, O', De, or Van are treated as two words. Letters are then deleted, from right to left, in the following order until four remain: a, e, i, o, u, w, h, y, one of each double, t, n, s, r, l, d, c, m, f, g, p, k, b, v, x, j, q, z. All the records for each name have the same mnemonic but different numbers.

Updating and Data Retrieval

Updating, deleting, and creating new records are done on a continuing basis using a text-editing program called LOTUS (Level One Ted Update System) with Ted software in the Multics computer. Some 28,000 records now show the status of geologic names of the United States as of 1980.

Data retrieval and report generation utilize the QUERI program developed for the Multics computer. Conditions and logic are defined by the user, the records in the master file are searched, and those selected are copied into a new file which can be sorted by any of the 10 fields, in ascending or descending order, and are printed out. Examples of the type of sorts that can be made are: Names in one or more States, sorted alphabetically by name, or sorted by age in ascending or descending order; or all names of a certain age in one or more geologic provinces or States.

The GEONAMES data base may be accessed only by users of the USGS Multics computer, but the data retrieval and report generation service is available to anyone requesting a printout of selected data from the Geologic Names Unit in Reston, Va. The main data base has been divided into four areal files--Atlantic (ATL), Central (CNT), Mountain (MTN), and Pacific (PFC). Tapes of these files or of the complete GEONAMES data base are available for loan to anyone who may wish to copy them.

References

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Meyer, R. F., 1970, Geologic provinces code map for computer use: American Association of Petroleum Geologists Bulletin, v. 54, no. 7, p. 1301-1305.

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ST.	GEOL. AGE	GEOLOGIC NAME	USAGE	LITH.	GEOL. PROV.	THICK-NESS	TYPE LOC.	REF.	IDENT.
PA	341	/ANALOMINK,RED SH MBR (CATSKILL FM)	U		160	30	NW	A	ALMK 01
PA	341	[ANALOMINK,SH MBR (CATSKILL FM)]							ALMK 03
WA	311	ANARCHIST,GP	U	MSED		>1500	CAN	A	ARCS 03
ME	350	ANASAGUNTICOOK,FM (WOODSTOCK GP)		SCH,GN	100		NW	D	AGCK 03
FL	112	ANASTASIA,FM	U	LS	140	18	EC	A	ANSS 01
FL	112	ANASTASIA,FM (FORT THOMPSON GP)							ANSS 02
CA	121	ANAVERDE,FM	U	CGL,ARK	760	610	SC	C	AVRD 01
IL	364	ANCELL,GP		SS	310		NC	C	ANCL 01
WI	364	ANCELL,GP							ANCL 03
NM	121	ANCHA,FM (SANTA FE GP)	U	SS,STS	460	61	NC	C	ANCH 01
NV	331+	ANCHOR,LS (MONTE CRISTO GP)		LS	625	120	SE	C	ANCR 06
NV	337	ANCHOR,LS (MONTE CRISTO GP)							ANCR 07
NV	331+	ANCHOR,MBR (MONTE CRISTO DOL)							ANCR 11
NV	337	ANCHOR,MBR (MONTE CRISTO DOL)							ANCR 12
CA	331+	ANCHOR,MBR (MONTE CRISTO LS)	U						ANCR 02
NV	331+	ANCHOR,MBR (MONTE CRISTO LS)	U						ANCR 04
CA	337	ANCHOR,MBR (MONTE CRISTO LS)	U						ANCR 03
NV	337	ANCHOR,MBR (MONTE CRISTO LS)	U						ANCR 05
CA	112	/ANCHOR,SILT MBR (SAN PEDRO FM)			760	18	SC	C	ANCR 01

Figure 1. Printout of part of the GEONAMES data base.

