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COLLECTIONS FOR THE FUTURE:

ARCHIVISTS, CURATORS, HISTORIANS, BIBLIOGRAPHERS SPEAK

Edited By

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TABLE OF CONTENTS

PART III

POSTER SESSION

APPENDIXES

PREFACE

The Geoscience Information Society (GIS) is an independendent, nonprofit, professional society which was established in November, 1965. The Society was created to improve the exchange of information in the geosciences by cooperation of an international membership which is now composed of approximately 250 documentalists, editors, geoscientists, information scientists, and librarians. GIS is a member society of the American Geological Institute and an associated society of the Geological Society of America. The annual meeting of the Society is held concurrently with that of the GSA.

The proceedings consist of papers presented at the Annual Meeting. The papers published here are grouped in the way that they were presented at the meeting -- in a symposium, a technical session, and a poster session. As Program Chair, I convened the GIS-sponsored symposium entitled "Collections for the Future." The volunteered papers were part of a technical session entitled "History, Archaeology, Information and Education" which GIS cosponsored with the National Association of Geology Teachers and the Geological Archaeology and History of Geology divisions of the Geological Society of America. The volunteered poster papers are from the "Geoscience Information" section of Poster Session VI of the conference.

I wish to thank Laura Feld of MIT's Lindgren Library for typing and Diane Mayers of MSU's Science Library for typing and production help. I thank Jim O'Donnell, GIS Publications Manager, for doing several production chores, and for publishing and distributing these Proceedings.

Jean T. Eaglsesfield
1987 Program Chair

PART I

SYMPOSIUM:

COLLECTIONS FOR THE FUTURE:

ARCHIVISTS, CURATORS, HISTORIANS, BIBLIOGRAPHERS

SPEAK

INTRODUCTION

This symposium is a discussion of collections by archivists, historians, museum curators, librarians and geologists/administrators. It is important to address this topic because the present day situation in the earth sciences is rich yet bleak. Today, there is a wealth of materials--rock collections, teaching collections, data, research reports, company documents, and growing library book, journal, thesis and map collections--but all too often too little space and too little staff to organize and care for such materials. Beyond this situation lies the intellectual problem of the difficulty of assessing this large volume of material to determine what to keep for the indefinite future.

The archive community has worked in recent years to outline these issues and to give preliminary solutions. Four societies--the History of Science Society, the Society of America Archivists, the Society for the History of Technology and the Association of Records Managers and Administrators--formed the Joint Committee of Archives of Science and Technology (JCAST). This committee's final report, entitled Understanding Progress as Process: Documentation of the History of Post-War Science and Technology in the United States, edited by Clark A. Elliott (1983, distributed by the Society of American Archivists, Chicago) makes note of the large collections in most fields of science and the need to find a way to determine what to keep for the future. The report summarizes the development of discipline history centers in numerous fields of science and laments the fact that no such center exists for geology.

This symposium was convened as the result of a concern that many people in the earth sciences are coping with these problems (the librarian trying to help the family of a dear departed geologist determine where to send his/her papers, the harried professor with no time and staff to care for the department's specimen collection, or the manager who is told to go pick up the "records" of a small company that has been taken over) without knowing that such situations are extremely numerous in this field and without knowing the ideas that have been offered by the archive community. This is an attempt to bring together representatives from diverse walks of life in geology to talk about "collections" in general in the earth sciences and to see what kind of picture emerges. Each participant was asked to read Understanding Progress as a Process as the beginning point and to address specific issues in his/her field that are relevant to the JCAST report.

Deborah Day, Archivist of the Scripps Institute of Oceanography, opens the symposium by explaining archival theory and methods used by the archivist to determine which materials to keep indefinitely.

Since the federal government's work in the earth sciences is so large, it is fitting to look at archives and museum collections of that sector. Thibodeau and Melson discuss archives and museum collections of the National Archives and Records Administration and the Petrology and Volcanology Division of the National museum respectively, both giving succinct historical summaries of these earth science collections.

Socolow's paper carries the look at government agencies to the state level and is also valuable for its thumbnail sketch of the history and political setting of state geological surveys.

The JCAST report raises great concern for earth science data that is in the private sector, that so much raw data, documents, and manuscripts are not available to historians of science and to scientists. Sturdivant's paper shows that industry has clearly established the right to keep proprietary data and indeed he surveyed approximately 100 companies on their employee agreement policies. This paper raises the issue that industry support of history centers would insure that there would be a way to help properly dispose of those collections that are disbanded due to company downsizing or dissolution.

Turning to academic libraries, Rosalind Walcott's study of geoscience theses in the U.S. is a sobering reminder that even universities who are among the best archiving institutions in society and libraries renowned as great caretakers of collections and servers of the public, have their shortcomings. Theses in the earth sciences have characteristics quite different from those of most other fields, present unique preservation problems and are difficult to access.

No such discussion would be complete without representation of a curator outside the government. Julia Golden summarizes paleontological curating and professional societies involved in this. This paper also reports on her recent survey of 66 major collections and happily ends on a optimistic note, despite the discussion of "orphaned" collections.

The concluding paper, by Gerald Friedman, long associated with history of geology endeavors, sketches some history centers in other sciences and pleas for a center to be established for the field of geology.

Each paper summarizes and gives an excellent overview to a specific topic. Each raises challenges and points to issues that should be addressed. It is hoped that by having all these various professional points of view together in one symposium, the earth science community will be able to define issues and rise to meet these challenges as we build collections for the future.

I enthusiastically thank the authors for putting together such fine papers and for coordinating their ideas. Many people helped me develop the themes of the symposium and to find speakers. I especially thank Helen Slotkin, Institute Archivist of MIT, Clark Elliott of Harvard's University Archives and Michele Aldrich of the American Association for the Advancement of Science for their special efforts and encouragement.

Jean T. Eaglesfield
East Lansing, MI
Winter, 1988

ARCHIVAL DOCUMENTATION OF THE HISTORY OF GEOSCIENCE

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Abstract--This paper describes the historical and scientific research value of earth science archival and manuscript collections. The author concludes that it is necessary to selectively collect records of geoscience organizations, departments, programs and personal papers of individual geoscientists in order to fully document the growth and achievements of the field and support research on the history of geology.

The author reviews earth science documentation strategies suggested by the work of historians including Aldrich, Frankel, Porter and Schroder and geologists including Greene and Odishaw. The author describes archival theory and methods employed by archivists to select collections of enduring value from among the massive paperwork generated by scientists and scientific organizations. The work of Brichford, Elliott and Warnow are discussed, and the achievements of the Joint Committee on the Archives of Science and Technology are highlighted. The author concludes that archivists, historians, geologists and other scholars must work together to identify primary resource material documenting earth science, to develop, support, strengthen and advise archives that collect and preserve geoscience collections and to encourage research on the history of geology.

Archival Documentation

Scientists sometimes think of the history of science as utterly peripheral to their own intellectual interests, or as a study of the ancients and pioneers of their field. Even those scientists who have written histories of their discipline are sometimes startled to find an archivist at their own doorstep. I recently wrote Kenneth Emery inquiring about the fate of his personal papers. You may remember that Emery and Dietz (1976:19-22) wrote an amusing and informative account of their geological graduate studies with Francis P. Shepard in the 1930's. "My correspondence has systematically been discarded after three years," Emery (1987) wrote me,

> Seldom needed after that, it occupies
> more space than it is worth...

Fortunately other geoscientists have valued their papers more highly. Tuzo Wilson's papers were recently donated to the University of Toronto. Emma Rogers followed the examples of Katherine Lyell and Elizabeth Agassiz by editing and publishing a volume of the letters of her husband, William Barton Rogers. The Rogers Papers are at the Archives of the Massachusetts Institute of Technology. Harry Hess' papers are awaiting processing at Princeton University archives. Bruce Heezen's papers were preserved by Marie Tharp and are now at the Smithsonian. The National Archives holds the remarkable correspondence of John Wesley Powell. Why are these collections preserved? Who uses them? Why should the history of geoscience be documented?

Science has grown at an almost unbelievable rate in the United States during this century. There were only 38,000 engineers in the United States in 1900 (U.S. Department of Commerce, 1973, p. 140). In 1937 there were approximately 71,000 scientists and engineers in this country (The President's Scientific Research Board, 1947, p. 11). By 1984, there were over four million American scientists and engineers (U.S. Department of Commerce, 1986, p. 569). The American Geological Institute estimates that there are now 120,000 geoscientists in this country alone (American Geological Institute, 1987, p. 7). There were no petroleum engineers in 1859 when the first major oil strike occurred in Pennsylvania (Friedman and Poissant, 1985:217-226). Yet in 1987, half of all geoscientists — 60,000 men and women -- are employed by the petroleum industry (American Geological Institute, 1987, p. 7). The development of science in this country is nothing less than phenomenal. It has changed the daily lives of every citizen. It is such a powerful force that society must understand it. What is science? How is it organized and how does it grow? How does it affect the economy, the political system, and society at large? These are profound questions, questions that historians, philosophers and sociologists of science seek to explore.

Historians of geoscience study the establishment of geology as a scientific discipline, the development of geoscience methods, theory and terminology, the lives of prominent geoscientists, the history of geoscience industries such as petroleum and mining, great geological expeditions, and the history of geoscience associations, to mention just a few topics. Their work is vigorous and has attracted the attention of the intellectual community at large. Martin Rudwick's The Great Devonian Controversy has already had a great influence on how history of science is written (Rudwick, 1985) (Turner 1986:508-511). Papers on the history of the theory of plate tectonics by Henry Frankel, Bill Menard, William Glen, and many others, have raised important questions about how new scientific theories develop and how they are accepted or rejected by the scientific community.

Historians of science and historians of geoscience need access to materials which document the history of science in order to do their work. This documentation is large and various. It includes scientific and historical publications, reports, pamphlets and near-print material, and unpublished material such as correspondence, diaries, field notes, data, oral history interviews, photographs, films. This published and unpublished documentation is the raw material of history. It is the historian's data bank.

Historians of science are not the only scholars who need access to material that documents the history of geoscience. Geoscientists themselves often use this documentation to support their own scientific research. Hugh Odishaw (1962:80-86) has written about the importance of saving geoscience data. Longitudinal studies cannot be conducted without old data. Old maps and photographs are an invaluable aid to geoscientists interested in changes in landforms over time. Meteorological observations and descriptions of earthquakes have enduring value to scientists in many fields. Environmental scientists constantly seek old data on environmental conditions for comparison with recent data.

Science administrators also need access to historical documentation of geosciences. Geoscience manpower analyses require employment, salary and other old data in order to place current manpower status in perspective and prepare estimates of future employment trends. Scientists, science administrators and many others are concerned with the efficacy of scientific communication. Efforts to improve scientific communication must begin with an understanding of how scientists communicate now, and how they have communicated with one another in the past.

Sociologists of science study scientific communication and other forms of interaction among scientists and among scientific disciplines. Public policy scholars seek to describe the development of national science policy. Their work focuses on the historical development of science policy. This would be impossible to understand without access to both published and unpublished historical documentation.

Scientists use historical examples to persuade lawmakers and the public to support science education and research. It is no coincidence that the Office of Naval Research and the National Science Foundation were established just after the second world war, a war that scientists helped to win. Scientists want lawmakers and the public to remember their great technological achievements of the past in order to gain their support for future work.

I hope I have convinced you that it is important to document the history of geoscience. Now, how shall we document it?

I often visit prominent scientists seeking their papers -- their correspondence and subject files. One scientist told me that he had taken great pains during his long career to publish all of his significant findings. He told me that he wished to be evaluated by his peers and by history on the basis of his published work -- not on the basis of his hastily written correspondence and the unpublished remains of ideas that never panned out.

He has a point. The distinguished archivist Maynard Brichford has said that "published material forms the core of the modern archival collection" (Brichford, 1969 p. 11). Mott Greene (1985:97-116) has eloquently described the essential value of scientific literature as historical documentation. Greene notes:

> ...the historian's first responsibility is the study of printed sources. Unless this task is undertaken before more detailed study of archival materials, there will be no context into which the resulting work can fit.

The published literature of geoscience is essential documentation of the field, but it is not sufficient in and of itself to document the history of geoscience. "...Scientific papers are rarely explicit about the broad questions to which research is related," notes Bill Menard (1986, p.4) in his memoirs, "...so to understand why most papers are written, we must put them in the context of current theories." Frederic Holmes (1987:220-221) recently examined scientific papers and concluded with Peter Medawar.

> "That they are retrospective formulations of work previously completed. That they do not accurately represent the work they make public. That they are stereotyped according to canons of form dictated by the authority structure of scientific disciplines."

Scientific papers cannot tell us how an idea happens, or how a theory is accepted or rejected by the scientific community. Scientific papers alone cannot tell us how the discipline of geology emerged from natural history, or how geophysics distinguished itself from physics and geology. Primary sources -- unpublished material -- must be consulted if these important historical questions are to be answered.

It is, of course, geoscientists, not historians, who produce the historical documentation of their field. Geoscientists are the ones who collect the rocks, take the photographs, write the field notes, and correspond with their fellows. They are the ones who invent instruments and record data, write up experiments and publish their results in pamphlets, journals, monographs and in conference papers. Field notes, maps, books, data, samples, photographs, cores, correspondence: this is all documentation created by geoscientists for geoscientists. The value of this documentation is obvious when it is created. Most of it fulfills its original purpose and is then discarded, and rightly so. However, a very small portion of this documentation is of enduring scientific and historical value and ought to be saved. How do we identify and preserve this small part?

Maynard Brichford (1977, p. 1) speaks for all archivists when he notes that "the most significant archival function is the appraisal or evaluation of the mass of source material and the selection of that portion that will be kept." The History of Science Society sponsored a groundbreaking "Conference on Science Manuscripts" in 1960 to consider, among other things, what manuscripts should be saved for the use of historians of science (Conference on Science Manuscripts, 1962, 157p.). Since then, the archival literature has included many articles on the appraisal of scientific documentation. The work of Brichford

(1962) archivists Clark Elliott (1981), Joan Krizack, Helen Samuels, (Haas, Samuels and Simmons, 1985) and Joan Warnow (1985) is particularly worthy of note. However, one study stands above the rest, the final report of the Joint Committee on the Archives of Science and Technology (JCAST) (Elliott, 1983).

JCAST synthesizes and contributes to an appraisal philosophy for contemporary scientific records. JCAST provides insights into the creation and value of scientific records that are applicable to the records of geoscience. JCAST does not give easy answers to that difficult question, what shall we save. JCAST doesn't tell archivists to keep all correspondence and throw away all data. Obviously, no simple formula based on record types could possibly meet all the information needs of scholars. Instead, JCAST carefully explains that science during the post-war period is pursued collectively by groups of scientists working within institutional contexts. JCAST suggests that archivists, also working within institutions that nurture science, must work with scientists and historians to decide what records are worthy of preservation and what records are not.

This is an important point. It means that archivists cannot fully document the history of geoscience by collecting the personal papers of the ten or twenty or even one hundred most prominent geoscientists of today, although the personal papers of individual geoscientists are important and ought to be saved. Geoscientists don't pursue their work alone. Historians want to study more than scientific biography. Consequently, archivists need to preserve records that document how scientists associate and work. We need to save the important records of the institutions, industries, and professional associations that nurture and sustain the geoscience community. It is not enough to collect the papers of Alfred Wegener, although luckily the Alfred Wegener Institute in Bremerhaven has done so. The papers of the men and associations who opposed Wegener's theory must also be collected. It is not enough to collect the papers of John Wesley Powell; archivists must also collect the early records of the USGS and the papers of state geological surveys. It is not enough to have the personal papers of William Barton Rogers; archivists must also save the records of the M.I.T. geology and earth science departments, and the records of earth science departments in other academic institutions. It's great that the Benjamin Silliman papers are at Yale; but the important corporate records of the petroleum industry must also be preserved. Archivists don't need to save every record of every survey, association, natural science museum, or geoscience corporation, but archivists must identify and preserve a tiny fraction of the records of these institutions if we wish to provide scholars with a meaningful record of the history of geoscience.

JCAST makes an important distinction between the observational sciences and the experimental sciences. Observational scientists make observations of unique, non-repeatable phenomena. Clearly the geosciences are observational science. JCAST notes that data collected by observational scientists has near permanent value and should be retained because the subject of their study, in this case the earth, changes so slowly that data collected today may be useful for an extended period of time. JCAST (Elliott, 1983, p.33) instructs archivists collecting observational scientific records to retain them if scientists advise that the records have enduring scientific research value.

JCAST concludes that archivists already working in scientific institutions should appraise and preserve the archives of contemporary American science. The archives of Rensselaer Polytechnic Institute must be responsible for documenting geological education at that remarkable institution, and the lives of prominent Rensselaer geologists. Archivists at the National Archives should be relied upon to collect records documenting the history of the USGS. 3M Archivists should collect records documenting the work of early company geologists. This is a good, intelligent division of the archival work, but not all of the places that should have archives actually have one. Lamont-Doherty Geological Observatory does not have an archives, and Columbia University Archives does not collect Lamont records. The Maurice Ewing Papers were donated by his family to the University of Texas. Shell Oil Company has a records management program which schedules the disposition of corporate records, but Shell has no archivist to review its schedules and preserve the Shell records that historians may need in the future to write histories of the petroleum industry. I know of only one archives that is actively collecting records of the petroleum industry, and that is the Petroleum History and Research Collection of the American Heritage Center at the University of Wyoming.

The Colorado School of Mines is the oldest institution in the United States devoted exclusively to the education of mineral engineers. It was established in 1874. Sometime after 1950, masses of old Colorado School of Mines administrative records were discarded. Two years ago, the library of the Colorado School of Mines applied for and received a grant from the

National Historical Publications and Records Commission to hire a consulting archivist. The archivist recommended that the library start an archival program and apply for additional funding from the Commission. However, the library concluded that there would not be enough administrative support to continue the archival program at the conclusion of the grant, and therefore did not apply for it. Therefore no one is systematically collecting the records necessary to document this important institution.

In general, academic institutions operate many more archives than corporations do. Archives do not demonstrate a bottom line profit. This should concern historians because most geoscientists are employed by industry. The petroleum and mining industries, as Gerald Friedman (1978, p. 215) has noted, are trapped in a pattern of economic feast and famine, now depressed and cutting back their professional staff (Friedman, 1986:1587-1588). It may be difficult to convince some of these companies that they ought to start corporate archives.

The basic problem is that there are not enough archives serving geoscience institutions. There are not enough archives seeking and accepting geoscience records and the papers of geoscientists. Archives which are collecting geoscience records and manuscripts are not always well funded and often cannot process collections promptly. "...Efforts to preserve scientific records cannot succeed unless there is an increase in the number of repositories willing to acquire such records" (Janzen, 1980, p. 29).

The papers of many prominent geoscientists have been preserved and are available for the use of scholars at American archives across the country. The George Otis Smith Papers are at the American Heritage Center in Laramie, Wyoming. The Henry William Menard Papers and the Francis P. Shepard Papers are at the Archives of the Scripps Institution of Oceanography, University of California, San Diego. The Louis Agassiz Papers are at the Archives of the Museum of Comparative Zoology at Harvard. The Florence Bascom Papers are at Smith College Archives. These important collections have been saved. But what about the records of the Colorado School of Mines? What about the records of Shell Oil and other petroleum companies? What about the papers of today's prominent geologists? I must end by urging all of you to give this problem some thought and to discuss it with your colleagues. Existing archives can save some important geoscience records and papers. Historians of geoscience can write some important histories of geoscience from the sources at hand. However, geoscientists and geoscience institutions must support archives and cooperate with archivists and historians if a meaningful record of today's geoscience is to be preserved for tomorrow's scholars.

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FOR THE RECORD: FEDERAL GEOSCIENTISTS AND THE NATIONAL ARCHIVES

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Abstract--Since the early 19th century, federal geoscientists have displayed a commitment to the careful creation of record material. Recognizing the value of this material, their employers quickly established mechanisms for accumulating and organizing it, but did not always succeed in protecting it from loss by fire.

The constant threat of fire inspired support for construction of a suitably safe "national archival depository." Such a depository was finally completed in 1935. With the passage of the National Archives Act, the depository began to accept transfers of some of the earliest records of federal geoscience.

In recent years, as funds for keeping records have failed to keep pace with funds for creating them, the importance of retaining valuable geoscience information may have been overshadowed in the minds of many by recognition of a need to eliminate information considered superfluous. The National Archives now must cooperate with agencies involved in federal geoscience to balance these twin records-related concerns and to communicate clear records disposition instructions to present-day federal geoscientists who share with their 19th century colleagues a propensity for careful records creation.

The Recordkeeping Heritage

Any year now we will be celebrating the bicentennial of the inclusion of geoscientists in the federal bureaucracy. Very soon after the ratification of the Constitution, the federal government engaged in some kind of geoscientific activity - first, under the auspices of the Army and Navy and later, by 1807, under civilian sponsorship (Dupree, 1957, p. 24-29). Individual scientists engaged in the activity from its federal beginnings displayed a singular commitment to the careful documentation of their work. Ferdinand Hassler, an early leader of the federal geoscientific community, was among the first to articulate this commitment as he discussed with Congress the need to support the oldest civilian scientific agency, the Coast Survey. Having established the importance of documenting the work of the Survey, Hassler went on to point out that the value of this documentation extended beyond the Survey itself and should in fact "be considered national property" (Reingold, 1957, p.8).

Regulations relating to Coast Survey operations, drawn up in 1844, included two key passages covering documentation: 1) "immediately on the suspension of field operations, the work executed by the several field parties shall be delivered at the office of the Coast Survey in Washington;" and 2) "the chiefs of [field] parties [are] to make, at the end of each season duplicate journals and books of results, and return them to the office" (Reingold, 1957, p. 8). The regulations not only affirm a, by then, well-established recognition of the importance of keeping records of geoscientific field work, but also acknowledge that the records may need to be accessible to multiple users, some of whom worked in central office and some in the field. The 1844 solution was to direct that duplicate manuscripts be prepared, with one set deposited in central office and the other available to members of the field party for analysis.

The practice of establishing a central repository for geoscientific data gathered at federal expense, though probably originating with the Coast Survey, was not confined to that agency. Parties of the Army's Topographical Engineers engaged in exploration of the Western United States in the 1860's also forwarded records of their observations to a central repository, though not to one administered by their superiors in Washington. The War Department at that time displayed no continuing interest in geoscientific data, and encouraged its field parties to deposit any geoscientific results of their efforts with the Smithsonian Institution (Dupree, 1957, p.93).

In the late 1860's and 1870's, four comprehensive surveys of the West, conducted under the auspices of either the Department of the Interior or of the Corps of Engineers, yielded considerable geoscientific data. The data was accumulated by each expedition leader and deposited either with the newly interested War Department or with the newly established Geological Survey.

Following the example of what had, by 1878, come to be called the Coast and Geodetic Survey, the Geological Survey from its earliest days encouraged what appears to have been the natural propensity of its employees to document their field work. The reports to Congress from both the Chief Geologist and the Superintendent of the Coast and Geodetic Survey throughout the late nineteenth and early twentieth centuries include frequent references to actions taken to either create or accumulate records containing geoscientific data.

While the accumulation of geoscientific records in central reponsitories by the responsible agencies was intended to assure their long term preservation, it inadvertantly placed them at great risk in the period before fireproof structures became the norm. Both the collections and the geoscientists who relied upon them, like all federal records and employees at this time, tended to be housed in highly flammable wooden buidings. Reminders of this flammability eventually occurred with enough frequency to attract the attention of the Congress to the problem and to lend support to a growing movement for the construction of a fireproof building specifically designed to house valued accumulations of records created at federal expense. A particularly disastrous fire in the Geological Survey in 1910 inspired President Taft to request specific legislation authorizing construction of a safe Hall of Records in Washington (McCoy, 1985, p. 7). Such legislation was passed in 1913, but the necessary funds for carrying out the proposal were not appropriated until 1926.

By 1935, the building envisioned in the Taft administration was ready for occupancy; and an agency, The National Archives, had been established to administer its contents. The National Archives Act of 1934 placed under the "charge and superintendence" of the Archivist of the United States all archives or records belonging to the Government. The same act empowered the Archivist to requisition for transfer to the National Archives Building such archives and records as might be approved by a council comprised of, in addition to the Archivist, the heads of all executive departments, the Librarian of Congress, the Secretary of the Smithsonian Institution, and the chairmen of the House and the Senate Committees on the Library.

The Archivist's sole task in this early period was one of finding valuable government records most in need of or clearly eligible for transfer to a building guaranteed to house them safely. Among the first records to be recognized as eligible for relocation were hundreds of feet of records of geoscientific observations and surveys held by the Division of Library and Archives of the Coast and Geodetic Survey. In assuming custody of these records, the National Archives, very early in its history, established its concern for the preservation of federal records of geoscience. Though it might have, the Archives did not become the sole repository of federal geoscientific records. Records needed for current business and being safely maintained in agency custody - in particular, the records of the Geological Survey - were not requisitioned for transfer to the National Archives building.

The original National Archives act empowered the Archivist to take action to protect from <u>accidental</u> loss records agencies had elected to retain. Important legislation enacted in 1939 empowered the Archivist to take action if need be to prevent an agency from intentionally destroying its records. An Act Concerning the Disposal of Records, approved in August 1939, required each agency to submit to the Archivist a report of its intent to destroy records and to include in the report a description and examples of each type of record proposed for disposal. Records described on these lists considered by the Archivist to have permanent informational value or historical interest could be requisitioned for transfer to the National Archives building.

Though subsequent legislation affecting them has been passed by the Congress, the authorities and responsibilities of the Archivist with respect to federal records and to the agencies that accumulate these records - remain, in essence, what they were in 1939. Today, as then, federal records may not be destroyed without the Archivist's approval. Any federal records worthy of continuing preservation by the government are eligible for transfer to the National Archives.

A survey of the current holdings of the National Archives reveals that the following geoscientific records have been transferred:

From the Coast and Geodetic Survey:

Geodetic Reports, 1851-1911, 15 ft.
Azimuth Observations, 1844-1919, 425 vols., 16 ft.
Latitude Observations, 1833-1933, 1135 vols., 43 ft.
Longitude Records, 1844-1939, 775 vols., 65 ft.
Descriptions of Stations, 1834-1937, 525 vols., 30 ft.
Reconnaissance Notes, 1843-1912, 140 vols., 6 ft.
Base Measurements, 1833-1935, 610 vols., 31 ft.
Computations of Base Lines, 1857-1937, 7 in.
Observations of Horizontal Directions and Angles, 1817-1948, 22,400 vols., 1061 ft.

Computations of Plane Coordinates, 1934-1937, 44 ft.
Descriptions of Bench Marks, 1878-1938, 155 vols., 52 ft.
Spirit Level Observations, 1844-1939, 18,235 vols., 1000 ft.
Leveling Records, 1877-1937, 7 ft.
Observations of Vertical Angles, 1833-1929, 860 vols., 35 ft.
Field Observations of Terrestrial Magnetism, 1832-1930, 240 vols., 63 ft.
Observations at Magnetic Observatories, 1854-1935, 87 ft.
Seismograms, 1903-1930, 138 ft.
Data for the 1945 Magnetic Charts of the World, 1945, 60ft.
Gravity Observations, 1873-1919, 290 vols., 10 ft.
Hydrographic Survey Soundings, 1835-1929, 5210 vols., 450 ft.
Philippine Sounding Records, 1901-1918, 4385 vols., 159 ft.
Tide-Staff Readings, 1935-1939, 199 ft.
Descriptions of Tidal Benchmarks, 1854-1908, 1 ft.
Observations of Currents, 1844-1914, 555 vols., 29 ft.
Tide Station Leveling Records, 1846-1936, 1785 vols., 54 ft.
Correspondence from Field Parties, 1844-1910, ~200 ft.
Published Maps and Charts, ~64,000 items.

From the Geological Survey:

Correspondence of the Hayden, King, and Wheeler Surveys, 9 ft.
Records of the Geological Division, 1867-1968, 440 ft.
Correspondence of the Topographic Division, 1880-1962, ~200 ft.
Microfilm Copies of Field Notebooks, 1882-1962, ~4000 rolls.
Manuscript and Published Maps, 1869-1974, ~100,000 items.

From the Corps of Engineers:

Field Notebooks from the Office of Geographical Surveys West of the 100th Meridian (Wheeler Survey), 1869-1883, 500 vols., 25 ft.

Modern Recordkeeping Practices

Geoscientists at work today - whether in or for the federal government - continue the recordkeeping practices initiated by their predecessors in government service. They record - sometimes with the help of graphic instruments and computers - a vast quantity of data collected at field locations. The data relates to a wide variety of scientific disciplines - geology, oceanography, seismology, vulcanology, etc. In addition to recording data, federal geoscientists prepare reports, exchange memos relating to the administration of their research projects, and - it seems with decreasing frequency - correspond with professional colleagues concerning scientific matters.

The combination of these actions over an entire federal career can result in the accumulation of a considerable quantity of documentary material. What is its ultimate fate? Does it get saved for use by future geoscientists or, for that matter, by future historians of geoscience? Or is it discarded to lighten the load during an office move or to conserve limited space? The answer to all of these questions is: it depends...

on the existence of agency recordkeeping requirements;
on the success with which existing recordkeeping requirements are communicated to records creators;
and on the nature of the recordkeeping requirements.

<u>First, do recordkeeping requirements exist?</u>

We have ample evidence that they do, and have since the beginning of federal geoscience - especially with respect to observational data. Witness the accumulation of field notebooks resulting from instructions issued by Alexander Dallas Bache, Clarence King, J. W. Powell and their successors.

<u>How does one learn what these requirements are today?</u>

In the modern federal government, recordkeeping requirements may be articulated in a variety of management-authored issuances. These include:

1) directives, which inform employees that they must create or accumulate certain records in the course of their work;
2) file plans, which tell employees how to keep the records they are required to create or accumulate; and
3) records schedules, which tell employees how long they should keep a given type of record and what steps they should take to dispose of records they no longer need.

These separate formal documents, often written in inscrutable bureaucratese, may be recast as easier-to-read handbooks and manuals, intended for wide circulation within the agency. Periodic reminders of recordkeeping requirements have been known to appear in employee newsletters. For example, in the August 1985 issue of <u>The Cross Section</u>, the Chief Geologist reminded readers of requirements for handling all original recorded data of completed field projects.

<u>What is the Nature of Modern Geoscientific Recordkeeping Requirements?</u>

As the Chief Geologist's August 1985 message indicates, the requirements involving data have hardly been affected by the passage of years of federal geoscientific activity. He says (Hamilton, 1985, p. 3):

> "All field notes, field maps, photographs, annotated aerial photos, and other field documents acquired by (Geologic) Division employees in the performance of their official duties are Government property and form a very valuable part of official Survey records. The materials should be

deposited in the Field Records Library or the Photographic Library, both of which are in Denver, when they are no longer being used for a project."

In conveying this message, the Chief Geologist has paraphrased Ferdinand Hassler as well as a section of a National-Archives-approved records schedule that goes on to provide that records sent to the Denver Libraries be microfilmed, and a master copy of the microfilm be deposited with the National Archives (USGS, 1986, p. D-183).

Recordkeeping requirements for data - particularly observational data of the sort gathered by geoscientists in the field - tend to emphasize its retention. It is difficult to generalize about the requirements which relate to other types of documentary material created or accumulated by geoscientists. The requirements may vary from office to office and from agency to agency. Disposition of this accumulated material is subject to the approval of the Archivist of the United States, unless it is unrelated to official agency business.

As an example, the correspondence, printed material, abstracts, and graphic presentations providing background information on any project conducted by the Geologic Division of the Geological Survey are records whose disposition is subject to review by the Archivist of the United States. The records schedule which documents the results of the Archivist's review instructs geologists who accumulate this information to transfer it to a Federal Records Center ten years after the project is completed. Such records must be held in the Federal Records Center for 40 years before they may be destroyed (USGS, 1986, D-179).

Even the most thorough attempts to communicate information about proper handling of accumulated documentary material may not succeed in reaching all the federal geoscientists who need to know. Questions about the proper disposition of individual files will inevitably arise on moving or retirement day. When they do, they should be directed to a supervisor or to an official in the agency who has been assigned records management responsibilities. Questions about recordkeeping or records disposition may also be directed to the Office of Records Administration at the National Archives.

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NATIONAL COLLECTION OF ROCKS AND ORES

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Abstract--The Smithsonian rock and ore collections had their origins in the mid-nineteenth century, during the time of the early surveys of the American west, such as the 40th Parallel Survey collection. The collections were dormant during the Second World War, were reactivated about 1964 and now consist of about 180,000 samples. The collections (1) document major discoveries and/or are relevant to major problems of current interest, such as the G.J. Wasserburg collection of isotopically studied rocks from West Greenland that are over 3 billion years old; igneous and metamorphic rocks from the deep-sea floor; and secular sequences from active volcanoes, (2) include genetic groups, e.g.layered complexes; ultramafic nodules; and especially of such collections assembled by petrologists who have specialized in particular groups of rocks or ores, such as the Dale Jackson Collection; the Cross, Iddings, Pirsson and Washington (CIPW) Collection of igneous rocks, (3) document the approaches of well-known early geologists of the late 19th and early 20th centuries, such as Barrell's Marysville collection re magmatic stoping; and some early collections of Waldemar Lindgren, (4) samples that are of interest and cannot be readily re-collected e.g. Comstock lode mines, Miyaquez and Uvalde drill cores, and (5) collections relevant to applied geology. During the period 1980-86, 2375 samples were loaned to outside investigators. The future of the collections depends on donations of "meaningful" (likely to be used) samples from researchers. Samples described in the geologic literature that bear on topical problems are particularly valued.

Introduction

In spite of their importance, rocks and ores have received far less attention in most museum and university collections than the other "hard rocks": minerals, gems and meteorites. The problem is partly that of not appreciating that which at first glance appears commonplace, while treasuring that which is rare, especially if showy as well. Perhaps this point of view is best summarized by long-term meteoriticist and a curator emeritus Edward P. Henderson who refers with affection to our Division of Petrology and Volcanology as the "Division of Curbstones". Yet, rocks and ores are scientifically no less important than their inseparably related components nor their cosmic sisters. In a museum environment, a largely biological one, I view petrology as a kind of geological ecology, bearing a similar relationship to mineralogy as biological systematics does to ecology.

This paper intends to review the history of our rock and ore collections, the current state of our computor-based collection information system, and, finally, to address future purposes and needs of such collections. More importantly, I wish to make our collections more fully known to the geological community, so that they may serve those who have need of them and at the same time increase their value through suitable contributions.

History

The history of the Mineral Sciences collections (Mason, 1972) bears directly on their present status and on predicting their likely future. It is also relevant to all institutional natural history collections. The Smithsonian collections were off to a unique and strong start through the original endowment of englishmen James Smithson. His original collections were housed at the Institution but were lost in a disastrous fire in 1865. They consisted of "a cabinet, which ... proves to consists of a choice and beautiful collection of minerals, comprising probably eight to ten thousand specimens, though generally small, are extremely perfect, and constitute a very complete geological and mineralogical series, embracing the finest varieties of crystallization, rendered more valuable by accompanying figures and descriptions by Mr. Smithson, and in his own writing. The cabinet also contains a valuable suite of meteoric stones, which appear to be suites of the most important meteorites which have fallen in Europe during several centuries." (Goode, 1897, p. 305).

The subsequent development of the collections reflects the interests of the sequence of Smithsonian Secretaries and geology curators, as well as national activities. In 1853, J. Lawrence Smith established under then-secretary Joseph Henry a chemical laboratory for the analysis of minerals and meteorites. Smith's interest in specimens reflected a time scientific appreciation of collections but, alas, a short one. Smith left the Smithsonian in 1854.

After 25 years of collection inactivity, Professor Thomas Egleston of Columbia University was employed at the Smithsonian in 1861. His activities appear to have not been in the best interests of the Smithsonian Collections according to George Merrill (1925). Many suites were sent to Columbia University so that they might be assembled into a single coherent collection there, with duplicates exchanged, and the remaining high-graded collections returned to the U.S. National Museum. Evidently, this effort did not go well, and many collections were dissipated or depleted during this time. According to our present records, we have no described rock or ore collections that date prior to 1870, possibly reflecting the loss of these early collections.

The impact of national activities were felt at the Museum from 1873 to 1879, when the collections were managed by F. M. Endlich. He worked with the Hayden surveys in Colorado, and many specimens from that survey found their way into the National Collections. In all, the collections then contained about 6300 specimens. The Bicentennial Exhibition of 1876 included many newly obtained minerals, rocks and ores. Their acquisition began a period of major collection growth and in 1880 the Institution was re-organized and greatly expanded to take care of the newly acquired collections not only in mineral sciences but in the arts and industries, the name given to the Arts and Industry Museum which was built at that time. A newly formed Department of Geology was chaired by George W. Hawes, with three assistants, one of whom was to play a critical role in the future of the collections of mineral sciences: George P. Merrill.

Eventually, in 1897, George Merrill became head curator of a newly organized Department of Geology, with three divisions: Physical and Chemical Geology, Mineralogy and Stratigraphic Paleontology. Merrill also served as curator of physical and chemical geology. The rock and ore collections grew rapidly under Merrill, spanning about 1890 to 1920 (figure 1).

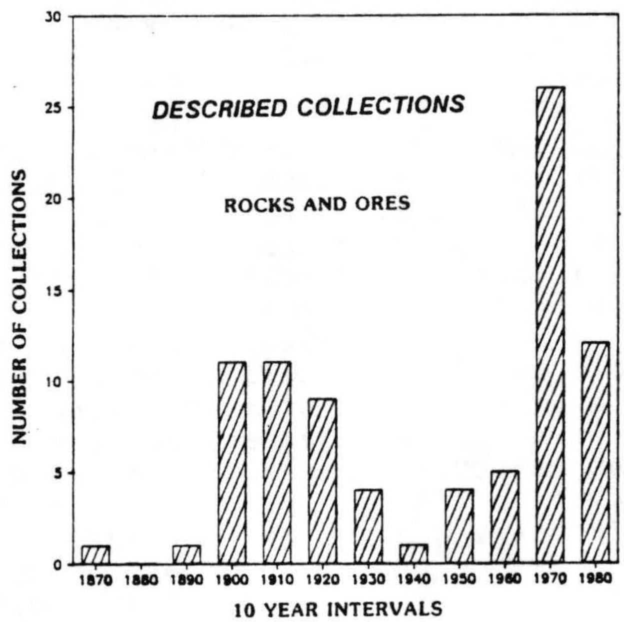

Figure 1. Growth of described collections

The Department remained unchanged organizationally until 1963, when it was split into the departments of Mineral Sciences and Paleobiology, the current structure. The rock and ore collections were preserved and grew somewhat under Chairman George Switzer in the fifties and early sixties. In 1964, Mineral Sciences was divided into three divisions: Mineralogy, Meteorites and Petrology. I was hired in 1963 as Curator-in-charge of the rock and ore collections by George Switzer and Paul Desautels, then curator-in-charge of Mineralogy. I began adding described collections (figure 1) after about 35 years of little activity. During that interval, the rock and ore collections remained intact, except for the transfer around 1943 of a large collection of building stones to the Bureau of Standards. These were assembled into a wall for the purpose of studying the relative weathering rates of the diverse rock types (Kessler and Anderson, 1951, p. 1).

Around 1970, because of heavy involvement in volcanology, the Division of Petrology was designated as the Division of Petrology and Volcanology. In 1972, Tom Simkin and, in 1976, Richard Fiske joined the Division strengthening research in volcanology. In 1984, Sorena Sorensen began to strengthen the collections in metamorphic rocks and to participate heavily in curation.

Some Notewothy Collections

It is clearly not possible to review our 180,000 specimens, but it is possible to give some sense of them by highlighting the major collections.

The CIPW Collection (Cross, Iddings, Pirsson and Washington) collection of about 2000 igneous rocks beautifully documents a critical time in the development of igneous rock systematics. Joseph P. Iddings, appointed honorary curator of petrology in 1916, began work on this and other collections, and continued until his death in 1920. Whitman Cross was in this honorary position until his death in 1940. This brought two of the authors of the CIPW rock classification to the Smithsonian. A third author, and the source of many collections, H. S. Washington (figure 2), was then at the Carnegie Institution's Geophysical Laboratory. Cross assembled samples he had collected, some from Iddings and Washington, as well as numerous others, many from the U.S. Geological Survey, into a collection of about 2000 rocks comprising most of the types established by the CIPW system. This collection was assembled under the support of the U.S. Geological Survey and officially transferred to the Museum in 1923. Each sample is documented by a thin section, chemical analysis and petrographic description meticulously typed on a file card. We have maintained these samples, file cards, and the original cabinets which housed the file cards. This remarkably well-organized collection remains a useful one for the purpose for which it was intended: as a reference for most types of igneous rocks, even though the elaborate nomenclature it documents is no longer used.

The The Ore Collection contains samples from many now-closed mines from the American west. The collection is arranged by ore type, and includes an "Industrial" mineral section, containing things like abrasives and fire clays. This collection was largely assembled during George Merrill's time, the late nineteenth and early twentieth centuries. Because we have no curator specifically interested in ore deposits, this collection has not grown significantly since that time.

The Lithologic Series reflects the deep interest that George Merrill had in samples illustrating geological processes, such as ventifacts, salt casts, and concretions. These were assembled into a unique collection, still intact and used in exhibits and in museum education programs.

The Building Stone collection still includes about 2000 samples representing major types from the U.S. and abroad.