ERA	PERIOD	EPOCH OR PROVINCIAL SERIES	CODE
Cenozoic			100
late			101
middle			104
early			107
	Quaternary		110
		Holocene	111
		Pleistocene	112
	Tertiary		120
		Pliocene	121
		Miocene	122
		Oligocene	123
		Eocene	124
		Paleocene	125
Mesozoic			200
late			201
middle			204
early			207
	Cretaceous		210
		Late	211
		Gulfian	212
		Early	217
		Comanchean	218
		Coahuilan	219
	Jurassic		220
		Late	221
		Middle	224
		Early	227
	Triassic		230
		Late	231
		Middle	234
		Early	237
Paleozoic			300
late			301
middle			304
early			307
	Permian		310
		Late	311
		Ochoan	312
		Guadalupian	313
		Early	317
		Leonardian	318
		Wolfcampian	319
	Pennsylvanian		320
		Late	321
		Virgilian	322
		Missourian	323
		Middle	324
		Des Moinesian	325
		Atokan	326
		Early	327
		Morrowan	328
	Mississippian		330
		Late	331
		Chesterian	332
		Meramecian	333
		Early	337
		Osagean	338
		Kinderhookian	339
	Devonian		340
		Late	341
		Middle	344
		Early	347
	Silurian		350
		Late	351
		Middle	354
		Early	357
	Ordovician		360
		Late	361
		Middle	364
		Early	367
	Cambrian		370
		Late	371
		Middle	374
		Early	377

Figure 2. Geologic age code for the Phanerozoic.

TIME	EON	ERA	CODE
Precambrian			400
	Proterozoic		401
		Late	410
		Middle	420
		Early	430
	Archean		404
		Late	440
		Middle	450
		Early	460
	pre-Archean		407

Figure 3. Geologic age code for the Precambrian.

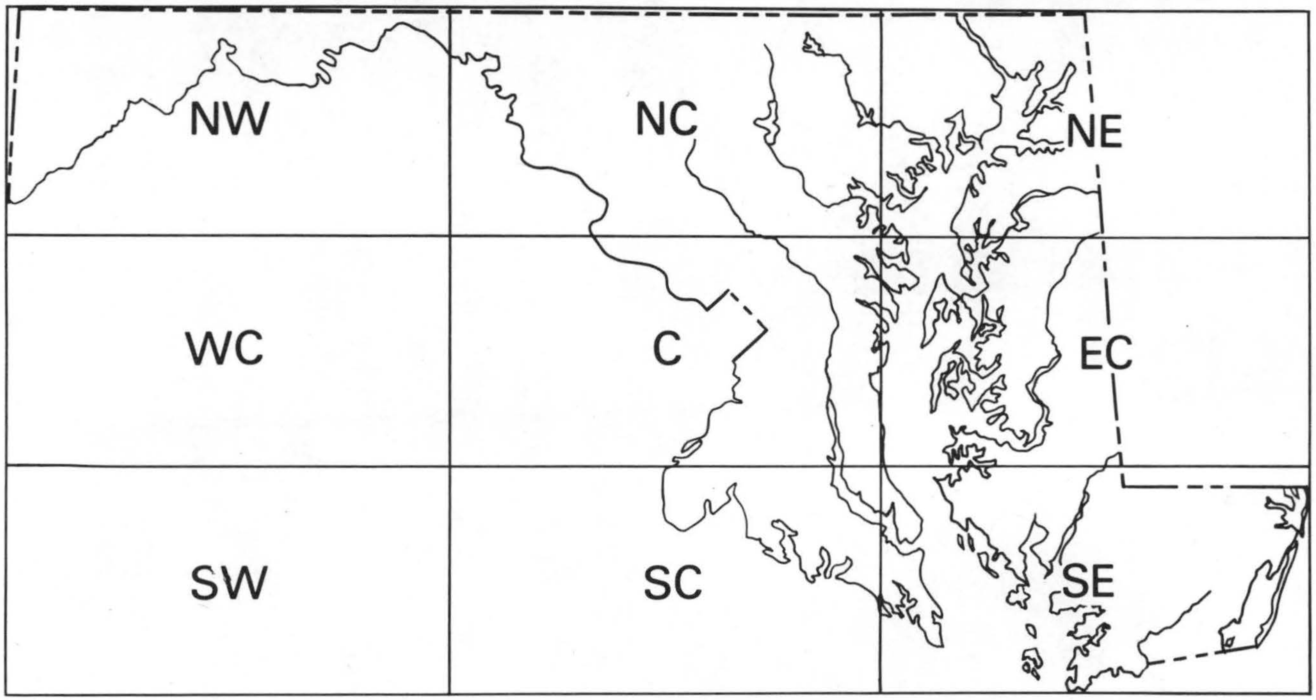

Figure 4. State of Maryland showing nine-part division.