The Petrologic series is a systematic collection of about 7000 igneous, metamorphic, and sedimentary rocks, which has value because of wide coverage of both common and rare rock types.

The Locality Collection Series is our largest one, containing about 90,000 specimens mainly of early and more recent collections described in the porfolios, bulletins and professional papers of the U.S. Geological Survey. The rapid growth in described collections in the early part of this century (figure 1) reflects the addition of many such collections. The Becker (1882) collection from the Comstock Lode was added during this time.

The Active Volcano series contains sequences of samples erupted at precisely known times that are a most valuable part of this collection. Most of the 6000 specimens are not only described, but cannot be recollected because of burial of early flows or pyroclastics by later ones. Co-operations with the U.S.G.S. Cascade Volcano Observatory has produced an exceptionally well-documented sequence from Mt. St. Helens. Recently, a large collection of dated eruptives from the U.S.G.S. Hawaiian Volcano Observatory, from eruptions of Kilauea and Mauna Loa volcanoes, was transferred through Thomas L. Wright, Director.

The The Oceanic Rock Collection contains about 10,000 rocks dredged from depths of over 1000 meters from or near sea-floor spreading centers. Most are basaltic pillow lavas, but some plutonic and metamorphic rocks are included as well. Most of these collections are described, and about 6000 glass samples, mostly chips from the rinds of pillow lavas, have been assembled under the Smithsonian Volcanic Glass Project. The samples were obtained through collaborative studies with a number of oceanographic institutions, and during cruises in which our staff participated. Geoff Thompson of the Woods Hole Oceanographic Institution has been a major contributor.

The The Dale Jackson Collection includes samples from the Stillwater Complex, samples from other layered complexes, some associated with ophiolites. Also, a large collection of ultramafic and mafic nodules is an important and frequently used part of this collection. The collection contains about 6000 specimens and 2500 thin sections and was assembled and described during the career of U.S. Geological Survey Geologist Everett Dale Jackson.

The Impactite Collection consists of a samples from a number of major impact or suspected impact sites, and includes samples collected by Bevan French, Bob Fudali and others.

The Exhibit Collection in the "Restless Earth Hall" contains many exceptional rock and ore specimens and on occasion some of these have been loaned for short-term exhibits. About 1000 exhibit quality specimens illustrating salt casts, ventifacts, and numerous other features are not on display and make up our Petrologic Features collection.

Collection Information Data Base

Much information on individual samples and, in some instances, collection level information, are now in data bases on the Smithsonian mainframes. Improving the completeness and accuracy of that data base is an ongoing project. At this time, requests for information in regard to specific localities, donor name, rock or ore type, location in collection and other parameters must be directed to the curator-in-charge, Petrology and Ore Collection. We are now preparing short-form databases suitable for personal computer searches.

Collection Usage

Samples from our collections now and historically have played an important part in Earth Science research. They have been described or referred to in over 1000 published references. Mineral Science staff and outside researchers continue to re-examine samples. Often, some portion of the sample is allowed to be consumed for analysis or for thin-section preparation. It is up to the requester to justify such destructive analyses, and in no case do we allow consumption of an entire specimen nor loss of critical textural features during sub-sampling. Our ability to respond in a timely way is dependent on the level of collection assistance and the size of the request. We require that all unused powders and that any thin sections that are prepared by returned to the Smithsonian, normally within one year, and that we receive copies of preprints and reprints which include data on the samples. This information is added to a data base to gauge collection usage and to inform future users of what is known about particular samples and collections. Between 1980-86, we provided about 2375 specimens to researchers.

Future Directions

We anticipate growth in the size, quality, computer-accessible data, and in usage of our collections. This will come about because of communication to more and more of the scientific community about the content and value, and the ongoing growth in geological research. This paper and its presentation at the special Geological Society of America symposium "Collections for the Future", organized by the Geoscience Information Society, is a move toward enhanced communication.

Collections like ours face important problems. Good curation and collection management, ranging from the solicitation of collections to the numbering and labeling of each sample require much time. Our staff directly involved with the Petrology and Ore Collection on a day-to-day basis consists of two geologists, both busy with research projects as well as collection matters, and three support personal, including a collection manager and two technicians. We find this is just about adequate meet our present collection workload yet many desirable tasks must go unmet.

Adequate space for our collections remain an ongoing problem. Already, we have very little space remaining for collection expansion, in spite of the recent completion of the Museum Support Center in Suitland, Maryland. We are dealing with that problem in three ways: petitioning our administration for yet more space, preserving some seldom-used collections in well-labeled boxes instead of cabinets with drawers, and loaning and exchanging collections when we are assured that they will be preserved.

More and more our role has been to encourage collection growth at other institutions. We long ago passed the time when any single institution could meet National no less international reference collection needs. We applaud the curatorial programs and staff of the Deep Sea Drilling Project and now the Ocean Drilling Program and of the various oceanographic institutions. Although we have no funding to directly support curatorial programs, we have worked with individuals and institutions to secure such support from the National Science Foundation and elsewhere. Our role as the National Museum will continue to be a key one. As possible, we note the whereabouts of critical collections are refer users to them when we cannot be of help.

Acknowledgments

The contributors, users and supporters of our collection efforts too numerous to individually acknowledge, but they are responsible for the current content and value of the rock and ore collections. The collection's value and availability depend critically on a number of peoples who work in the collections, especially Lynda Crouse, Geneva McClain, and, until recently, Harold Banks. I am particularly indebted to Sorena Sorensen who kindly consented to present this paper when I was unable to attend the symposium and, more importantly, I appreciate her commitment to our collections and to specimen-oriented research. Tom Simkin is important advisor and supporter of curatorial matters. Dick Fiske, Bob Fudali and Janet Gomon of the Museum have provided much of the administrative support needed in supporting the rock and ore collections. Finally, I wish to thank Jean Eaglesfield for pulling the Symposium and this volume together. Her frequent reminders of deadlines is especially necessary and appreciated.

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EXTENT AND LIMITS AT STATE GEOLOGICAL SURVEYS

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Abstract--The fifty State Geological Surveys vary in institutional designation, size, funding, and scope of missions. Yet they all have in common that each is a government agency which functions at the interface of basic research and public service. This dual function creates unique opportunities as well as delicate responsibilities.

As research agencies, State Geologic Surveys acquire vast amounts of quantitative and qualitative data as well as reference collections of minerals, fossils, and stratigraphic units. The challenge of research calls for effective integration, analysis, and interpretation of accumulated data.

As service agencies, the State Geological Surveys have an obligation to make their data available and accessible to the public in a timely and meaningful format. Aside from the limited capability that many of the State Surveys have to cope with with accumulated data, a serious problem exists with the need to protect the confidentiality of certain critical data. For a governmental service agency, operating under right-to-know laws, this poses a dilemma, for future data acquisition often depends upon respecting confidentiality.

Retirements and staff turnover also impose a data management responsibility upon State Geologic Surveys. Individual project records and notes must be maintained and filed in an accessible and usable manner for the benefit of continuity, future research, and public utilization.

Before I discuss the status and future of information at State Geologic Surveys, it's desirable that you have a clear understanding of the nature and roles of State Geologic Surveys.

There are actually fifty State Surveys in existence, even fifty-one when you count that of Puerto Rico. While the Surveys have a commonality of purpose, there is considerable diversity in such aspects as formal titles, affiliations, responsibilities, sizes, and histories.

Titles range from State Geologic Survey, to Bureau of Mines and Mineral Resources, Geology and Land Survey, Geological and Natural History Survey, Bureau of Economic Geology, Division of Land and Water Development, Division of Geological and Geophysical Surveys, Topographic and Geologic Survey, and several other variations.

Approximately half of these geological agencies are located on or adjacent to university campuses; many of these are administratively affiliated with the universities, even though they are functionally mandated by state law.

The other half of what can generically be called State Geological Surveys are administratively and physically part of state government, being commonly located at the state capital grounds. They are variously attached to Departments of Natural Resources, Economic Development, Commerce or Conservation.

The State Surveys, again generically speaking, range in full-time staff size from a high of about 130 (as in the case of Illinois) to a low of one geologist (as in Massachusetts, New Hampshire, and Rhode Island). And of course the budget range among the State Geologic Surveys in comparable.

I should note that there is not a direct relationship of Survey size to state population or to mineral resources; the political climate and leadership have in many cases been the decisive factors.

Because it relates to the subject of accumulated data about which we are concerned, it should be noted that there is also a considerable range in the historical record of the State Geological Surveys. The earliest Surveys originated in the early 1800's; between 1825 and 1838 some 17 State Geological Surveys were founded (some fifty years before the U.S.G.S.). All but a few of the existing State Surveys are well over fifty years in age. Thus, we are dealing with a group of state agencies which individually and and collectively have assembled an extensive body of data.

Beyond the common, basic geological role of Surveys are individual variations in designated responsibilities; some Surveys are responsible for carrying out a program of topographic mapping; some Surveys have water responsibilities, although even that varies as some deal with both surface and ground water while others work only with ground water. Some State Surveys have regulatory and permitting responsibilities of such activities as oil and gas well drilling, water well drilling, core drilling, mining activities, waste disposal siting, etc. Most Surveys, however, do not have such regulatory responsibilities, and from personal experience at the Pennsylvania Survey I can tell you it is no bargain. While permitting and regulatory activities do provide additional data, the price is high as no one likes a policeman. Actually, as far as the geologists at the State Survey are concerned, many data sources dry up when the geologist is identified as being affiliated with a regulatory agency - even though the geologic work is not regulatory. Mining operations, for example, are afraid that their information will get to state inspectors and regulators, or even to the IRS and State revenue people.

Still in the realm of diversity of missions, while some of the State Geologic Surveys apply much of their effort to basic geologic research, others do not, and function primarily in the areas of geologic mapping and and geologic data collection; such functions result in significant accumulations of data, examples of which I shall enumerate shortly. Other State Surveys, primarily the smaller ones, operate primarily in the area of geologic advice and services, and do not generally accumulate significant quantities of data.

As one might anticipate when dealing with a complex natural science and with government agencies of considerably diverse functions, the varieties of data accumulated are many. There are the physical collections, often times overlooked when enumerating data on hand. Every State Geological Survey of whatever size, function, history, and affiliation has some such data. Physical specimens are inherent in the nature of the science of geology and are important for applied and basic research. Specimen collections may be limited to samples of economic mineral varieties of the state, or the collections may be extensive, including systematic collections of minerals, fossils, and rock types which occur in the respective states. In addition, some states maintain core libraries with representative drill cores showing either the stratigraphic succession at a site, or mineral relationships in significant bodies of ore and industrial minerals. There are also systematic collections of drill cuttings taken from oil and gas wells, as well as water wells.

Those physical collections present a challenge to the state agencies. They require considerable space and storage equipment such as shelving and cabinets, and particularly manpower to organize, prepare, and maintain the collections. Because of the continuing availability of new specimens, the growth of the collections must be monitored and selective, keeping in mind the basic purpose of each physical collection. And, most important, the collections are useless if they are not reasonably accessible to interested parties, particularly industry and the public.

The written data on hand at State Geological Surveys varies according to the functional emphasis and historical development. Most common are geologic records acquired through geologic mapping by staff, as well as provided by the industrial and academic communities and by federal agencies. Some may not have recognized that geologic maps, field notes, and topographic maps are actually data collections, but in this era of digitization and scanning plotters the data aspects of such maps and notes are readily apparent. Maps, of course, provide two-dimensional data, but when we add the geologic information provided by drill holes and wells, we have acquired third dimensional geologic data. Pennsylvania, with its long history and continuing activity of deep coal mining, has acquired thousands of drill core records, many provided by the coal companies and many by Survey contract drilling.

There has been a real challenge to convert the voluminous physical files of two and three dimensional geologic data, which commonly occupy many rooms, to modern computer systems capable of storing and retrieving that data quickly and efficiently with minimum space requirements.

Other varieties of data which have been accumulated by State Surveys include mineral resources data, including both geologic parameters and production figures; water well records which involve locations, depth yields, aquifer identifications, and mechanical specifications. For states like Pennsylvania which require individual well reporting, the data on 25,000 new water wells each year has resulted in a monumental quantity of records whose space requirements were overwhelming. Fortunately, computer programs have relieved the space problem, although a manpower problem has arisen to convert past accumulated data while keeping up with the influx of new data.

Many State Surveys have also been involved with geophysical exploration carried out either by staff, by contract, or through voluntary submittals by industry. Here again records have accumulated in great quantities which are now being processed and stored via computer systems.

Oil and gas producing states, some thirty in number, accumulate vast quantities of down-hole data. Pennsylvania, North America's first oil producer in 1859, got a late start in collecting oil well data, but now has considerably over 100,000 well records which are slowly and with difficulty being transformed into computer language for storage, retrieval, and manipulation.

To the above data varieties at State Surveys should be added records on geologic hazards, such as landslides, sinkholes, mine subsidence, flooding, and currently the hot subject of radon occurrences.

Without further elaboration on the range of data among the State Geologic Surveys, let us consider some of the attendent problems and issues beyond those of storage and retrieval. First, they must serve the needs of fellow governmental agencies, primarily state agencies, but also federal and local government agencies. Serving their needs means being aware of their needs and pursuing the appropriate data in a timely and orderly fashion. This may involve rock characteristics and topographic data for the Highway Department's routing and excavation activities; mineral resources data for the Commerce Department; water data for the Agriculture Department; bedrock data for General Service Construction projects; radon data for the Health Department, etc.

Industry and the general public depend on State Geologic Surveys for reliable and timely data on a variety of subjects, including minerals data to aid in exploration and development of mineral resources; lithologic data to plan for excavation and construction projects; water data for commercial and private water supplies; stratigraphic data for land use planning and for conservation practices; hydrologic and structural data for power plant siting and for waste disposal sites; and even fossil and mineral data for mineral collectors and Scout groups.

I should mention that among the most frequent users of Survey data files are geologic consultants who depend heavily upon Survey files and publications to service the needs of their clients.

Being staffed by competent scientists, State Geologic Surveys are under continuing pressure for data needed to conduct creative research by the staff geologists. In the face of limited funds and manpower there is sometimes an internal conflict whether to pursue the data needed for research versus that required by industry, the public, and fellow government agencies. It falls to the administering State Geologist to walk the tightrope of this thorny issue. The challenge is to keep the staff happy while still providing for the data needs of the "customers".

As government agencies, State Surveys face a major data problem with the issue of public right-to-know vs. data acquired on a confidential basis. Geology, truly a three-dimensional science, needs as extensive an areal and sub-surface data base as possible to develop meaningful interpretations. Thus, the data base depends not only upon that acquired by the staff, but also that solicited from or volunteered by the private sector. But industry may have costly and valuable exploration data on properties not yet under their control. Yet they are willing, on many occasions, to let State Surveys have access to such data in recognition of the Survey's ability to develop a regional geological interpretation based on data from a wide variety of sources--provided the Survey can guarantee that the individual company data are kept confidential. This may involve confidential or locked files. And it may mean entering the data into a computer system in a manner that is coded confidential and somehow tabbed for non-retrieval by the public.

The matter of confidential data is particularly sensitive if the State Survey is a unit of a regulatory agency, as was the case in Pennsylvania. After we became part of a department with regulatory functions, there was a knee-jerk reaction by industry not to share data with us for fear that we would share it with the regulatory bureaus of the Department, resulting in possible punitive actions. We had to convince industry that we of the Survey were the good guys who could keep a promise to hold data confidential and that our integrated interpretations would be beneficial to the industry sources. I must admit that maintaining confidentiality in the face of right-to-know laws creates delicate situations, raising questions of both legality and conscience. As a practical example, the U.S. Bureau of Mines provides to the State Geologist mineral production records, company-by-company, with the stipulation that they be kept confidential. I kept them in a personal files and released only integrated totals to my staff as needed.

Radon offers another aspect of data sensitivity. If measurements of a home or property indicates a high concentration, the release of such data can do immense economic harm to the property owner, and even the entire community involved. Thus, Pennsylvania radon measurements are being kept confidential and released only to the property owner. There is, of course, always the concern of possible leaks by staff researchers.

Mention might be made here about the handling of records and notes when a staff member leaves a State Geological Survey, be it by retirement of change of position. It is the general policy that all geologic data developed on the job belong to the Survey and are retained by the agency when the staff member leaves, for whatever reason. Notebooks, maps, preliminary texts, and all other records are retained on open file. Open file is the status of all our data, (except the confidential) though in Pennsylvania we have had a legal ruling which states that data from an incomplete project in progress may be withheld, pending verification and editing.

While at present there are no formal plans for standardization of data systems amongst the State Geological Surveys, it is gradually developing in two ways: First, many states are engaged in identical cooperative data systems with the U.S.G.S., as in the case of NCRDS, a coal data program, and water data programs such as STORET and WAMIS and WATSTORE. There are also co-op data programs for topographic mapping and mineral resources.

The State Geological Surveys also share techniques via the Association of American State Geologists which meets twice annually and also publishes state program summaries and periodic newsletters. There is a very cordial and cooperative working relationship amongst the State Surveys, and a ready willingness to share methodologies.

In summary, the range of functions assigned to the State Geological Surveys, the diversity of users and their respective needs, the limitations imposed by staff, space and budget, and the conflicts between governmental and industrial responsibilities, all make for a difficult challenge in the assembly and management of the wide array of data involved. No single set of guidelines can address the data needs of every State Geological Survey. Certainly the respective data collections will continue to expand and to adopt now technologies, if for no other reason than the fact that the demand for geologic data is continually increasing.

GEOSCIENCE PROJECT DOCUMENTATION: ARCHIVAL ACCESSIONING AND PROCESSING PROCEDURES OF U.S. INDUSTRIAL RESEARCH RECORDS

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Abstract--One hundred ninety-five profit-making corporations conducting geosciences-related research at approximately 245 laboratory sites in the United States have been identified. Because of the nature and ends of this research work, most of the records and reports generated as a result of it (legally defined as "intellectual property") are closely held and are never published or otherwise made available outside these companies.

Ironically, this closely held geoscience information receives substantial attention internally and is frequently cared for very systematically by information management specialists who are more likely to be held accountable for what they can retrieve, than lose; and for what they preserve, than for what they destroy.

Interestingly, the present-day industrial environment of mergers and down-sizing resulting in personnel layoffs, early retirements, etc., is creating major documentary deficiencies in this information, and future access to it will no longer simply be a problem of the outside world, but also to the company that paid for it.

Recognizing and Understanding the Problem

This study was designed as a straightforward clarification of some of the underlying reasons for what some have perceived as a serious deficiency in the transfer of scientific information (Elliott, 1983, p. 12). It's an attempt to explain the problem of limited public knowledge of, and access to, proprietary geoscience research documentation generated by U.S. companies.

Researchers, archivists and historians of science have recognized problems in dealing with closely held and unpublished corporate research information. Schuchman (1981, p. 259) in her noteworthy study of scientific and technical information transfer in U.S. companies wrote:

> "A large amount of . . . work is recorded in internal reports for exclusive use within the firm. These probably contain a significant amount of the basic research done in industry . . . Little is known about this form of information. There are few measures of the size of this literature or any of its characteristics"

And Rossiter (1984, p. 298) in a review commented:

> "The weakest sector for science archives, according to the Joint Committee, is that of industry, especially small businesses which do much of the innovative work in technology and engineering but which rarely maintains an archive or have any sort of records management"

Rest assured, with hundreds of millions of dollars spent each year by private U.S. industry in the area of geoscience research in order to develop new prospects, new techniques and devices (or to improve old ones) and generally to gain an edge over competitors, the resulting documentation is being managed as the valuable business resource it is (Goodhue, 1987, p. 1). And, as we will see later, for the most part it is being archived for the future. However, from a corporate standpoint, just precisely what this documentation has to do with the special problems of archivists and historians concerned with the history of science, is something that, as you can imagine, is not readily appreciated.

Geoscience Research--Internal Documentation

There are abut 200 U.S. for-profit corporations conducting some form of scientific/technical research in the geosciences. In the main, this research work is being done for the parent firm (as opposed to government contract work, contract work for other companies, or as consultive work for others). Included are petroleum and mining companies as well as environmental/remediation, service and engineering geology firms.

It's probably fair to assume that each of these research programs is conventional in that its end-products are "studies", "papers", "histories", "analyses", "reports", etc., typically resulting from three main phases of research activity (Lewison, 1960, p. 300):

Phase I. Problem Formulation and Planning
Phase II. Experimental, Observational and/or Statistical Data Gathering
Phase III. Presentation of Results

Phase I. This documentation includes: statement of the research program, definition of its objectives, establishment of its budget and provision for its staffing, description of its techniques, provision for its tools, e.g., sample design or laboratory apparatus, and a time schedule or sequence of operations. Most of this documentation remains unpublished and frequently it is archived on microfilm in corporate records centers away from the research facility as a requirement of auditors.

Phase II. Documentation from data gathering is unique in that there are few research projects whose data are made wholly available, in some final, recorded form, as a report, a set of tabulations, a map, or other kind of document. Depending on the nature of the research project Phase II data are documented in a variety of ways ranging from being recorded in laboratory notebooks by geochemists, in field notebooks by stratigraphers, or on optical discs by geophysicists.

Most of this documentation remains unpublished and much of it is eventually archived as hard copy at file centers located at the research facility site. In the last several years, significant employee staff downsizing from terminations, retirements, etc., has occurred in many geoscience research organizations in the U.S. It has become increasingly popular to store records and documentation left behind by the more conscientious former employees in original, unevaluated form at offsite storage facilities. Less conscientious individuals either developed their own ad hoc "scorched earth" or "what's mine is mine and what's your is mine" policies. Major documentary deficiencies have occurred in instances and some information has been lost forever. When accessioned, Phase II information is usually microfilmed (when possible) for disaster recovery.

Phase III. This documentation includes final internal reports and manuals as well as published articles and delivered papers, i.e., the presentation of results. However, most of this documentation remains unpublished and it is always permanently retained. Usually it receives very sophisticated treatment from bibliographic control and disaster recovery standpoints.

Ownership

The bulk of documentation flowing from corporate geoscience research is considered proprietary information and in many instances neatly fits into the legal definition of a trade secret and, if not, is certainly intellectual property owned by the company that paid for it. The law has long recognized that this documentation is entitled to special protection (Brooks, 1982, p. 229). Courts have held that employees should not be allowed to breach the confidences entrusted to them by using an employer's documentation to the employer's detriment. However, such protection must be balanced against the right of employees to exploit their talents and to pursue their profession without undue hinderance. Most of us can understand a company's concern if its confidential documents, maps, diskettes, etc. are being "misplaced" by departing employees. But does the law preclude an existing employee from discussing his/her work from memory with a former professor at a scientific meeting? Maybe, if the employee has signed a confidential information "employee agreement".

Employee Agreements

In most geoscience research organizations on the first day of work new employees sign something called an "employee agreement" in which one legally agrees that, except as directed by the company in writing, he/she will not disclose to others, copy, or make notes of **any** confidential knowledge, or any other knowledge of, or relating to, the business of the company which comes to his/her knowledge during employment (see Appendix - Page 1/8). How pervasive is the "employee agreement" concept and what additional steps, even beyond these convenants, are companies involved in geoscience research taking to protect internal proprietary information?

The Survey

To answer this question, questionnaires were mailed to the chief attornies of 195 U.S. companies engaged in geoscience research. One hundred one usable questionnaires were completed and returned. Please refer to Appendix for a specimen copy of the questionniare, as well as other details. (Figures 1 through 5 graphically illustrate replies to Questions 1 through 5.)

With employee agreements in place, restricting communication, and denying investigative browsing, it seems that archivists and historians of the geosciences are facing a serious uphill battle in even requesting the use of (much less using) unpublished correspondence, reports, notebooks, notes, computer records archived by U.S. companies. Basically, these documentalists can't use geoscience records they can't find out about.

There probably isn't a basic unwillingness on the part of the companies to share scientific records (especially those which are outdated and archived) with the public. But these firms have, through their own legal diligence and concern for protection of internal information, built a system that argues against the basic concept of public sharing. Of course, many former employees are becoming increasingly clever in seeking ways around employee agreements. And there are invisible colleges and informal networks, but the prejudices of these in excluding some groups (e.g. women) from information transfer can be far more effective than legal restraints.

The Present Situation

Some signs indicate corporate restrictions on public use of internal information may be worsening as reported by The American Archivist (1985, p. 4.37):

> "As a result of a restructuring of the AtlanticRichfield Company, the archives has been moved to the company's records center and is now available only to company employees, Inquiries may be directed to . . ."

And Elliott's analysis (1981, p. 131) of the citation patterns of literature of historians of science reveal some scholars may be neglecting unpublished corporate records in their studies.

There have been some recent attempts directed toward the establishment of discipline-based history centers such as the Petroleum History and Research Center described by Shirley (1987, p. 14) followed by generous donations of corporate research records and money. Let us hope that these commitments to the special problems of geoscience archivists and historians can continue to be made by industry. And that corporate research documentation, which has gone well beyond immediate strategic usefulness, will be neglected by no one, nor denied to anyone.

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TYPICAL EMPLOYEE AGREEMENT
MARATHON OIL COMPANY AND SUBSIDIARIES
EMPLOYEE AGREEMENT

Employee Name: Soc. Sec. No:

Address: Employee No.:

City, State: Zip Code:

EMPLOYEE and MARATHON agree as follows:

1. **Definitions.**
   (a) "MARATHON GROUP" means Marathon Oil Company, and its present or future majority owned subsidiaries.

   (b) "MARATHON" means that company in the MARATHON GROUP by whom the EMPLOYEE is employed from time to time. After EMPLOYEE is no longer employed by any company in the MARATHON GROUP, "MARATHON" means the company in the MARATHON GROUP which was the last employer of the EMPLOYEE.

   (c) "Confidential Information" means any information EMPLOYEE generates or obtains during employment that is not generally available to the public (whether constituting a trade secret or not) and which relates to the present or reasonably anticipated business of the MARATHON GROUP.

   (d) "Intellectual Property" means all inventions, discoveries, developments, writings, computer programs and related documentation, designs, ideas, and any other work product made or conceived by EMPLOYEE during the term of employment with MARATHON which (1) relate to the present or reasonably anticipated business of the MARATHON GROUP, or (2) were made or created with the use of Confidential Information or any equipment, supplies or facilities of the MARATHON GROUP. Such property made or conceived by EMPLOYEE (or for which EMPLOYEE files a patent or copyright application) within one year after termination of employment with MARATHON will be presumed to have been made or conceived during such employment.

2. **Non-Disclosure of Confidential Information.** Except in the discharge of EMPLOYEE's duties to MARATHON, EMPLOYEE will not disclose or use any Confidential Information without the express written permission of MARATHON.

3. **Disclosure and Assignment of Intellectual Property.** EMPLOYEE agrees to promptly disclose to MARATHON and does hereby assign to MARATHON all Intellectual Property, and EMPLOYEE agrees to execute such other documents as MARATHON may request in order to effectuate such assignment.

4. **Previous Inventions and Writing.** Below is a list and brief description of all of EMPLOYEE's unpatented inventions and unpublished writings. MARATHON agrees that such inventions and writings are NOT Intellectual Property and are NOT the property of MARATHON hereunder. If no listing is made, EMPLOYEE has no such inventions or properties.

5. **Confidential Information of Third Parties.** EMPLOYEE understands that any confidential information of third parties acquired prior to employment by MARATHON remains the property of such third parties, and EMPLOYEE agrees to maintain such information in confidence, not to disclose it to MARATHON and not to use it in EMPLOYEE's employment with MARATHON.
   Except in the discharge of EMPLOYEE's duties to MARATHON, EMPLOYEE will not disclose or use any confidential information of parties doing business with MARATHON obtained by EMPLOYEE during employment with MARATHON.

6. **MARATHON Documents In Possession of EMPLOYEE.** All MARATHON documents containing Intellectual Property or Confidential Information will remain the property of MARATHON. EMPLOYEE agrees to return such documents, together with all copies, to MARATHON upon termination of employment or upon request by MARATHON.

7. **Ownership of Writings Prepared By EMPLOYEE.** Writings prepared by EMPLOYEE which relate to the present or reasonably anticipated business of the MARATHON GROUP shall be deemed "works made for hire" and shall be the property of MARATHON. EMPLOYEE shall hold such writings in confidence unless MARATHON authorizes publication.

8. **Notice to MARATHON of New Employment.** Upon termination of employment, EMPLOYEE will inform MARATHON in writing of the name and address of any new employer and the general nature of the employment, if known.

9. **General Provisions.**
   (a) This Agreement constitutes the entire agreement between MARATHON and EMPLOYEE with respect to the subject matter hereof and it does not provide or imply the duration or other terms of employment.

   (b) This Agreement shall be governed and construed in accordance with Ohio law.

   (c) Any portion of this Agreement which is finally determined to be invalid at law shall be severed from the Agreement and shall have no effect on the other provisions.

MARATHON

By ______________________

Date

EMPLOYEE

By ______________________

Date

Form 626 Rev. 9-84

195 SURVEYED CORPORATIONS
(n = 101 replies)

ADVANCED DECISION SYSTEMS (ADS)
Mountain View, CA

AERO SERVICE
Houston, TX

AGES LABORATORIES
Norristown, PA

ALLIED ANALYTICAL & RESEARCH LABORATORIES, INC.
Dallas, TX

ALPINE GROUP, INC.
Norwood, NJ

AMERICAN COPPER & NICKEL CO., INC.
Wheatridge, CO

AMERIDIAN INTERNATIONAL, INC.
Amherst, OH

AMOCO PRODUCTION COMPANY
Tulsa, OK

AMUEDO AND IVEY
Denver, CO

APPLIED GEOENGINEERING, INC.
Applegate, CA

APPLIED GEOPHYSICS, INC.
Salt Lake City, UT

AT&T TECHNOLOGIES, INC.
Albuquerque, NM

ATKINSON-NOLAND & ASSOCIATES, INC.
Boulder, CO

ATLANTIC RICHFIELD COMPANY
Plano, TX

AUTOMETRIC, INC.
Falls Church, VA

BAIRD PETROPHYSICAL GROUP, INC.
Houston, TX

BARRINGER GEOSERVICES, INC.
Golden, CO

BCI-GEONETICS, INC.
Laconia, NH

BENDIX FIELD ENGINEERING CORPORATION
Columbia, MD

BISON INSTRUMENTS, INC.
Minneapolis, MN

BOWSER-MORNER, INC.
Dayton, OH

BUSINESS & TECHNOLOGICAL SYSTEMS, INC.
Seabrook, MD

CAE GOEPHYSICS GROUP
San Diego, CA

CALOCERINOS & SPINA
Liverpool, NY

CAMPBELL, FOSS AND BUCHANAN, INC.
Houston, TX

CARR RESEARCH LABORATORY, INC.
Wellesley, MA

CARSON GEOSCIENCE COMPANY
Perkasie, PA

CER CORPORATION
Las Vegas, NV

CH2M HILL COMPANIES, LTD.
Gainesville, FL

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.
Anchorage, AK

CHEVRON OIL FIELD RESEARCH COMPANY
La Habra, CA

CITIES SERVICE APPLIED RESEARCH & TECHNOLOGY CENTER
Tulsa, OK

THE CLEVELAND-CLIFFS IRON COMPANY
Cleveland, OH

COASTAL ECOSYSTEMS MANAGEMENT, INC.
Fort Worth, TX

COMPUTER SCIENCES CORPORATION (CSC)
Falls Church, VA

CONOCO, INC.
Ponca City, OK

CONVERSE, WARD, DAVIS, DIXON
Caldwell, NJ

CTL ENGINEERING, INC.
Columbus, OH

DALTON, M. L., RESEARCH
Dallas, TX

DAMES & MOORE
Los Angeles, CA

DE GOLYER AND MACNAUGHTON
Dallas, TX

DENVER MINERAL EXPLORATION CORP. (DEMEX)
Littleton, CO

DIGICON, INC.
Houston, TX

DOWL ENGINEERING
Anchorage, AK

DRESSER ATLAS
Houston, TX

EA ENGINEERING, SCIENCE & TECHNOLOGY, INC.
Sparks Glencoe, MD

EARTH OBSERVATION SATELLITE COMPANY
Lanham, MD

EARTH RESOURCES DATA ANALYSIS SYSTEMS (ERDAS)
Atlanta, GA

EARTH SATELLITE CORPORATION (EARTHSAT)
Bethesda, MD

EARTH SCIENCE & ENGINEERING, INC.
Austin, TX

EARTH SCIENCE ASSOCIATES
Palo Alto, CA

EARTH SCIENTISTS OF AMERICA
Montclair, NJ

EARTH TECHNOLOGY CORPORATION
Long Beach, CA

ECOLOGY AND ENVIRONMENT, INC.
Buffalo, NY

ECOSYSTEMS MANAGEMENT ASSOCIATES, INC.
Encinitas, CA

EDCON (EXPLORATION DATA CONSULTANTS, INC.)
Denver, CO

EG&G GEOMETRICS
Sunnyvale, CA

EIKONIX CORPORATION
Bedford, MA

THE ELECTRO-MECHANICS COMPANY
Austin, TX

ENGINEERS INTERNATIONAL, INC.
Westmont, IL

ENRON CORPORATION
Omaha, NE

EVANS & SUTHERLAND COMPUTER CORP.
Salt Lake City, UT

EVEREST GEOTECH, INC.
Houston, TX

EXMIN CORPORATION
Bloomington, IN

EXXON PRODUCTION RESEARCH COMPANY
Houston, TX

FAIRCHILD DATA CORP.
Scottsdale, AZ

FAIRFIELD INDUSTRIES, INC.
Houston, TX

FLUOR MINING AND METALS
Redwood City, CA

GALLAGER RESEARCH & DEVELOPMENT CO., INC.
Lakewood, CO

GEORGE J. GEISSER, JR. CONSULTING ENGINEERS
Riverside, RI

GEO DECISIONS, INC.
State College, PA

GEO INFORMATION SERVICES, INC.
Stackville, MS

GEOBASED SYSTEMS, INC.
Research Triangle Park, NC

GEOCHEM RESEARCH, INC.
Houston, TX

GEOGRAPHICS
Champaign, IL

GEOGROUP CORPORATION
Berkeley, CA

GEOLOGIC ASSOCIATES, INC.
Franklin, TN

GEOPHYSICAL RESEARCH CORPORATION
Tulsa, OK

GEOPHYSICAL SURVEY SYSTEMS, INC.
Hudson, NH

GEOPHYSICAL SYSTEMS CORPORATION
Pasadena, CA

THE GEOPHYSICS GROUP
San Diego, CA

GEOPHYSICS INTERNATIONAL CORP.
Dallas, TX

GEOPLAN, INC.
Missoula, MT

GEOQUEST SYSTEMS, INC.
Houston, TX

GEOSCIENCE AND SERVICES, INC.
Ft. Worth, TX

GEOSOILS, INC.
Irvine, CA

GEOSOURCE, INC.
Houston, TX

GEOSPATIAL SOLUTIONS
Boulder, CO

GEOSPECTRA CORPORATION
Ann Arbor, MI

GEOTEK CONSULTANTS, INC.
Denver, CO

GEOTEST INSTRUMENT CORPORATION
Chicago, IL

GEOTRONICS CORPORATION
Austin, TX

GEOVISION CORPORATION
Aurora, CO

GLOBAL EXPLORATION ENTERPRISES, INC. (GLOBEX)
Teston, VA

GLOBAL GEOCHEMISTRY CORPORATION
Canoga Park, CA

GLOBE UNIVERSAL SCIENCES, INC.
Houston, TX

GOLDER ASSOCIATES
Lakewood, CO

JORDAN GORRILL ASSOCIATES
Portland, ME

GOULD, INC.
Fremont, CA

GREENHORNE AND O'MARA, INC.
Greenbelt, MD

GRUY, H.J. AND ASSOCIATES, INC.
Irving, TX

HALEY AND ALDRICH
Cambridge, MA

HALLIBURTON COMPANY
Duncan, OK

HARDING LAWSON ASSOCIATES
Novato, CA

FRED C. HART ASSOCIATES, INC.
New York, NY

HART-CROWSER & ASSOCIATES, INC.
Seattle, WA

HAZEN RESEARCH, INC.
Golden, CO

HEINRICHS GEOEXPLORATION COMPANY, INC.
Tucson, AZ

HEMPHILL CORPORATION
Tulsa, OK

HORVITZ RESEARCH LABORATORIES, INC.
Houston, TX

HUNTING SURVEYS AND CONSULTANTS, INC.
New York, NY

HYPERDYNAMICS
Santa Fe, NM

THE IMR CORPORATION
Arlington, VA

IN-SITU, INC.
Laramie, WY

INTEGRATED GEOSCIENCES, INC.
Golden, CO

INTERA TECHNOLOGIES
Austin, TX

INTERNATIONAL GEOPHYSICAL COMPANY
Tulsa, OK

INTERNATIONAL REMOTE SENSING INSTITUTE
Sacramento, CA

IO GEOLOGICAL CONSULTANTS
Fairfax, VA

JACOBS ENGINEERING GROUP, INC.
Lakewood, CO

KAISER ALUMINUM & CHEMICAL CORPORATION
Pleasanton, CA

THE KEPLINGER COMPANIES, INC.
Dallas, TX

ERNEST K. LEHMAN & ASSOCIATES, INC.
Minneapolis, MN

LOCKHEED ENGINEERING AND MANAGEMENT SERVICES CO.
Las Vegas, NV

LONE STAR INDUSTRIES, INC.
Houston, TX

R. V. LORD & ASSOCIATES, INC.
Boulder, CO

MANDEX UNDERWATER SYSTEMS GROUP
Rockville, MD

MARATHON OIL COMPANY
Littleton, CO

MAXWELL LABS
La Jolla, CA

McCLELLAND ENGINEERS, INC.
Houston, TX

MERRITT CASES, INC.
Redlands, CA

MOBIL OIL CORPORATION
Dallas, TX

MORRISON-KNUDSEN ENGINEERS
Boise, ID

NEWMONT MINING CORPORATION
Tucson, AZ

NL INDUSTRIES, INC.
Houston, TX

NORTHWEST GEOPHYSICAL ASSOCIATES, INC.
Corvallis, OR

THE H. C. NUTTING COMPANY
Cincinnati, OH

OCEANOGRAPHIC SERVICES, INC.
Goleta, CA

OLIPHANT LABS, INC.
Tulsa, OK

PALISADES GEOPHYSICAL INSTITUTE, INC.
West Nyack, NY

PENNZOIL COMPANY
Houston, TX

PETROCONSULTANTS
Houston, TX

PETROIMAGE CORPORATION
Golden, CO

PETROLEUM INFORMATION CORPORATION
Littleton, CO

PHILLIPS PETROLEUM COMPANY
Bartlesville, OK

QUANITATIVE TECHNOLOGY CORPORATION
Beaverton, OR

RE/SPEC, INC.
Rapid City, SD

REFRACTION TECHNOLOGY, INC.
Dallas, TX

REMOTE SENSING CONSULTANTS
Stanford, CA

RITTENHOUSE-ZEMAN & ASSOCIATES
Bellevue, WA

ROCKWELL INTERNATIONAL CORPORATION
Pittsburgh, PA

ROCKY MOUNTAIN CONSULTING PETROGRAPHY, INC.
Golden, CO

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Tucson, AZ

PLEASE RETURN BY AUGUST 31, 1987

Many companies involved in industrial research minimize loss of archived proprietary information by taking steps to preserve its secrecy, including notifying employees of their obligation to preserve secrecy. As a company have you implemented the following business practices?

1. Do you archive proprietary geoscience research documentation (internal records, field notes, etc.)?

☐ 1 YES ☐ 2 NO ☐ 3 DON'T KNOW

2. Written Employment Agreement (Legally obligates employee by making him/her aware of the duty of confidentiality of proprietary information. Normally signed on the first day of employment.)

☐ 1 WE HAVE ☐ 2 WE DON'T HAVE ☐ 3 DON'T KNOW

☐ 4 WHETHER WE HAVE (OR NOT) IS COMPANY CONFIDENTIAL

3. Company's postion on Information Confidentiality widely disseminated (Statement of policy in employee handbook, or expressed otherwise in writing or posted on walls in work areas.)

☐ 1 WE HAVE ☐ 2 WE DON'T HAVE ☐ 3 DON'T KNOW

☐ 4 WHETHER WE HAVE (OR NOT) IS COMPANY CONFIDENTIAL

4. Limit access to Key Employees (Have procedure for storing archived proprietary information in vaults/safes, locked cabinets, secured computer systems, etc. --only certain individuals can have access.)

☐ 1 WE HAVE ☐ 2 WE DON'T HAVE ☐ 3 DON'T KNOW

☐ 4 WHETHER WE HAVE (OR NOT) IS COMPANY CONFIDENTIAL

5. Exit Interviews with Company Attorney (Have procedure to debrief jobswitching (or otherwise) departing employees reminding them that their work product, even for inactive or defunct projects, belongs to the company.)

☐ 1 WE HAVE ☐ 2 WE DON'T HAVE ☐ 3 DON'T KNOW

☐ 4 WHETHER WE HAVE (OR NOT) IS COMPANY CONFIDENTIAL

Results will be incorporated in a paper to be presented at the Geological Society of America 1987 Annual Meeting, Phoenix Civic Center, Phoenix Arizona, October 26, 1987. What about confidentiality? The information you provide will remain anonymous. The replies will be used for research purposes only and the identity of individual companies will not be divulged under any circumstances.