A SURVEY OF MAJOR LIBRARY COLLECTIONS IN THE GEOSCIENCES IN THE STATE OF VICTORIA, AUSTRALIA

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Abstract:

The purpose of this five-month survey was to assess the adequacy of the major library collections in Victoria in filling the needs of current research, teaching, professional activities and public interest in the geosciences. The geosciences were limited to Dewey classes 549-568 for the purposes of the survey, and a questionnaire was constructed requesting detailed information of the strengths of the geoscience collections in each library surveyed. Ten libraries were visited and their collections reviewed in person to enable profiles of these libraries to be prepared. Oceanography serial and monograph holdings were investigated in greater depth, as there was special interest in the status of these holdings. Union lists were prepared for the most-cited serials in geoscience and oceanography to help identify gaps in the collections, and to act as a finding tool for users. These union lists were compiled by using the Master Copy of Scientific Serials in Australian Libraries. Monograph holdings were checked by using the National Union Catalogue of Monographs files at the National Library of Australia.

The survey showed that geoscience serial holdings are quite strong; 77% of 174 most-cited serials and 45% of all serials checked (1542) have full backsets held. Significant geoscience monographs are also readily available, 69% of 572 monographs checked. Oceanography serial holdings were weaker than those for all geoscience; only 56% of 110 most-cited oceanography serials have full backsets held. Oceanography monograph holdings were surprisingly strong, 73% of 118 monographs checked. A list of recommended purchases designed to fill gaps in the collections was presented for action to the Australian Advisory Council for Bibliographical Services.

I propose to tell you today why sabbaticals are so good for you, and why, as soon as you return from this meeting you should request one immediately. If your organization does not grant sabbaticals, then you should lobby for a change of policy. Nothing else is quite so well designed to clear the cobwebs, shake you out of your rut, and set you on the path of righteousness again. A sabbatical offers a change of pace, different surroundings, a new set of coworkers, and the chance to learn another institution's routines and methods.

I was fortunate enough to be on sabbatical leave from Stony Brook for the five-month period December, 1981 to April, 1982. I was based at the Baillieu Library at the University of Melbourne in the state of Victoria, Australia. My project was to assess the adequacy of the major library collections in Victoria in filling the needs of current research, teaching, professional activities and public interest in the geosciences. This project was proposed to me by the Subcommittee on Resources of the Victorian State Committee of AACOBS. What is AACOBS? The letters stand for the Australian Advisory Council on Bibliographical Services. AACOBS is a planning body set up in 1956 to oversee and facilitate bibliographical services in Australia. Its membership includes representatives from every facet of Australian librarianship; from the National Library of Australia, state libraries, university libraries, library boards, CSIRO (Commonwealth Scientific and Industrial Research Organization), public libraries, school libraries, special libraries, archives, the Parliamentary Library, colleges of advanced education, the Library Association of Australia and other interested groups. From its inception AACOBS has been interested in surveying library resources in Australia, in identifying strengths and weaknesses in the collections, and in working to fill gaps in the collections. For example, AACOBS initiated and supported the Tauber survey, a systematic survey of the total library resources of Australia, conducted in 1961. It is humbling for me to note that Maurice Tauber visited 162 libraries in six months and distributed more than 4,000 questionnaires. I take heart from the fact that he had assistance, and worked long and hard on the project both before and afterwards to complete it. Since the Tauber report the surveys that AACOBS has sponsored have become more specialized. They have a policy of encouraging surveys of collections in particular subjects and in particular geographic areas, and this is where I fitted in. My sponsorship by AACOBS meant that I had a group of experienced librarians in Victoria willing to give me advice on the project, and it also meant that all doors were open to me. The National Library of Australia and the CSIRO Central Library both welcomed me, and Baillieu Library provided me with a room, phone, clerical assistance and a valued mentor in Juliet Flesch, Principal Librarian for Collection Development at the University of Melbourne.