Please return this sheet in the accompanying envelope (or, if you prefer an additional step of anonymity mail it for processing (in another envelope) to):

JEAN EAGLESFIELD
President, GeoScience Information Society
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Cambridge, MA 02139

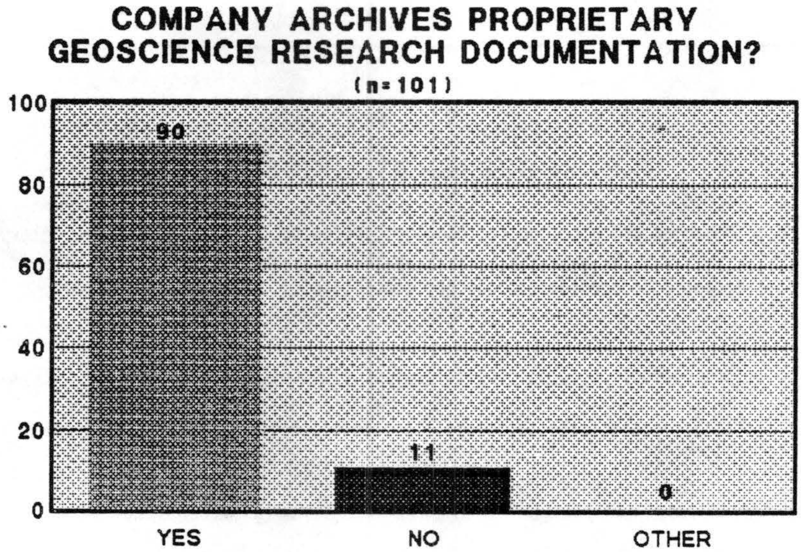
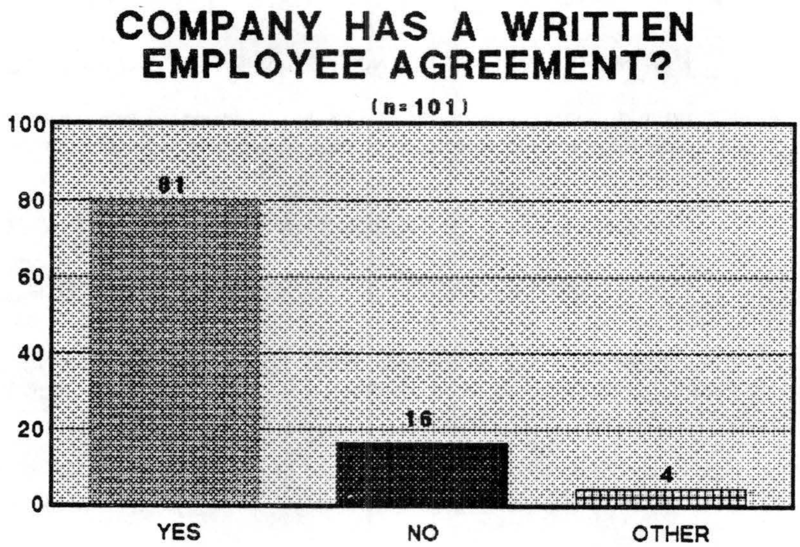


Figure 1.



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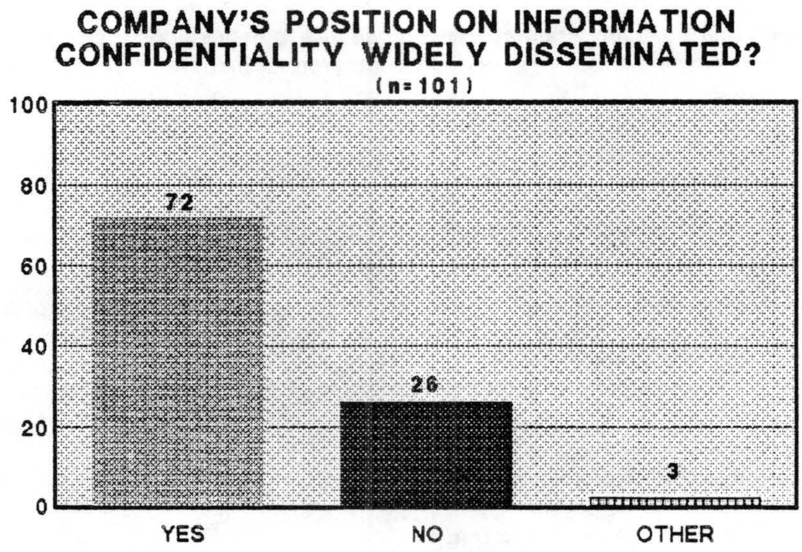


Figure 3.

LIMIT ACCESS TO KEY EMPLOYEES?

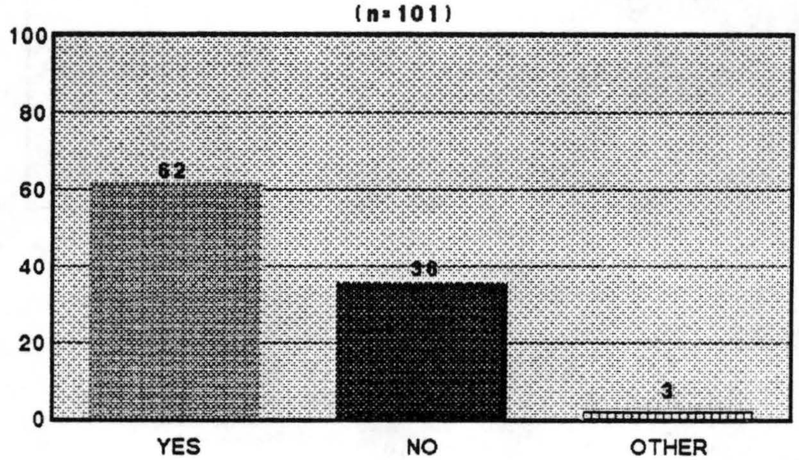
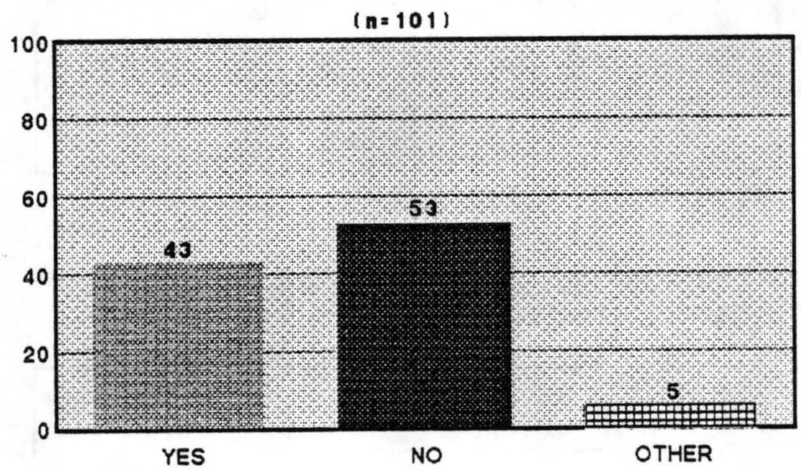


Figure 4.

HAVE EXIT INTERVIEW?



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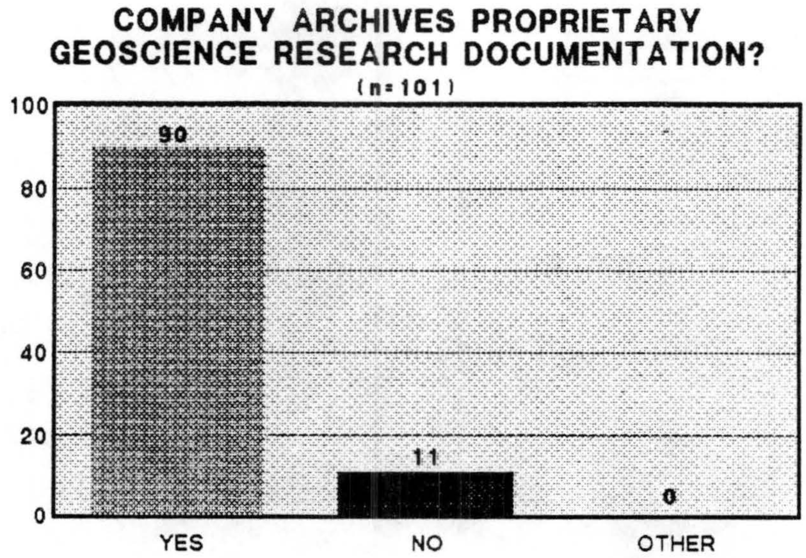
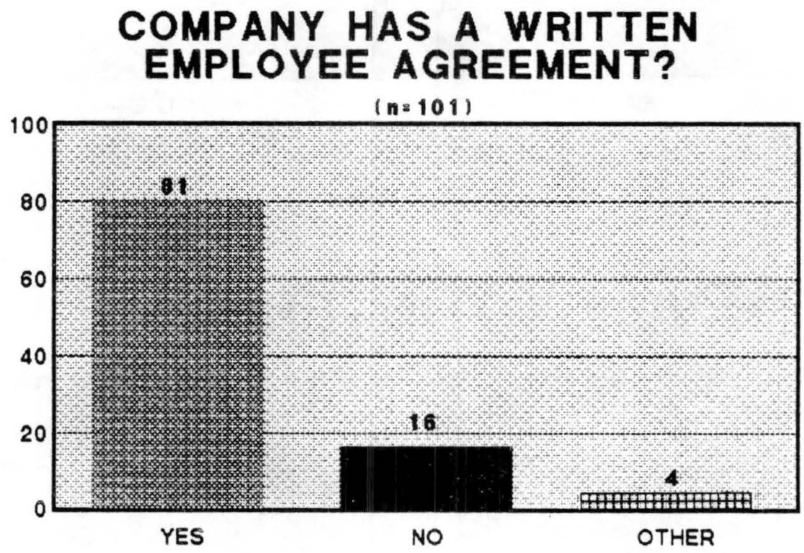


Figure 1.



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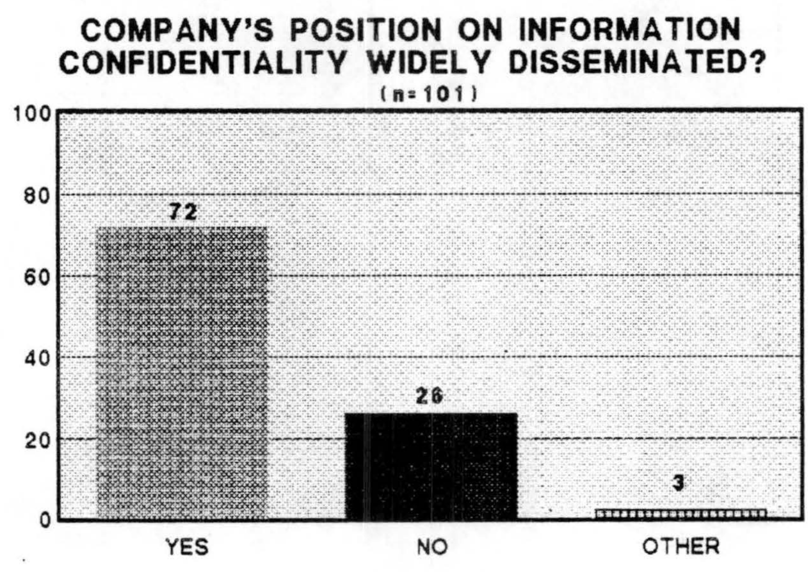

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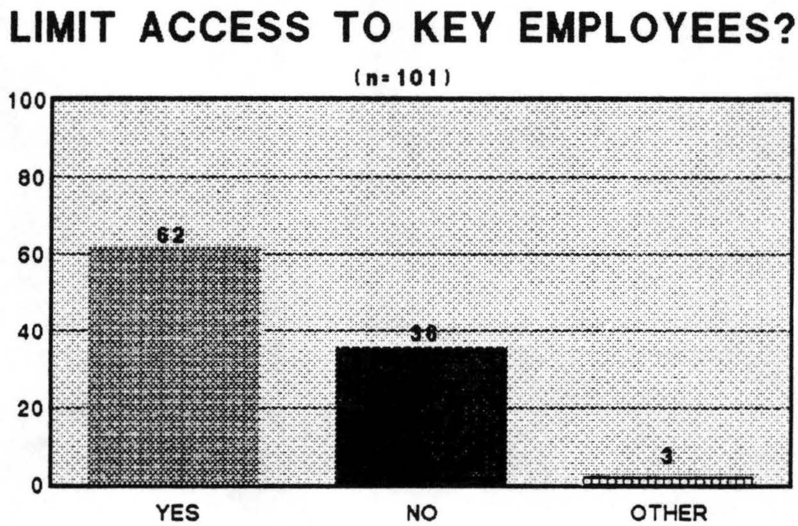

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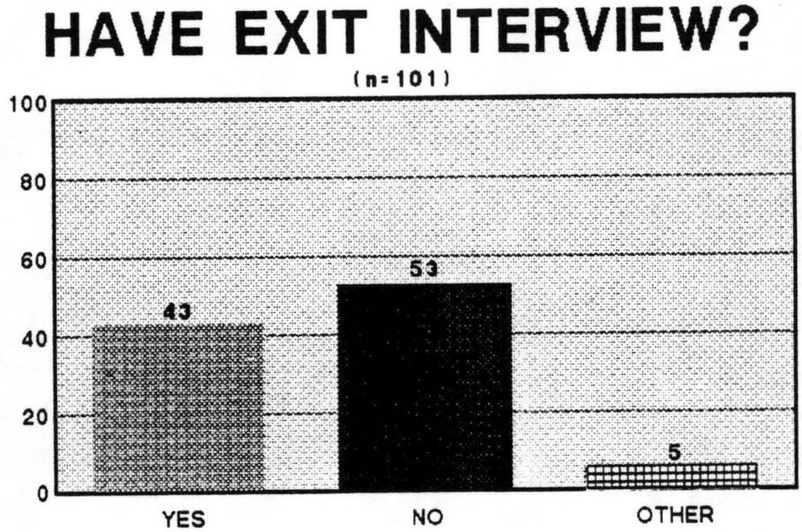

Figure 5.

GEOSCIENCE DISSERTATIONS FOR THE FUTURE: A CASE STUDY FROM THE UNITED STATES

Rosalind Walcott

Earth and Space Sciences Library
SUNY at Stony Brook, Stony Brook, NY 11794-2199

Abstract--Dissertations occupy a special niche in the geoscience literature. Because of the regional nature of much of geoscience, geoscientists cite dissertations more often than other scientists do. Geoscience dissertations are often circulated and requested for loan, even though they are not as readily accessible to the researcher as published materials. Bibliographic identification of dissertations is sometimes difficult, although access to Dissertations Abstracts Online can solve most problems. Many dissertations are not cataloged, and therefore do not appear in national databases. Not all dissertations are indexed in GeoRef. Of a recent sample of 628 dissertations, randomly chosen from all geoscience doctoral dissertations submitted 1981-1985 in the U.S., 22% were not indexed by GeoRef.

Microfilm copies of most, but not all, geoscience dissertations are available from University Microfilms International, (UMI). Of 1,864 doctoral dissertations in geoscience submitted 1981-1985 in the U.S., 7.5% are not available from UMI. Copies from UMI are relatively expensive, and present technology does not allow clear, colored reproduction of important plates, diagrams and maps. Obtaining the original dissertation from the relevant institution is often time-consuming, and many dissertations are not available for loan. Of 500 doctoral dissertations in geoscience chosen randomly from those submitted 1981-1985 in the U.S. 102 or 20% were at institutions which do not loan their own dissertations. All dissertations submitted to U.S. academic institutions should be quickly cataloged, indexed, and made available for circulation and inter-library loan.

Dissertations are important to geoscientists. Those of us in GIS know this from our daily work. We know that dissertations are circulated often to our graduate students and faculty, and that dissertations are commonly requested on inter-library loan by other researchers and professional geoscientists. We also have evidence from a citation study of the special importance of dissertations in geoscience. Garfield, (1974), ranked the most-cited periodicals in geology and geophysics for the period 1969-1972. In his study he treated the category "theses" as though it were a periodical title. This category ranked number 20 on the list of 132 most highly cited items in geology and geophysics. Garfield states that it is very unusual for the literature of any science to cite theses as often as the geoscience literature does on this list, (1974, p.105). I have checked the lists of highly cited material determined for other sciences in similar studies by Garfield and have not found theses listed as a highly cited item on any of them. The main reason for geoscience's reliance on theses is that so many studies are regional in nature and unpublished theses are often the only information available on a particular area.

A dissertation is characteristically a requirement for all doctoral and most masters degrees in geoscience. Students and faculty spend endless time and effort writing and editing dissertations, so one must assume that there is a valid reason for all this effort. A dissertation is supposed to be both a demonstration of the student's ability to do original research and a contribution to the advancement of the subject. If a dissertation is not a real contribution to the subject then how can it be a demonstration of the student's ability to do original research? This being the case, then surely dissertations should be made available to patrons as easily as other research documents. Many detractors from the usefulness of dissertation research state that if the research is really useful that it will be published in a "regular" refereed journal. Certainly, many portions of dissertations are published, and, as we shall see, many dissertations actually include previously published papers as an integral part of the dissertation itself. However, there are many parts of dissertations which do not get published, e.g. those important "negative" results, details of methodology too space-consuming to be published in a regular paper, and critical reviews of the literature. This information is part of mainstream research and should be readily available to researchers. Boyer (1972) found in a study of the use of doctoral dissertations as an information source that nearly one third of all disserations studied were not used to produce any publication at all. He concluded, (1972, p.100), that "it is disturbing that so much energy and so many resources, both human and monetary, have been expended to develop dissertation research for which a very large percentage of the results have not been disseminated."

The data used for this paper arises from a larger study of geoscience doctoral dissertations on which I am presently working. My research aims to describe the characteristics of citations in geoscience doctoral dissertations. I am interested in what sources geoscience doctoral students find most useful for writing their dissertations in order to be able to better serve that most important clientele of the academic geoscience library. I am also interested in how the sources used by doctoral students differ from sources cited by professional geoscientists writing in the periodical literature. Most previous citation studies of the scientific literature have concentrated on citations in the published journal literature. In order to systematically study the citations in doctoral dissertations I have limited my study to those doctoral dissertations submitted during the period 1981 through 1985 in the United States. I identified the total population of dissertations, 1,864 of them, by searching Dissertations Abstracts Online using a previously determined number of subject codes. I then took a random sample of 500 of these dissertations in order to study them in detail. This summer I have been attempting to obtain copies of the bibliography and reference sections of these 500 dissertations for my citation study. That exercise has provided the data for this paper.

Most colleges and universities treat their dissertation collections a little differently from routine collections of monographs. In some cases this difference enhances access and in other cases it merely puts additional barriers in the path of the patron. Dissertation collections in centralized libraries are often segregated in the stacks, cataloged to sit apart from the rest of the collection, and usually located at the back far corner in the dustiest and darkest area. Not so in branch geoscience libraries. All the branch geoscience libraries I visited this summer had their dissertation collections close at hand, and most often arranged alphabetically by author for quick access. These collections were obviously used by patrons. One geoscience library, that of Pennsylvania State University, had their dissertation collection running around the wall of the entire library, so that one was surrounded by dissertations of past Penn State graduates.

This paper is a story of gaps, a series of minor gaps which accumulate into a major problem - gaps in collections, gaps in indexing, gaps in availability and gaps in servicing of collections. Some libraries do not own circulating copies of their own dissertations - this creates gaps in collections. Many libraries do not loan their dissertations - this creates gaps in availability. Some dissertations are not available from University Microfilm International - another gap in availability. Some dissertations do not have abstracts attached to them in the Dissertations Abstracts Online database. This constitutes a gap in availability and servicing. Most dissertations available from UMI are not available with usable copies of maps, charts, diagrams and plates. This shortcoming is often a crippling lack for the users of these dissertations.

Let us look more closely at the nature and magnitude of these various gaps. One of the first gaps which will be noticed by a researcher attempting to obtain a particular dissertation is that a certain percentage of dissertations are not available from University Microfilm. In this study, 7.5% of the 1,864 theses identified were not available from UMI. When dissertations are not able to be obtained from UMI there is also very little information available about them, as no abstracts are given in Dissertations Abstracts Online database.

Another extremely important gap is that many dissertations are not indexed by the major geoscience database, GeoRef. This means that a person searching for information on an area or topic in this database will often not find relevant dissertations because the dissertations are simply not indexed. Although UMI's coverage of dissertations seems to be more complete, I do not think that their indexing of geoscience dissertations is nearly as expert as that of GeoRef. GeoRef's expertise, however, is not being fully utilized as of 628 doctoral dissertations checked for this study, 141 or 22%, were not indexed in GeoRef. This omission is after these dissertations have been submitted to UMI at least two years ago and some as long as seven years ago. The bottom line is that if researchers are searching for geoscience dissertations published in the U.S. during the 1980's 20% of the time they will not be able to locate them in GeoRef. It is interesting to note here that users of GeoRef indicated in a survey completed in 1984 that one of their highest priority items for improvement of the GeoRef database would be the indexing of all dissertations, (Pruett, 1985, p.144).

The cost of obtaining dissertations from UMI is high, $28 for softbound paper copy, $35 for hardbound paper copy and $18 for microform. The costs are even higher if the buyer is "non-academic", $49.50, $59.50 and $28.50 respectively. The cheapest that I could buy the 500 dissertations I need for my project would be $9,000 in microform or $14,000 in paper, obviously an unreasonable amount for an individual researcher to pay. But there are problems other than price associated with obtaining dissertations from UMI. Unless the dissertations are purely text with simple line charts, vital parts of the dissertation are obtained in an unusable form. Maps are butchered into fragments, plates are reproduced without needed detail, and essential color is absent from photographs, maps and plates. The severity of this problem for geoscience dissertations is demonstrated by the fact that 65% of the 240 dissertations I received on inter-library loan had illustrative material and maps which could not usefully be reproduced from microfilm. After many complaints from users and librarians UMI is now offering the option of obtaining 35 mm slides or black and white glossy prints of maps, plates and other illustrations - at a price. Slides are $1 each, 6" x 9" photograph/illustration prints are $5 each, and 17" x 23" map prints are $10 each. Through the good offices of Connie Manson and her colleagues from the Washington Department of Natural Resources, Division of Geology and Earth Resources, this option has recently been examined.

The thesis examined was that of Fletcher (1986), the original of which was kindly loaned by Stanford University. This thesis contained 27 illustrations, many of them photomicrographs, 9 tables and 5 hand colored, oversized maps and diagrams in a pocket. The cost of obtaining the new UMI products for this thesis would vary between $41 and $194 depending on which products you chose. The products examined for this thesis were provided by UMI, for which we are most grateful.

The reviewers thought that the map prints were of quite good quality and vastly superior to the UMI text copy. The map is complete on one sheet, which in itself is a major improvement. The original maps in this dissertation were hand-colored, so that not all units were labeled, and the nuances of color are hard to distinguish in the UMI continuous toned print. Some reviewers urged that geoscience departments require that maps be reproducible in black and white, and that standards be set, and enforced, for all maps in theses submitted in the U.S. Some reviewers wanted UMI to offer full color copy of maps which are colored in the original. The scale of the map reproduction is usually not the scale of the original, so the scale bar on the reproduced map can be misleading. The prints of the photographs and illustrations were considered to be of high quality. Most details reproduced well, although color prints would be far more desirable. The 35mm slides were of excellent quality and much cheaper than other products. Slides are useless for field work, of course, but copies could be made.

The reviewers concluded that these new UMI products were vastly superior to past offerings, although the lack of color is still a major problem. The price of these products was thought to be very high, but all reviewers were pleased that UMI was offering an alternative to their familiar reproductions from microfilm. This new service is available only for dissertations with a UMI order number prefix of 86 or higher.

If you elect to try to obtain dissertations from the relevant school, as you must do if you need more than one or two dissertations or if you need maps, plates and diagrams, then many obstacles await you. I have just tried to obtain 500 dissertations from universities across the U.S. The very worst news is that of the 500 dissertations I needed, 102 or 20% were at institutions which do not loan their own dissertations. This rate represents an unacceptably high number of academic institutions with a less than academic outlook. Those of you, many of you in the audience, whose libraries did loan me dissertations, I give thanks for your sensible policies. Those of you who did me special favors and made obtaining the copies I needed easier, I also thank you, but I wish that I did not have to ask you for special favors in this case. All dissertations should be available on inter-library loan. All academic libraries should make room for circulating copies of their own dissertations. Researchers should not be held to ransom and forced to buy dissertations without first having the option to examine the dissertation. Many research uses of dissertations are one-time or quick reference uses. Researchers do not need to own a copy of the dissertation in these cases and should not have to buy one.

Those dissertations which I did obtain on inter-library loan, 240 of them, came in a reasonable period of time. There was an average of approximately 15 days from the date of request to date of receipt, using RLIN, OCLC and ALA forms. This period stretches out a little when one considers that there will be preparation time between receiving a request from a patron and sending that request, and time after receipt of the material until the patron is notified and appears in the ILL office. So a more reasonable time period for the total transaction would be three weeks. When received, the dissertations usually were circulated with loan periods of two weeks to four weeks.

I also visited a dozen different libraries and copied from over 100 dissertations in these libraries. Of the 417 dissertations that I have copied from so far, 55 or 13% are in microform and a further 12 or 3% were hard copy from UMI. So even if libraries are willing to loan their theses or let you copy from them in the library that does not guarantee your ability to see hard copy. Of these 417 dissertations, 24 or 6% have published papers included in them. Columbia University was the only university which had a few dissertations consisting entirely of a bundle of published papers bound together. Is this a trend or just New York eccentricity? Most dissertations are still of the classical form, a series of chapters with one reference or bibliography section at the end of the dissertation. However, there is a disturbing trend, at least disturbing to me, of splitting the references into sections. This division means that if you want to find a reference after you have read a dissertation you have to be able to remember in which section it occurred or you have to search several reference sections. Not only does this waste the reader's time, it also adds to the bulk of the dissertation, as many of the references apply to several different sections and are therefore repeated. As far as I can see there are no advantages to splitting the references into sections and many disadvantages. 78 or 18.7% of the dissertations I examined have divided references. Division of references seems to be a purely bicoastal phenomenon. Universities located on the East and West Coasts allow this practice in their dissertations. I wish they would revert to the traditional outlook of the heartland and have a single bibliography or reference section. Incidentally, the longest reference section I have encountered so far consisted of 105 pages, this in a massive 600 page dissertation from University of Texas at Austin.

Microform is a frustrating format to use. Everybody knows this. I have proved it to myself over and over again during this project. It takes me four times as long to copy the same amount from a microform copy of a dissertation as it does from a hard copy. This is with everything going well, with machines that I know, and which are available and working. Even then the result is not nearly as satisfactory as from hard copy, despite the advent of better microform copiers. Many libraries still do not have microform copiers with electrostatic processes, so I have some damp, grey, chemically scented, rapidly decomposing copies amongst my papers. Even the paper copies produced from microfilm by UMI are not very satisfactory. The format is too small. One must enlarge the pages if one is over 30 years old or wears corrective lenses. These reproductions also suffer from the same disabilities in illustrative material as do the microform copies themselves.

After handling all these various dissertations I have a few personal observations and preferences to offer. Do not use gold lettering on the spine of the bound copy of a dissertation if either light or eyes are dim. Do not use black for the bound copies of dissertations - preferably use an institutional color. Many schools already do this. Do require a short biographical sketch to be included in the dissertation - more than just a list of schools attended. These biographies give useful information on the cultural and scholastic background of the student and personalize a dissertation. Do make sure that every part is listed in the Table of Contents, very often vita and bibliography are missing. Do use institutional end papers when binding dissertations and do use institutional paper if you have it. These touches lend class to the finished product and we do aim for class in geoscience. More importantly, these touches also state that the institution wants to be identified with this dissertation, and is proud of its product.

What are my suggestions for better dissertation collections in the future?

1. We need complete, expert, and timely bibliographic control of geoscience dissertations. All dissertations, masters and doctoral level, should be indexed in GeoRef within six months of being accepted by the appropriate academic insititution. Better methods of collection of the necessary information should be instituted by GeoRef. Reliance on an annual letter to the chairpersons of geoscience departments is not sufficicent.

2. All academic institutions should maintain circulating collections of their own dissertations, and lend them freely to the research community at large. It is part of an academic obligation to the research community to allow free circulation of dissertations in hard copy. If each academic insitution fulfilled its part of this obligation then all would benefit. Objections to this stipulation will be loud and vehement; space restrictions, copyright restrictions, another copy needed of the dissertation, hardship for students, etc. Students who have tried to use other students' dissertations will understand that an extra copy of their own dissertation is needed to create a circulating collection. Copyright restrictions on dissertations are similar to those on other copyrighted works, such as monographs. Fair use of such works is allowed under Section 107 of the U.S. Copyright Act of 1976.

3. Academic institutions should catalog their dissertations fully so that dissertations appear in routine subject searches of catalogs and databases. Cataloging should be timely. This recommendation will raise a collective groan as dissertations need original cataloging and copy cataloging is so much easier.

4. Maps, diagrams, plates, photomicrographs and other essential illustrative material must be available to researchers. This means that students should provide copies of these materials with the circulating copy they lodge with the library.

5. Microform should exist only as an alternative format. For some types of dissertations microform can be marginally adequate. For many dissertations it will always be totally inadequate. For these dissertations, reproductions

from microform, as done by UMI, are equally and similarly inadequate.

6. Universities should stop trying to make money on reproducing copies of their own dissertations for sale and concentrate on providing easy access to these same dissertations and preserving them for the future. Students should be required to deposit their dissertations with UMI, indeed most already are, so that UMI can index them and publicize their availability.

7. UMI should be encouraged to continue to improve the coverage of its Dissertation Abstracts Ondisc and update it much more frequently. The new technology will perhaps make it easier to tailor new products for specialized audiences. One of my faculty members recently complained that there is not a monthly listing from UMI of geoscience dissertations deposited with them. That is the type of tailored and up-to-date product that researchers really need.

If we could implement these simple suggestions we would truly protect our dissertation collections for future geoscientists.

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WHAT HAS MILLIONS OF PIECES, WEIGHS HUNDREDS OF TONS AND CAN'T TAKE CARE OF ITSELF? A PALEONTOLOGY COLLECTION

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Department of Geology, Iowa City, Iowa 52242

Abstract--Paleontology collections (invertebrates, vertebrates and plants), housed by museums and universities and cared for by curators, serve for studies that include systematics, evolution, biostratigraphy, and paleobiogeography. Type specimens are usually isolated and individually catalogued. General collections, large suites of non-type specimens, are stored uncatalogued as research and/or teaching collections. Prior to 1972 and the establishment of the NSF Biological Research Resources Program, funding for curation of paleontology collections was scarce. Through FY86, 9 invertebrate collections have received $1.4 million and 16 vertebrate collections, $5 million in grant support to hire personnel, renovate and reorganize collections, and implement computer systems.

Results of a survey of 66 (48 responses, 73%) of the first- and second-ranked paleontology collections indicate that 50% have no written curatorial manual and that except for loan policies, alarmingly few have written formal policies for accessions, collecting, deaccessions, sales or purchases. Fifty-eight percent of the collections are using computers for collection management and 27% are planning automation. Presence of supporting documents, such as photographs, maps and field notebooks, is retrievable in the majority of collections. Interest in a paleontologic network is high, but a network is not realistic at this time. Three California institutions are designing a network, and the paleontology community should monitor its progress.

Continued federal funding and strengthened professionalism as reflected in the cooperation among the professional societies make the future of paleontology collections relatively secure.

Introduction

Through the great halls, past diaramas and down long corridors lie the research paleontology collections of public and private museums, and university and college museums and geology departments. The collections may include plants, invertebrates and vertebrates. Conservative estimates of the number of specimens in paleontology collections range from 20 to 56 million. Collected for research and teaching, these specimens have been the core of studies on systematics, evolution, biostratigraphy and paleobiogeography. The collections are cared for by curators. The curator oversees the maintenance and growth of the collection, and establishes curatorial policies which insure that the collections will be available for future study (Waterston, 1979;

Doughty, 1984). In a research museum, Curator is a full-time staff appointment. Curators are assisted by a technical staff that may include collections managers, curatorial and research assistants, and preparators. In college or university collections, Curator and Professor are usually joint appointments and the staff may include part-time student assistants and/or a collection manager.

About fifteen years ago, professional societies with the support of National Science Foundation (NSF), conducted surveys to assess the holdings, status and needs of the systematics community (Steere, et al., 1971). The Paleontological Society (PS) representing invertebrate paleontology and Society of Vertebrate Paleontology (SVP) both published reports (Glenister, et al., 1977; Langston, et al., 1972 and 1977). This summer, I conducted a survey of the most significant paleontology collections, as identified in those reports. There are over 400 paleontology collections in North America. I limited the survey to sixty-six primary and secondary institutions in an attempt to find out about their current curatorial procedures and what changes, if any, have taken place in their collections in the past 10 years. Paleobotanical collections were not included specifically in the survey but twenty-one of the respondents included fossil plant collections in their responses. Forty-eight surveys (73%) were returned. The survey consisted of twenty-five questions, for which most answers could be circled (see Appendix 1), and space was provided for comments. The following discussion highlights the essential requirements for a well maintained paleontology collection and uses the survey results to reflect current practices.

Curatorial Methods and Policies

Curatorial methods differ for each kind of collection and may even differ within an institution. Specimen catalogues are maintained by all responding collections (see Appendix 1, question 3, hereafter references to specific questions will be cited App. 1-3). Cataloguing involves assigning a number to a specimen or specimen lot, recording specimen identification and collecting information in a ledger or file, preparing a specimen label, placing the specimen in a container and storing it in the collection.

An important division recognized within many collections, is the difference between the type collection and the non-type or general collection. Type specimens are those specimens that have been cited in the literature. Primary types are the ones on which the descriptions of new taxa are based. Secondary types are other figured, measured or mentioned specimens. Type specimens are the most well documented specimens in a collection and are usually individually numbered and catalogued. Institutions that house types are expected to follow Recommendation 72G of the International Code of Zoological Nomenclature to clearly mark specimens so that they are easily recognized as types, safely preserve them, make them accessible for study, publish type lists, and communicate information about the types when requested (International Commission on Zoological Nomenclature, 1985, p. 147). Not all collections contain type specimens. Smaller institutions, private companies and those institutions that feel that these obligations strain their resources are encouraged to reposit their type specimens in a larger institution.

The general collection comprises the remainder of the collection. Within any collection, these large suites of specimens may be stored by taxonomic group, stratigraphic level, geographic region, or any combination of these divisions. Many of these collections are extremely valuable, unique and irreplaceable because of who collected them, when and where they were collected and whether or not other comparable material exists. In university collections, these collections may contain the unpublished material on which Masters theses and Ph.D. dissertations were based. According to a recent estimate, 78% of vertebrate paleontology collections and 85% of invertebrate paleontology collections are uncatalogued. This percentage is quite high compared with an overall average of 36% for biological collections (S.R. Edwards, 1985, p. 29).

Type material is referred to frequently by researchers within an institution and by visiting scientists, and it may be loaned to qualified researchers. On the other hand, parts of a general collection may not be examined for years. Within collections lie undiscovered new species and stratigraphically significant specimens. A recent example is the discovery, in 1982, of the conodont animal among specimens from the Granton shrimp bed that had been stored in the Institute of Geological Sciences in Edinburgh since 1925 (Briggs, et al., 1983, p. 2; Aldridge, 1987, p. 23).

The exact methods of curating a collection are not as important as having clearly stated policies. One-half of responding collections have no written curatorial manual, and the lack of written formal policies is alarming (see App. 1-3, 1-4). Documentation of curatorial methods and written policy statements for accessions, loans, collecting, sales, purchases, adoptions and deaccessions are essential. Curators, collection managers and curatorial staff change but written policies help insure a well documented and useful collection. Policies must be reviewed and revised periodically. Sixty-four percent of the policies were written since 1970 which shows an awareness of the importance of such documents. A recent publication "Guidelines for Curation of Geological Materials" is an extremely comprehensive manual (Brunton, et al., 1986). All aspects of curatorial policy are examined and a section on occupational hazards is included as well. It is a useful guide for curators and collection managers who are formulating or revising curatorial policy.

In recent years, the U. K. Geological Curators Group, through symposia and publications, has led the way in demonstrating the importance of applying the principles and methods practiced by art and anthropology conservators to geological materials, including fossils (Crowther and Collins, eds., 1987). There are several geological conservators in the U. K. but none in the U. S. A new organization, Society for the Preservation of Natural History Collections, was founded in 1985 in response to scant attention paid by American and Canadian museum associations specifically to the problems of saving natural history collections from deterioration in their museum environments. Members include specialists in many natural history disciplines, conservators and archivists. The 1988 annual meeting will include symposia on the applications of art and human history conservation techniques and materials to natural history collections, museum environmental issues, including climate and light controls, and health hazards in collections (Williams, 1987, pers. comm.). The Conservation Committee of the Society is developing a resource list for natural history curators and conservators (Hawks and Rose, 1987).

University Collections

In addition to staff research, university collections grow by the incorporation of material from theses and dissertations. Not one respondent said that a course or part of a course in curating or cataloguing was required for an advanced degree in paleontology (see App. 1-23). Three respondents said such a course is an elective and several commented that students learn these procedures as they complete their own projects. Attitudes about the importance of their collections and curatorial methods for the care of their specimens must be taught to students.

Preservation of written theses and dissertations is essential as described by Rosalind Walcott (see Walcott, this volume). It is equally important to save the material on which theses are based. Sixteen of the respondents said that there is no written policy about satisfactory curation of fossil material before the advanced degree is conferred (see App. 1-24). Of the fifteen who responded yes, twelve said the policy was enforced. Each department should enforce a policy that requires thesis and dissertation collections to be catalogued and clearly labeled before the advisor signs the thesis or dissertation cover sheet. Students must realize that their study is not complete until their collections are properly reposited.

Teaching collections are separated from research collections in all but five of responding universities and colleges (see App. 1-25). However, many of the respondents commented that the research collections are available to students in advanced courses and for special projects.

Orphaned Collections

An endangered or orphaned paleontology collection is one that is scientifically valuable and one that the present owner is unable to maintain. The owner may be an institution or an individual and there may be many reasons for having to abandon the collection. Thirty-one respondents said that in the past five years they have adopted collections from amateurs, institutions, professionals and oil companies (see App. 1-5). One-quarter of the collections have a formal adoption policy; most decide on adoption on a case-by-case basis. The most frequently cited reasons for refusing a collection are lack of specimen information or poor quality of specimens. None of the respondents mentioned lack of space or curatorial staff as the reasons for refusing a collection. Allied to this is how the adoption decision is made. There were very few comments on this matter but several respondents mentioned that a staff member must have an interest in the collection before it will be adopted. Fourteen institutions are actively pursuing amateur, institution or professional collections. However, the majority of institutions are passive where privately owned collections are concerned.

Associations between amateur and professional paleontologists benefit both parties. Amateurs are helped in identifying specimens and realizing the importance of their collections, and professionals are often loaned or given material for study that would not be available otherwise. Valuable amateur collections probably have the greatest chance of becoming orphaned, in part because their existence may not be known by professionals. If a collector does not make provision for the placement of his collection, his heirs may not realize its value and allow it to be discarded.

Abandonment of a collection by an institution is more difficult to understand; however, this does occur (Holden, 1985, p. 38). Lack of space, changes in research interests, and budget reductions are commonly cited justifications. Equally dangerous as totally withdrawing support from a collection is reducing the budget and staff to a point where the collection is neglected. Neglect endangers a collection as seriously as does abandonment. One respondent commented that the paleobotany and vertebrate paleontology collections, both inadequately stored and curated in his institution, were being transferred to other institutions because curators in these disciplines had recently been hired, and the collections, in addition to being better cared for, would be more readily available to researchers (Meyer, 1987, pers. comm.). Eight respondents mentioned donations, exchanges, long-term loans and unreturned loans as reasons for giving up parts of their collections. The specimens in these types of transactions are not considered orphans.

The problems of endangered and orphaned collections will be addressed in a national symposium sponsored by the Association of Systematics Collections at their annual meeting in May 1988 at the Field Museum. Dr. Robert West, Director of the Cranbrook Institute, is organizing the symposium. The topics for discussion will be determined by the responses he received to a survey he distributed to more than 300 institutions in the summer of 1987 (West, 1987, pers. comm.).

Collections Management

Prior to 1972 and the establishment of the Biological Research and Resources (BRR) program within the Division of Biotic Systems and Resources of NSF, funding specifically for collections management was scarce. From 1972 through fiscal 1987, BRR has allocated more than $49 million in support of 108 systematics collections. Figures through fiscal 1986 show that nine invertebrate paleontology collections have received about $1.4 million (3% of the collections support budget) and sixteen vertebrate paleontology collections have received about $5 million (11% of the collections support budget) (J. Edwards, 1985, unpubl. summ.; 1987, pers. comm.). The grants enable institutions to hire personnel, renovate and reorganize collections and implement automatic data processing systems for collections management. BRR expects to continue funding curatorial projects in systematics collections at least at the same level and perhaps at an increased level through 1990. The areas in which increased funding may occur are support for catalogue production and for computer projects (J. Edwards, 1987, pers. comm.).