The purpose of the survey was to identify gaps in the collections, comment on areas of strength and weakness, and suggest particular titles for purchase. As the survey progressed I found that the surveyor has another important role to fulfill. I found that these geoscience librarians did not know each other, they had no point of contact, even though they worked in the same city. There was no organization which served to bring them together to talk over their particular problems. I found that I was acting as a sounding board for ideas and lending a sympathetic ear to complaints. An organization does exist called AGIA, Australian Geoscience Information Association, but at that time in Melbourne the organization was at a low ebb, and most of these librarians had not attended a recent meeting. Their isolation made me grateful, once again, for GIS and its dependable annual meetings. I hope that the Third International Conference on Geoscience Information to be held in Adelaide in 1986 will act as a spur for AGIA to become better established and to conduct regular meetings.

For the purposes of the survey I defined the geosciences in terms of Dewey classes 549-568, which include the following subjects; mineralogy, geology, geophysics, glaciology, geomorphology, hydrology, oceanography, meteorology, climatology, historical geology, structural geology, geochemistry, petrology, economic geology, regional geology, paleontology, and paleobotany. Most libraries I visited used Dewey classification so that this definition neatly limited the amount to be surveyed. Use of Dewey classes also enabled me to make comparisons among libraries using standard categories. The Subcommittee on Resources of the Victorian State Committee of AACOBS had identified 13 Victorian libraries which appeared to have sizeable collections in the geosciences. The Subcommittee had already sent a letter to these libraries in September, 1981 advising them of my survey and requesting their cooperation. After I arrived in Australia I juggled this list somewhat, adding some libraries and deleting others. I eventually sent a questionnaire to 14 libraries requesting detailed information on the strengths of their geoscience collections, and additional information on their acquisitions budget, acquisitions methods and access to their collections. The answers to these questionnaires formed the basis of Appendix A of my report, which is a capsule introduction to each of the ten libraries visited.

To enable me to become familiar with the active areas of geoscience research in Victoria, I compiled a bibliography of both published and unpublished research done in Victoria in 1979. A search for this material was conducted on AESIS, Australian Earth Sciences Information System. I assigned Dewey class numbers to the 330 articles retrieved, and found the resultant spread was surprisingly even over all of geoscience. This convinced me that to support ongoing research in Victoria, Victorian geoscience collections should represent, in aggregate, the entire spectrum of geoscience.

To estimate how adequate the collections were I followed several different lines of enquiry. Firstly I investigated the serials collections. I compiled a list of 171 most-cited geoscience serials using Garfield's Journal Citation Reports for 1979, Journals by Category (Ranked by Impact Factor), for Mineralogy, Oceanography, Paleontology, Geology and Geosciences, in conjunction with Garfield's Journal Citation Studies for geology and geophysics published in 1974. Citation analysis, while not without problems, is the best objective method available for ranking scientific serials in order of importance. To these 171 serials were added three serials of particular local interest, Alcheringa, Geological Society of Australia. Journal, and New Zealand Geological Survey, Bulletin. A union list for these serials in the nine major collections was compiled using the Master Copy of SSAL and SSAL Supplement. What is SSAL? The letters stand for Scientific Serials in Australian Libraries, and it is a union list of scientific serials held in Australian libraries, continuously updated from 1958 to 1976 by looseleaf additions. It is produced by CSIRO and they depend on reports from participating libraries to keep the list updated. The copy of SSAL which I worked from was the Master Copy held in CSIRO Central Library and updated by hand in pencil. SSAL Supplement is now being produced on microfiche and eventually SSAL will be totally revised and a corrected version published. It is an essential library tool for Australia, and a byproduct of my project was that I was able to assess the reliability of SSAL using geoscience serials in these nine libraries as a sample.