There has been a slight improvement in support, as the responses to question 7 reveal (see App. 1-7). For each area, staff, budget and space, one-third or more of the respondents indicated increases. Nine respondents indicated increases in all three areas. Seven respondents indicated funding from grants were responsible for increased curatorial activities. However, where comments were included, more staff increases were attributed to institutions increasing support. The respondents did not indicate whether grant support was contingent upon permanent staff positions being established, however, this is a common requirement for federal support. In addition to grant support and staff increases, the most frequently mentioned positive changes were new storage cases and/or compact-storage systems, improvement or renovation of facilities, new or improved cataloguing procedures, and new buildings. Only one respondent indicated a decrease in all three areas. In addition to indicating budget and staff decreases, respondents mentioned frequent personnel changes, reduction of curator position to half-time and lack of funding to hire student assistants as negative changes.

The increases in federal and institutional support are encouraging; however, this survey is very limited. The Association of Systematics Collections, in conjunction with NSF, will sponsor workshops in late 1988 to form committees, from many disciplines including paleontology. Those committees will be charged to assess the accuracy of the previous reports, to make new recommendations to governmental agencies on funding priorities, and to identify the needs of institutions and systematics collections for the 1990's (J. Edwards, 1987, pers. comm.).

Implementing a computer system is the most frequently mentioned project planned for the next five years (see App. 1-8). Cataloguing the back-log of material and producing type specimen catalogues were the next highest priority projects, closely followed by reorganizing the collection and gaining expansion space by installing new cases or compact-storage systems.

Computer Use

In the mid 70's, fifteen paleontology collections representing thirteen institutions were using automatic data processing. Of these, eight were using SELGEM, a package of programs designed by the Smithsonian Institution for collections management. In their reports, both the PS and the SVP encouraged institutions to adopt compatible computer systems (presumably SELGEM) (Glenister, et al., 1977, p. 29; Langston, et al., 1972, p. 9), since the Smithsonian had developed it and several large institutions were already using it. SELGEM runs on large mainframes and has not been adapted for every system. At that time, not every institution had access to or could afford to purchase the kind of equipment needed to run SELGEM. Many institutions rebelled against being told what system to buy and use. By the late 70's, collection managers' main concerns were choosing and installing a useful affordable system; compatibility concerns were secondary.

The 1983 Association of Systematics Collections' survey of museum computer projects in progress to mid 1980 (Sarasan and Neuner, 1983, p. 278-292), showed mainframe computers were still the main type of computer being used, and SELGEM was being used by more institutions or projects than any other system. In addition to SELGEM, thirty-eight commercial software systems and another forty locally developed systems were in use. Eight paleontology projects were listed. Five were using SELGEM, two were using commercial packages and one was using a locally designed system.

In response to the survey, twenty-eight respondents indicated that they are using computers for collection management (see App. 1-13). Thirteen of the remaining respondents are planning automation and ten respondents consider their manual catalogues sufficient. The latter reflects an attitude with which I concur. If a collection is catalogued and sorted well enough to answer most research inquiries sufficiently, implementation of a computer system may never be necessary.

The most frequently used mainframe systems are SELGEM and TAXIR (developed at University of Michigan), and the most popular microcomputer system is Ashton-Tate's group of d-BASE packages. FOCUS by Information Builders is available in mainframe and microcomputer versions. Interactive systems are replacing tape oriented systems like SELGEM. At least three SELGEM and TAXIR users are moving to other systems, among them the Smithsonian which is converting to INQUIRE, a commercially developed system.

Data base management systems are being used most frequently for cataloguing, label production and maintaining locality registers (see App. 1-18). They are used less frequently for inventory and accessions. This is probably a reflection of the tasks routinely performed in paleontology collections and not a reflection of the capabilities of systems. Preservation of supporting material, such as original labels, photographs, field notebooks and maps, is essential for documenting the history of the collection and for preserving the historical context of the collection. The majority of respondents have a method for indicating the presence of supporting documents either in related files, unique fields or text fields like remarks or memo (see App. 1-19).

There have been no mutually agreed upon data standards for paleontology collections. In both the SVP and PS reports, data fields given in appendices (Glenister, et al., 1977, p. 58; Langston, et al., 1977, p. 37) conform to SELGEM definitions in use at the time by the Smithsonian. I suspect that these data fields were adopted by many institutions for their systems whether or not they chose to use SELGEM. This is a probably a reasonable assumption because the fields describe most catalogue information items. Twenty-two collections maintain written data definitions lists (see App. 1-17) and twenty-three respondents believe that their data could be combined with data from other collections (see App. 1-22). This is an encouraging response but it remains to be tested.

The respondents are equally divided about whether a paleontologic network of catalogue information is realistic at this time (see App. 1-10). The majority of respondents agreed that they would like their collections to be associated with such a network, and that, if one existed, they would use it. Some respondents commented that they would allow only selected parts of their collections to be associated, and others mentioned hesitation if fees were assessed. A majority of respondents said also that if a central facility for storage of specimen data, such as measurements and faunal lists, were available that they would be willing to contribute to it (see App. 1-12).

Currently, several groups are investigating the establishment of networks which will allow a researcher to query another institution's files directly. Instead of a central database, each institution will be responsible for maintaining the accuracy of its own files and will be able to control the information available to researchers. Researchers will be able to choose the data fields to be retrieved and will have the flexibility to design reports once they have transferred the data to their own computers. Malacologists are investigating compatible formats and communications protocols for such a system, and the paleontology departments of three California institutions, University of California at Berkeley, the California Academy of Sciences and Los Angeles County Museum, are currently designing a network system (Lindberg, 1987, pers. comm.). Six art museums in Washington, DC, have formed a network, decided on the content for the associated files, and are formulating access protocol (Case, 1987, pers. comm.). The paleontology community should monitor the results of these trial networks and begin to lay the groundwork for a similar kind of association.

Continuing Trends

The future of paleontology collections is relatively secure. I say this because I am an optimist, and because I see an increased awareness of the importance of these collections and the expanding activities of professional societies. Earlier fears of the compaction of collections into a national one with a few large regional collections have not been realized, and a major reduction in the number of paleontology collections does not appear to be imminent. The federal budget for collections support is assured for the near future and may even increase. Professional societies are committed to acting together to make recommendations on collection maintenance, curatorial policy, museum professionalism and ethics, and standardizing data fields across disciplines. The willingness of the paleontology community to share catalogue information and the eagerness of researchers to have access to this information will encourage institutions to create a paleontology network. Perhaps regional networks will develop at first, but as more collections implement automatic data processing systems and join the regional networks, a national network may become a reality. Obviously, the picture is not all positive. The rising costs of running a museum and the reduction in the number of geology students, and hence departmental budgets, are very real threats to the proper maintenance of collections. It must be expected that some smaller collections will be faced with extinction. However, I think the paleontologic support structure (i.e. professional societies and federal programs) is strong enough to sustain this national resource.

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Appendix 1

Survey with summation of responses

COLLECTIONS AND CURATORIAL POLICIES

Note: The number of surveys returned was 48 (73%). The number of responses for any question may not total 48 because some questions were unanswered or ambiguously answered. Unless otherwise noted, blank answers were not counted.

1) Type of paleontologic collection:
   - 9 invertebrates only (includes micropaleontology)
   - 15 vertebrates only
   - 20 invertebrates, vertebrates, plants and micropaleontology
   - 3 invertebrates and vertebrates (no plants)
   - 1 invertebrates and plants (no vertebrates)

2) Collection manager/Curatorial staff training:
   - 1 Degree in Museum Science
   - 13 Geology Degree with Museum Science courses
   - 18 Trained on the job
   - 20 Other (17 Ph.D. in Geology or Biology)

3) Which of the following are formally maintained?

	Yes	No
Catalogue of specimens/specimen lots	48	0
Accession records	37	6
Locality register	39	8
Curatorial procedures manual	24	24*
Archives (institutional/departmental)	29	13
Library of publications related to coll'n	35	11
Cross indices (of catalogue information)	28	17

* 5 blank responses interpreted as No.

4) Which of the following have written formal policies?

	Yes	No	Strictly Adhered to? Yes	Strictly Adhered to? No
Collecting	9	35	5	1
Accession	24	22	19	2
Deaccession	22	24	13	1
Loans	33	15	22	5
Purchases	9	34	8	0
Sales of specimens	10	38	9	0

Note: 5 respondents commented sales are never made or are unthinkable.
1 respondent commented purchases are never made.

5) Adoption of orphaned collections:

	Yes	No
Have collection(s) been adopted in the past 5 years?	31	17
18 amateur 20 institution 3 professional or industry		
Are adoption procedures consistent or formally stated?	12	33
Are adoptions made case by case?	37	4
Have collection(s) been refused in the past 5 years?	15	26
Is the institution actively pursuing collections?	14	32
10 amateur 10 institution 4 professional or industry		

6) Have parts of your collection been given to another institution(s)?
10 Yes   38 No

7) In the past 10 years, has your collection undergone any significant changes in curatorial procedures and/or maintenance? 24 Yes   11 No

	increase	decrease	same
Staff	18	7	13
Budget	19	5	11
Space	16	2	17

8) Are any special curatorial projects planned for next 5 years?
37 Yes   11 No

9)

	Yes	No	Not enough information
Is there a need for a center for the documentation of the science of Geology?	12	16	15
Should a center be established?	10	14	1

10)

	Yes	No	?
Does a paleontologic network of catalogue/ collection information seem realistic at this time?	21	22	3
If such a network existed, would you be willing to have your files associated with the network?	41	1	2
If such a network existed, would you use it to inquire about collections in other institutions?	37	4	4

11) Are data (e.g. measurements) on individual fossils specimens routinely stored on computer by any researchers in your institution?
17 Yes (in-house)   29 No

12) If available, would you and/or your colleagues send specimen data (e.g. faunal lists, measurements, abundance counts, etc.) to a central data-storage facility?   30 Yes   7 No   7 Maybe

AUTOMATION

Note: Responses for questions 14 through 22 are reported for collections that are currently using computers.

13)

	Yes	No
Is any of the collection in a computer-based system?	28	20
If no, is automation planned?	13	5
is manual system sufficient?	10	
was automation begun, but abandoned?	1	12

Summary of computer types and software

Computer Type: Mainframe/Mini 20 (10 IBM models)
Microcomputers 16 (9 IBM or IBM clones)

Software:

Mainframe/Mini		Microcomputer	
SELGEM	6	d-BASE II	2
TAXIR	3	d-BASE III	2
FOCUS	2	d-BASE III+	5
SAS	1	FOCUS	1
INFO	1	REVELATION	1
NOMAD	1	R:base:5000	1
SIR	1	DAY FLOW	1
OS-9	1	CONDOR	1
MIMS	1	FILEMAKER+	1
		UNIFY	1
		GDBM	1

14) How did you choose the system(s)?
- 8 adopted a system used by another paleontology collection
- 2 hired an outside consultant
- 12 did own research (magazines, computer stores, etc.)
- 16 used institution computer center advisors
- 3 other (used university system)

15) Did you implement the system by yourself? 16 Yes 14 No
If no, 5 hired consultants
7 hired students
9 used institution computer center personnel

16) Is a procedural manual for using the computer system maintained?
19 Yes 8 No

17) Is a data definition list maintained? 22 Yes 5 No

18) What collection management tasks are automated?

	Yes	No	Partially
cataloguing	18	2	7
label production	13	4	7
loans	8	10	5
inventory	9	7	5
locality register	13	5	7
accessioning	4	13	5

other: 1 taxonomic code; 1 conservation information

If more than one of these tasks are automated, are these tasks integrated in one comprehensive system? 15 Yes 10 No

19) If catalogue information is stored in a database, do you have a method of indicating presence of supporting documents (e.g. photographs, field notebooks, maps, etc.)? 22 Yes 5 No

If yes, 6 related file
15 in remarks
2 memo field
8 unique fields
1 other

20) Is the collection management system part of an institution-wide computer-based management system? 8 Yes 20 No

21)

	Yes	No	?
If you were asked to digitally transmit/transfer some specimen catalogue information today, would you be able to do so?	14	12	2
If yes, could you do so within three hours?	11	6	2

22) If any part of your collection is in a database, do you think that the data fields are well enough defined so that your information could be combined with data from other institutions? 23 Yes 2 No 2 ?

UNIVERSITY COLLECTIONS (36 respondents)

	Yes	No
23) Is a course (or part of a course) in curatorial principles/methods and specimen conservation/preservation required for an advanced degree?	0	33
24) Is there a written policy about satisfactorily curating/repositing thesis/dissertation material before a degree is granted?	15	16
If yes, is it enforced?	12	3
25) Are paleontology teaching collections separated from research collections?	31	5

CENTER FOR THE

HISTORY OF GEOLOGY

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Abstract--A center should be established as an independent not-for-profit corporation in conjunction with a university to preserve geological material of historical interest, to discover and disseminate information about historical geological resources, and to encourage scholarship, research, and popular writing in the history of geology. This Center should locate and preserve publications, manuscripts, and archival records of geologists, societies, geological surveys, and companies important in the history of geology, and organize a program of interviews and oral histories. The Center's collections should include extensive photographic archives, including portraits, and relevant memorabilia.

The Center should be involved in research projects in the history of geology and hence serve geologists, historians, archivists, and librarians. It should also spread to the public a knowledge of the achievements of geologists. Its staff should include specialists in the history of geology, in oral history, in library and records management, and in exhibits and the public understanding of geology.

The functions of the Center should compare with those of the Center for History of Physics of the American Institute of Physics and Center for the History of Chemistry. It should not compete with existing facilities, such as libraries, nor with home institutions such as universities or geological surveys which preserve their own archival material.

Introduction

The final report of the Joint Committee on Archives of Science and Technology (1983, p.5) painted a worst-case scenario:

> "Imagine a dimly lit warehouse with narrow aisles stretching a hundred feet or more between shelves piled to the roof with boxes, each box full of letters, reports, memoranda. Imagine, too, that only rudimentary lists are available to find what is within a given box or where the box is located. Now imagine hundreds of such warehouses scattered about the United States, and that you are a historian, sociologist, or other scholar a few decades in the future, studying American science and technology and wishing to understand its growth and structure. Records that might be needed to understand this, you

will be told, are in those warehouses......somewhere."

This worst-case scenario sounds dreadful and discouraging, yet for the science of geology matters are even worse. No boxes "full of letters, reprints, memoranda" are stored anywhere. Places for maintaining records on the science of geology for all practical purposes are non-existent. I wished that this worst-case scenario would hold for geology. At least material would be available in scattered locations for further accessioning. Surely something needs to be done. As Warnow-Blewett (1987 p.29) put it for the science of physics " librarians and archivists select materials that, "because of their valuable information content, deserve long-term retention". Physicists and other scientists together with archivists in their programs identify and preserve historically valuable source materials in appropriate repositories, assist institutions in initiating or upgrading archival programs, create oral histories and other supplementary documentation, and collect selected publications, audio-visual materials, and other resources. For geology only one big blank exists.

Centers For The History Of Other Sciences

Chemistry

As a member of long standing of the American Chemical Society I have received since its founding in 1982 the Newsletter of the Center for the History of Chemistry (CHOC) of the American Chemical Society and the American Institute of Chemical Engineers. This Center is a joint effort with the University of Pennsylvania. It was established in January 1982 to discover and disseminate information about historical resources and to encourage research, scholarship, and popular writing in the history of chemistry, chemibal engineering and the chemical process industries.

The aims of CHOC include organizing a program of interviews and oral histories on major developments in modern chemistry; locating historical manuscript and archival records of individuals, societies, trade associations, and companies important in the history of chemistry, chemical engineering, and the chemical process industries; encouraging the preservation of these records in appropriate archives; offering aid in the appraisal, arrangement, and description of such records; developing a comprehensive database describing such records, with finding aids and other reference tools ; and making known the achievements of chemists, chemical engineers, and the chemical industry. Hopefully in the not-to-distant future one will be able to substitute the word "geology" for those of "chemistry", "chemical engingeering" and related terms to serve the needs of the geological community, in an appropriate geologic Center.

I discussed on the telephone the Center with Arnold Thackray, its Director. He likes the relationship with the University; in fact, when he returned my call he announced himself as "of the University of Pennsylvania". In a University setting visitors feel comfortable and the University has library and other historical resources. The disadvantage is that the staff is subject to two sets of pressures, that of the University and that of the Societies.

Mathematics

The Archives of American Mathematics serves as a national repository for papers of mathematicians and records of mathematical organizations for which appropriate local preservation is not available. Initiated in 1975 with the preservation of the papers of University of Texas topologist Robert Lee Moore, the Archives is administered by the University Archives of the University of Texas and is the official archival repository of the Mathematical Association of America. The collections, now comprising over 450 linear feet, include the records of the School Mathematics Study Group and the papers of over twenty mathematicians. Most strongly represented are individuals and organizations active after about 1920.

Microbiology

In 1986 an agreement was signed by representatives of the University of Maryland and the American Society for Microbiology (ASM) to establish a Center for the History of Microbiology. The result of two years of planning, the center will be a part of the ASM Archives, located at the university. The ASM and the university have appointed Advisory Boards of distinguished microbiologists, industrialists and historians of science to provide advice on the center's goals and programs.

The primary purpose of the new center is to preserve historical materials relating to microbiology. In addition, the ASM hopes that the center will promote study of the history of microbiology by making historical materials easily accessible to qualified users, fostering an increased awareness of the impact of microbiology upon society, and developing educational materials related to the history of microbiology.

Physics

The Center for History of Physics has a collection of over 20,000 historical photographs, slides, lithographs, and engravings. The majority of the collection focuses on American physicists of the twentieth century. The Center received the Distinguished-Service-Award from the American Society of Archivists. Special programs in Oral History serve as focus for much effort.

The Center has a library, a gallery of Noble laureates, and an extensive archives room. The latter with its enormous collections has its own tempertature control to avoid fluctuations of temperature.

A Future Center For The History Of Geology

In a book review of "Oil on their shoes - petroleum geology to 1918" by Ellen Sue Blakeley in Earth Sciences History (1986, p.98) Gretchen Luepke mourned that "so much personal history of early geologists has already been lost that we are indebted to the author for ensuring that at least some of the exciting tales will live on". Although geology was already among the leading sciences in the 19th century its records have never been properly archived. There has been no repository nor a journal for archival material. For many years, I tried to establish a journal to serve the needs of the history of geology. The scene was one of pessimism and discouragement. Against all odds Earth Sciences History is now successful and in its seventh year. A Center for the History of Geology will likewise meet with success. Currently geophysics deposits its records with the Physics Center and geochemistry has at least some material in the Chemistry Center. Shall Paleontology go with Biology? In a recent newsletter of the Physics Center, I noted that the papers of Martin J. Buerger, distinguished mineralogist, went to the Physics Center, those of the distinguished sedimentologist Arthur Trowbridge whose classical 1930 paper on "Building of Mississippi Delta" in the Bulletin of the American Association of Petroleum Geologists my students still read, were accessioned in the Physics Center, and the papers of Bruce C. Helzen, distinguished marine geologist (a total of 122 cu.ft.) were deposited in the National Museum of American History. The papers of geochemist F.W. Clarke whose Data of Geochemistry published with the U.S. Geological Survey became classical, and the correspondence of petrologists and geochemists L.H. Adams and Arthur Day with the Geological Society of America landed in the Library of Congress. Is this dispersion in the interest of the geological community?

When George W. White was alive the University of Illinois, which has extensive holdings in the history of geology, was interested in establishing a Center. Currently the largest geological archives are located in the Petroleum Geology and Research Center of the University of Wyoming. In fact already over twenty years ago master persuader and historian Gene M. Gressley recruited my own archival papers to this collection. In a recent letter he wrote me that most presidents of the American Association of Petroleum Geologists have donated their papers to the Wyoming Center. Other notable collections, a total of 12,000, cover geology and natural resources, especially petroleum, mining, and agriculture. Company collections include those of Arco Coal Co., Anaconda, Sinclair, Exxon, and Midwest Oil Corporation.

Whether existing facilities, such as that of the University of Wyoming are enlarged or a new Center is established, the geological community needs to take such an effort seriously and involve the geological societies. The Center should be under multiple-society sponsorship and cater to academia, industry, and government. The time for a Center is overdue; geological collections should not be further lost or dispersed.

The Center should be an independent not-for-profit corporation set up in conjunction with a university to preserve geological material of historical interest, to discover and disseminate information about historical geological resources, and to encourage scholarship, research, and popular writing in the history of geology. This Center should locate and preserve publications, manuscripts and archival records of geologists, societies, geological surveys, and companies important in the history of geology, and organize a program of interviews and oral histories. The Center's collections should include extensive photographic archives, including portraits, and relevant memorabilia. The Center should be involved in research projects in the history of geology and hence serve geologists, historians, archivists, and librarians. It should also spread to the public a knowledge of the achievements of geologists. Its staff should include specialists in the history of geology, in oral history, in library and records management, and in exhibits and the public understanding of geology. It should not compete with existing facilities, such as libraries, nor with home institutions, such as universities or geological surveys which preserve their own archival material.