A list of 78 Australian geological serials was abstracted from Bibliography of Australian geological serials, Hill, 1980. These were also checked against SSAL to ensure that there was ready access to Australian geological serials in the state of Victoria.

In order to examine the geoscience serials collections in Victoria in more detail all English language serials and the majority of foreign language serials listed in Periodicals on geology held in the Science Reference Library (British Library), published in 1978, were checked against the Master Copy of SSAL, (1281 serials). Each serial was given a notation to indicate whether all volumes were held in Victoria; all volumes were held in Australia; a partial set was held in Australia or there were no holdings in Australia. This particular list was chosen for checking as the British Library is recognized as having one of the most compete retrospective and current collections of geoscience serials in the world. As all serials held in the library are listed, I could check Victorian holdings of both current and retrospective material. Another list of 29 meteorological serials drawn from Ulrich's International Periodicals Directory (Twentieth Edition, 1981), was added to the British Library list , and with the addition of the Australian geological serials list, and the oceanography serials, (see later), makes 1542 serials checked in all.

The second category I investigated was the monograph collections. A list of 506 key monographs was compiled by using books published in the geosciences selected for review by the periodical Choice between the years 1974 and 1980. Choice selections were used as it is the major classified reviewing journal for English language books at the undergraduate level. These titles were checked for holdings in libraries in the state of Victoria against the National Union Catalogue of Monographs (NUCOM) files at the National Library of Australia in Canberra. These files included all reported holdings up to February, 1982. Several librarians expressed doubts whether their holdings would be reflected accurately in NUCOM. NUCOM is, however, the best union listing available and the results are presented with the proviso that they are undoubtedly an underestimate of holdings.

After the preliminary overview of the geoscience field was obtained it was decided to specialize and review in more depth holdings in oceanography. Oceanography was chosen because the Victorian Institute of Marine Sciences is co-ordinating and stimulating oceanographic research in Victoria, and because at first glance, holdings in this area seem to be the weakest of all in the geosciences. A list of 110 oceanography journals was compiled using the serials list from Oceanic Abstracts for 1980 and the serial titles cited in Oceanographic Literature Review, (Deep-Sea Research, Part B), for 1980, together with Garfield's Journal Citation Reports for 1979 for oceanography. This list of serials was checked against the Master Copy of SSAL and the SSAL Supplement, and a union list of oceanography serials in the state of Victoria was compiled. There is some overlap between the two union lists, as key oceanography serials are also included in the geoscience serial union list.

Oceanography holdings for the nine major geoscience collections were verified before the union list was published. Holdings for libraries other than these nine are as they appear in SSAL. A list of 115 oceanography monographs reviewed in Choice during the years 1964-1981 were checked against the NUCOM files to identify holdings in the state of Victoria.

The checking against SSAL was done in Melbourne at the CSIRO Central Library, one of the better science libraries in Australia. For many days I took the tram from Carlton to Albert Street, East Melbourne, and set myself up at the transient's desk in the reference room to check titles against the big blue books of SSAL. Invariably the volume that I needed was the one that they were updating that day. The NUCOM files were located in the National Library of Australia in Canberra. I spent a week there in the NUCOM room checking titles in the tortuous rows of file cabinets which snaked all over the NUCOM room and out in to the corridor. I spent much time on my knees, as the titles I wanted were mostly in the bottom file drawer. The National Library of Australia is straining at the seams, and the two new wings promised for several years ago have still not materialized.

Visiting the ten libraries was done in January and February of 1982. I was shown great hospitality by all the librarians I visited, and had a chance to discuss the collections at length with those librarians responsible for selection. I saw some excellent collections, well housed and well selected for the clientele, (mostly in the universities and colleges of advanced education). I saw some excellent collections, appallingly housed and with virtually no access for the public. I will mention just two examples of the latter. The Royal Society of Victoria Library is housed in an architectural gem of a building in the middle of a park - a very small architectural gem.

The library has been overcrowded since the turn of the century, and they only have the volunteer services of a retired librarian one day per week. The collection is superb, and unusual. The Royal Society of Victoria has set up exchange agreements with any other scientific body in the world which is interested in their publications. As a result the collection is eclectic in the extreme, and it is stacked on Steelbuilt shelves from the floor to the 20 foot ceiling of a series of small rooms. Ladders are optional and at your own risk. The arrangement is geographical in an eccentric kind of way. When and if you find what you are looking for it will be unbound issues wrapped in heavy brown paper, and tied up with string and labelled in textacolor. With this sort of arrangement it is obvious that the collection is underutilized. In fact the main use is for inter-library loan as there are no problems with missing issues - all of their serial runs are complete back to volume one.

Another unhappy state of affairs exists in the Victorian Department of Mines Library, which is again overcrowded and housed in a partially converted parking garage. This is the only library that I have seen where the collection is double shelved- two rows of books on each shelf, one front and one back row. The issues were inches deep in dust and tied up (I kid you not) in red tape. There is no shelf list whatsoever and the arrangement is geographical. Once again the collection is largely the result of worldwide exchange agreements set up in the last century by some enterprising person. I did see a copy of the exchange agreement and some of the countries listed do not even exist any more. But it is a magnificent collection, with numerous compete sets of publications from various geological surveys and departments of mines. There is reason to expect that vast improvements have been made in this collection since I visited it, as the library was moving to new and spacious quarters, and a new librarian had been appointed.

The results showed that , in general, Victorian geoscience collections are adequate for the geoscientists' needs. 95% of the 174 most-cited geoscience serials were currently received in the state and 77% of these serials had complete backsets held. Out of all the serials checked (1542 serials), 45% of the titles have full backsets held in the state. Oceanography serial holdings were weaker than those for geoscience as a whole. Only 56% of the 110 most-cited oceanography serials have full backsets held in the state. Holdings of both geoscience and oceanography monographs were strong, about 70% of the titles were owned in the state in both cases. I made a list of 20 or so serial titles that I recommended for purchase, mainly oceanography serials and a couple of abstract journals.

I am still in contact with the Subcommittee on Resources and I have some progress to report as a result of my survey. The corrected union lists of serials for geoscience and oceanography have already been put to use by both librarians and researchers. I am happy to report that these lists have been found to be very useful. My report on the lamentable state of SSAL, (a 28% error rate according to my calculations for this set of serial titles), reached the right set of people at CSIRO and I hope that it will serve to galvanize them into action. Most of the fault lies with librarians too preoccupied to report their holdings to CSIRO. My recommendations for purchase have been discussed at a meeting of the Subcommittee on Resources and several recommendations have already been acted upon. My report was cited in a recent paper on collection development in special libraries as being an "extremely useful" contribution in a field which had not been documented before, (Tonkin 1983:19).

It was therefore a worthwhile project for AACOBS as well as for me. I learned something about Australian bibliography, quite a lot about Victorian geoscience collections, and met many valued colleagues. I had the satisfaction of, for once, being able to concentrate wholeheartedly on a research project and carry it through to its conclusion. So have I convinced you? Sabbaticals are good for you, physically (all that exercise), and mentally (all that work). Happy sabbaticals, everyone.

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APPENDIX

GEOSCIENCE INFORMATION SOCIETY

PURPOSE:

To initiate, aid, and improve the exchange of information in the earth sciences through mutual cooperation among librarians, earth scientists, documentalists, editors, and information specialists.

MEETINGS:

Annual, with that of the Geological Society of America.

MEMBERSHIP:

Open to persons and organizations whose professional activities are related to geoscience or who are interested in the purpose of the Society. Dues are $20 (individual), $ 30 (institutional) and $100 (sustaining). There are currently more than 300 members.

PROGRAMS:

The management, organization and dissemination of geoscience information.

PUBLICATIONS:

A directory of geoscience libraries, a union list of geologic field trip guidebooks, the Proceedings, and the GIS Newsletter.

PERMANENT ADDRESS: Geoscience Information Society
c/o American Geological Institute
4220 King Street, Alexandria, VA 22302