Funding will be a key to the success of the Center. Such funds should be generated through research projects, and through various funding agencies, such as the National Historical Publications and Records Commission, the Department of Energy, National Science Foundation, industrial corporations, foundations and individuals. For the latter, a "Friends of the Center" program should be arranged. Matching gifts are available from many employers.

At the beginning a core staff should consist of three: historian, archivist, and secretary. A library is not necessary for a new center.

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PART II

TECHNICAL SESSION

THESAURUS PROBLEMS AND SOLUTIONS: THE LANGUAGE OF GEOLOGY DEVELOPS STEADILY

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Abstract--Scientific thesauri are developed as the need to interrelate and regularize vocabulary becomes apparent. The original edition of The GeoRef Thesaurus and Guide to Indexing (1977) began as a reflection of established indexing practice. It did not signal a change in terminology, but reflected a significant step toward control of a steadily growing vocabulary. From 9000 terms in 1977, the Thesaurus, now in its fifth major revision, has grown to more than 15,000 geologic and geographic terms. Additions reflect the growth of the GeoRef file, as well as changes in geologic terminology and the identification of historical variations in indexing practice. As the primary tool for users of the GeoRef data base, the Thesaurus defines the structure of the geologic terminology to be used by eliminating synonyms, displaying hierarchies, and establishing relationships. Availability of the Thesaurus in an online environment offers new options to users.

Introduction

GeoRef, the bibliographic geoscience data base, became available to the public through online access in 1973. The move to online access represented a major change from a manually-accessed printed product. The time to evaluate and adapt a retrieval vocabulary, which had served a manual environment, had arrived. Online access introduced new opportunities for improved recall in retrieval while adding new avenues for inaccuracy. While an individual doing a manual search may overlook a relevant citation due the shear volume of material to scan, he or she will not be likely to select unrelated references based on the co-occurrence of two unrelated terms. Online systems have mastered the problem of volume, but not the problem of context.

Definition

Vocabulary control and consistency become of paramount importance in preserving the accuracy of information retrieval in an online environment. The mechanism for achieving this control is a thesaurus. Not a thesaurus like the ubiquitous Roget's, but an information retrieval thesaurus. The definition of this type of thesaurus from the American National Standards Institute is a compilation of words and phrases showing synonymous, hierarchical and other relationships and dependencies, the function of which is to provide a standardized vocabulary for information retrieval and storage (ANSI, 1980). In short, a thesaurus is a guide to the usage of synonyms, homonyms, orthographic conventions, classification systems and ores and Mercury Planet are both in the See Also list for mercury.

The See Also relationship directs the user to related terms or terms that often co-occur, but are not subject to a hierarchical relationship. The intention is to alert the user to possible alternate terms or combinations of terms, i.e. kettles SA potholes.

Second Edition

Features:

A. 12,500 terms

B. Geographic coordinates

C. Autoposting

D. New term relationships
   1. BA/NA
   2. BX/NX
   3. BZ/NZ

The second edition of the GeoRef Thesaurus and Guide to Indexing appeared in 1978. Containing 12,500 terms, it introduced major changes in the structure and functioning to the Thesaurus. Geographic coordinates (i.e. latitude and longitude) were introduced for geographic place names. Adjectives were replaced with nouns, i.e. argillaceous was replaced with argillaceous texture. Six new term relationships were allowed. Autoposting or up-posting of broader terms (the addition of broader hierarchical terms automatically for each use of a narrower term) was introduced.

Three variants of the Broader Term/Narrower Term relationship were introduced. The most significant is the Automatically-posted Broader Term (BA) and its reciprocal, the Narrower Term that generates automatic posting (NA). In the BA relationship the term marked BA is a broader term that is automatically added each time the narrower term is used. Automatic addition of terms occurs in one direction, from specific terms to broader terms. The net effect of autoposting is that it insures consistency of retrieval of general terms in a data base that prefers specific terms to general terms in indexing, i.e. a search on phosphates retrieves references to all the specific phosphates such as apatite.

In theory a simple hierarchical relationship sounds neat and clean. In the real world things get a little sloppier. Geographic terms are a sloppy area. As non-unique terms, a simple hierarchical relationship is not sufficient to deal with the complexity of geographic place names. Counties are a good example of overuse of a single term. Washington County appears in thirty-two states. Terms can be altered to accommodate overuse. The Washington County in Arkansas can be indicated by a compound term -- Washington County (Arkansas). In GeoRef, terms have traditionally been used in their simplest form. All Washington counties are identical in form. Users are able to identify the Washington County of their choice through the use of coordinate searching. To cope with the confusion created by using the same term for more than one purpose, a new type of broader term/narrower term relationship (BX/NX) was introduced, i.e. Jefferson County BX Alabama BX Arkansas, etc.

The third type of hierarchy (BZ/NZ) that was introduced in the second edition was designed to handle terms that are part of multiple hierarchies where it is desirable for more than one broader term to be automatically added to each appropriate record. This applies, for the most part, to minerals. Some minerals are classifiable as more than one type of major mineral group, i.e. topaz BZ fluorides BZ nesosilicates. In this example each usage of the term topaz generates automatically both the term fluorides and the term nesosilicates.

Third edition

Features:

A. 13,500 terms

B. Changes for French exchange

The third edition of the Thesaurus contained 13,500 terms and appeared in 1981. This represented the addition of 1000 new terms. 277 terms were new geographic terms and 40 were new non-geographic terms. Most of the remaining terms reflected changes in terminology in order to facilitate an exchange of references with the Bureau de Recherches Geologiques et Minieres and the Centre Nationale de la Recherche Scientifique of France. The majority of the changes for the French exchange involved cases where the terms used in GeoRef were non-unique terms, i.e. one term was being used for several different purposes. A good example of this type of term is Mollusca. Prior to 1981, Mollusca was used for both paleontologic and stratigraphic studies involving Mollusca. Beginning in 1981, the common term mollusks was used for stratigraphic studies and Mollusca was retained for paleontologic studies.

Fourth edition

Features:

A. 15,000 terms

B. Additions reviewed by task force

C. Cross-references to terms used in pre-1969 file segments

D. Improved documentation of autoposting

The fourth and current edition of the Thesaurus appeared in 1986. Approximately 1500 terms were added after review by a Vocabulary Task Force non-hierarchical relationships employed by a data base producer.

First edition

Features:

A. 9000 terms

B. Scope notes

C. Term relationships
   1. Broader Term
   2. Narrower Term
   3. Use
   4. Use For
   5. See Also

In late 1975, GeoRef began work on a thesaurus. The initial version of the thesaurus was intended to serve a dual purpose. Searchers were to be provided terms and histories of past usage. In addition, current indexing structures were to be included to aid in manual searching of the Bibliography and Index of Geology. Indexers were to use the thesaurus as a guide to current indexing structure and vocabulary. The first edition, the GeoRef Thesaurus and Guide to Indexing, appeared in 1977. It included over 9000 terms. The majority of the terms were geographic place names. Other major types of terms that were included were systematic terms, such as rocks, minerals, and fossils, and non-systematic terms, such as geologic processes, features, materials, properties. This list of terms did not represent any change in terminology, but rather displayed and interrelated vocabulary in use since 1969. Geographic and systematic terms used more than four times and non-systematic terms used more than twenty-four times were considered for inclusion.

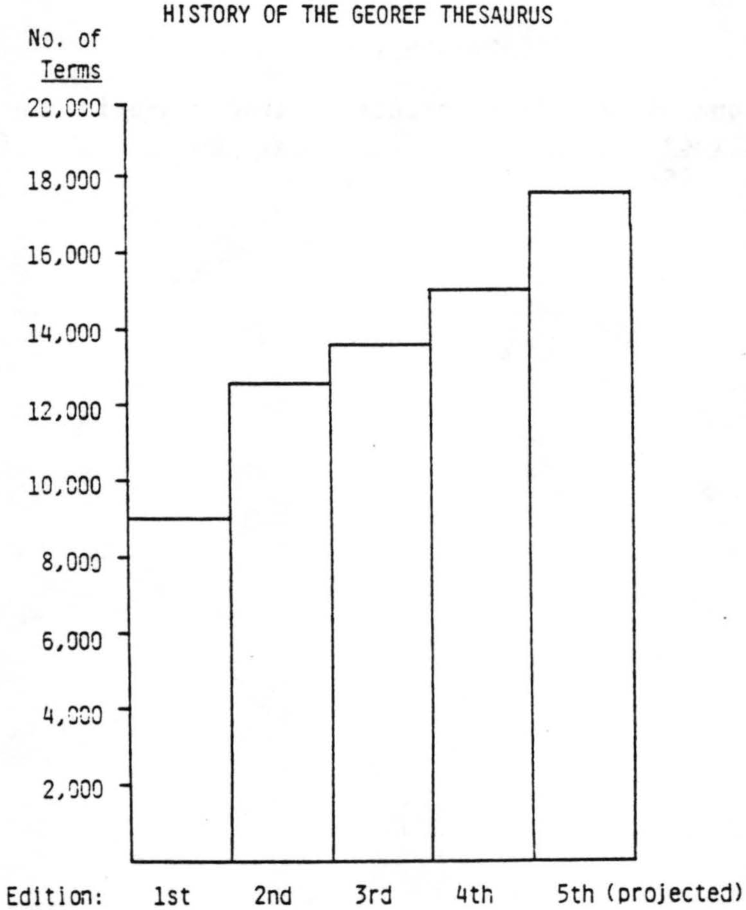
Five types of term relationships were permitted -- broader terms, narrower terms, use, use for, and see also. Hierarchical relationships are indicated by the broader term/narrower term (BT/NT) indicator. This type of relationship can be defined as the relationship of a group to an individual, i.e. igneous rocks NT granites; granites BT igneous rocks. Part-whole relationships are only allowed for geographic terms and age terms, i.e. Wyoming NT Sweetwater County; Aptian BT Cretaceous.

Synonyms (two or more words with the same meaning) are indicated in the Thesaurus by use and used for (UF) relationships. Under the discarded term a user is directed to use a different term, i.e. hydrargillite use gibbsite. Under the preferred term the user is shown a list of discarded terms that the individual term is used for, i.e. Bet-Pak-Dala UF Hunger Steppe.

Homonyms (one word with two or more meanings) are handled by the use of the See Also (SA) relationship as well as through explanations embedded in descriptive paragraphs known as Scope Notes, i.e. mercury is defined in its Scope Note as a chemical element and the user is directed to use mercury ores for mercury as a commodity and Mercury Planet for the planet; mercury composed of users of the data base. Most of the new terms were county and stratigraphic names. After analyzing the indexing employed in segments of the Bibliography of North American Geology and the Bibliography and Index of Geology Exclusive of North America 300 historical terms were added with scope notes explaining the dates of usage.

What's Next?

The fifth edition of the Thesaurus is underway. Approximately 2600 terms are being considered as candidate terms for this edition. These terms are composed of terms that have been used in GeoRef more than 9 times since 1984.



Conclusions

The growth of the GeoRef Thesaurus and Guide to Indexing, from 9000 terms in its first edition to 15,000 in its fourth edition, is largely the result of internal changes in GeoRef, rather than a reflection of growth in geoscience vocabulary. The other major category of growth is in the area of geographic terms. The large change (3500 terms) from the first edition to the second reflects the decision to publish the first edition as quickly as possible. In the rush to make a working Thesaurus available to users, the first edition was published before work on all the candidate terms was complete. The 1000 new terms in the third edition reflected only 40 new non-geographic terms. All other terms were either geographic terms or were changes to existing terms generated by the French exchange. Of the 1500 new terms in the fourth edition, 300 were historical terms and the majority of the rest were county and stratigraphic names. Internal adjustments to GeoRef have dominated the growth of the Thesaurus. The fifth edition will be the first revision to be based solely on growth in term usage.

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THE NATIONAL GEOLOGIC MAPPING PROGRAM: A REVITALIZATION OF GEOLOGIC MAPPING IN THE UNITED STATES

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Abstract--The U.S. Geological Survey (USGS) initiated a new National Geologic Mapping (NGM) Program in October 1987. The program will respond to the need for geologic maps that has increased dramatically in the past 40 years by reversing the steady decline in the production of geologic maps during the past 20 years. The NGM Program will reorganize and expand Federal geologic mapping; expand the Cooperative State-Federal Geologic Mapping (COGEOMAP) Program; when fully funded, will initiate contracts to universities, other organizations, and individuals; and introduce new automated data processing technology into map preparation and publication.

USGS Circular 1020 describes the goals, objectives, and long- range plans of the NGM Program. A second planning document that identifies geologic-map requirements within the United States has been released in draft form as USGS Open-File Report 86-572. This report has been reviewed by the USGS, State Geological surveys, university scientists, and industry representatives in order to insure a comprehensive and balanced evaluation of the geologic-map requirements of the Nation. Other Federal agencies are being asked to identify their geologic information needs so that NGM can establish priorities for the program. The NGM Program will support geologic, geophysical, isotopic, geochronologic, and geochemical investigations of regional-scale study areas and crustal transects. Above all, the new program will address the ever-increasing demand for general-purpose geologic maps by systematic geologic mapping and increased production of geologic maps.

Introduction

Geologic maps are the primary data source for nearly all pure and applied earth-science research. The number of uses to which geologic maps are put has increased markedly during the last three or four decades as shown in figure l. Basic understanding of geologic hazards, land-use issues, waste disposal, and energy and mineral resource assessments has increased markedly over the past few decades. However, new and more precise geologic information bearing on these issues is needed, and the adequacy of such information depends greatly on the accuracy and availability of modern geologic maps.

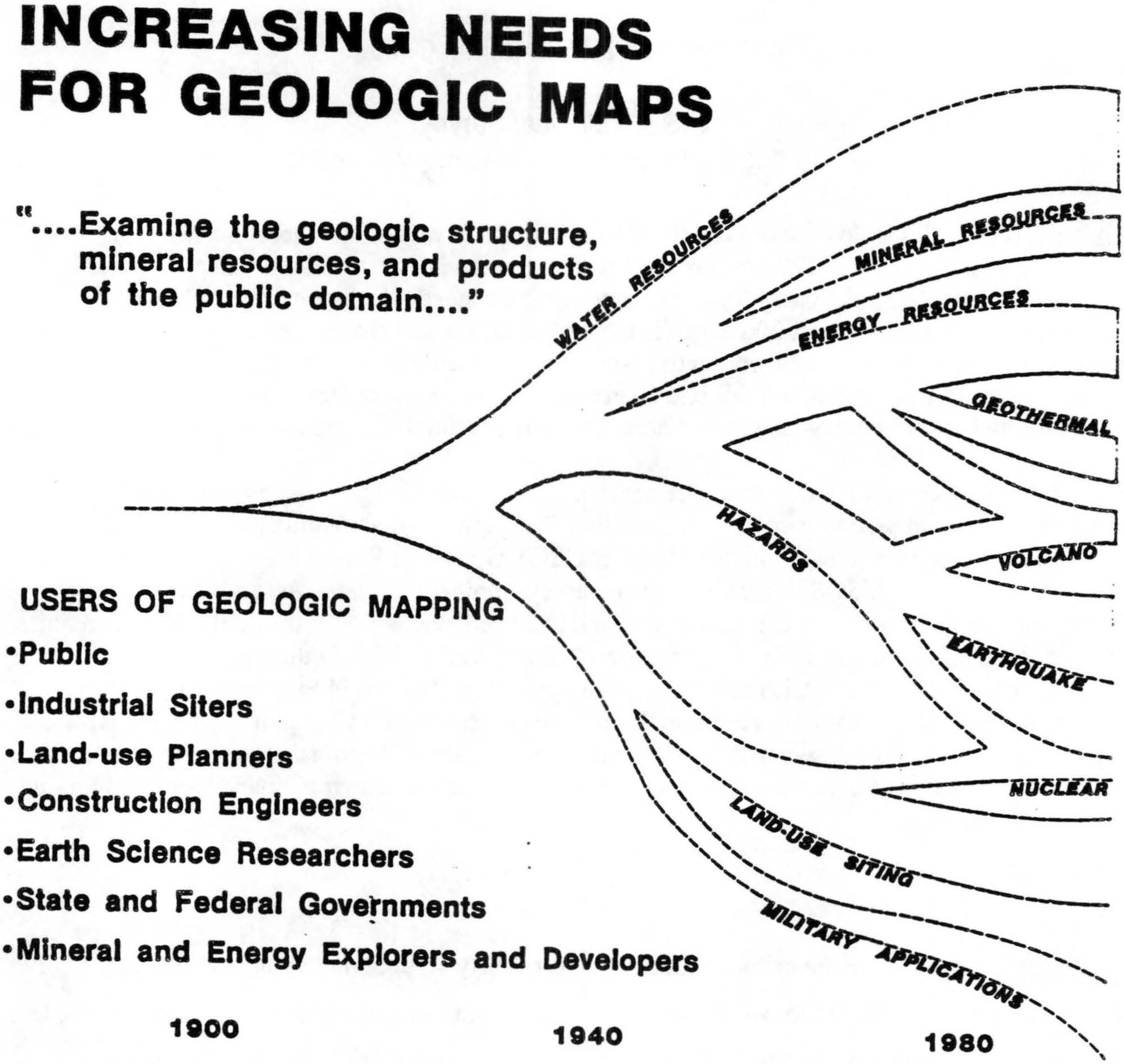

Figure 1. Increasing needs for geologic maps. From 1900 to the present the use of geologic maps has steadily increased and diversified. Geologic maps are the basic data source for almost every type of study involving the earth sciences.

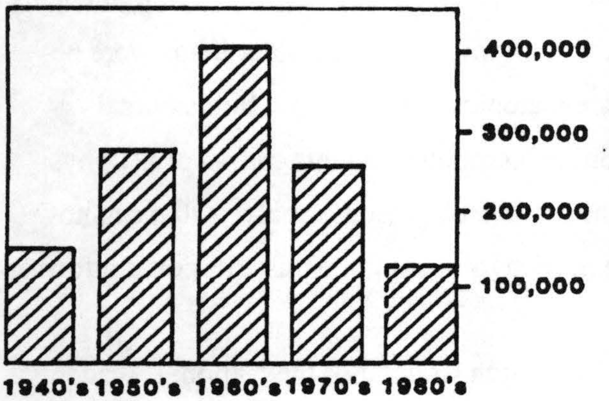

Figure 2. Number of square miles mapped by geologists during each of the last five decades. Only maps at scales of 1 mile to the inch or larger, by far the most widely used, are included. Although map productions increased from the 1940's to the 1960's, the decline since then has resulted in a production rate that is now lower than it was in the 1940's. The 1980's bar is a projection based on data for 1980 through 1985.

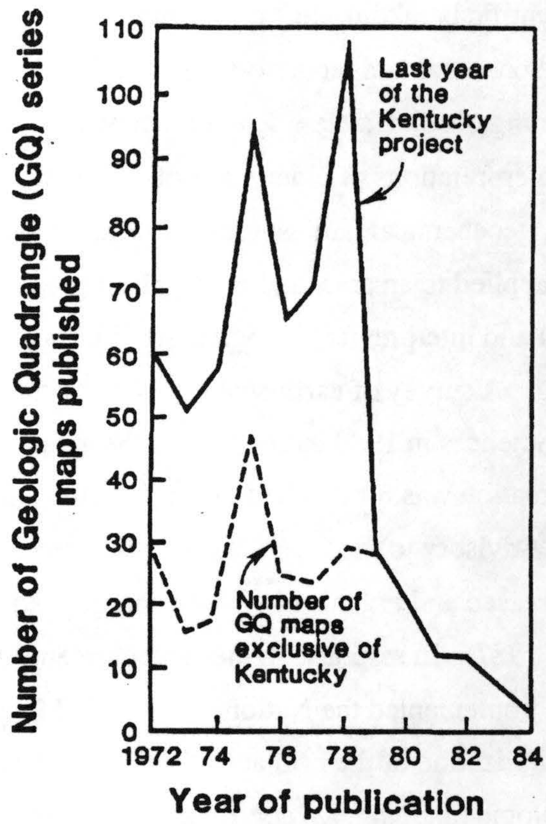

Figure 3. Number of maps published in the U.S. Geological Survey's Geologic Quadrangle series between 1972 and 1984. Geologic maps are also shown exclusive of those produced under the USGS-Kentucky cooperative project, because the Kentucky project was of finite length, separate from all other USGS mapping efforts, and represents a period of anomalously high map production.

The USGS and the State geological surveys conduct most of the geologic mapping done in the United States today; supplemental mapping is carried out by geologists in various universities across the country, some other Federal agencies, and by private industry. Although the efforts of these groups over the years have resulted in fairly complete coverage of the Nation by small- to-intermediate scale geologic maps (covering large areas), only about one-third of the country is covered at scales of 1-mile-to- the-inch (1:62,500) or larger, and only about 11 percent is covered by the more useful large-scale geologic maps (at scales of 1:24,000 or larger). Furthermore, production of 1-mile-to- the-inch or larger scale maps has been steadily declining over the past 20 years (figure 2). This decline is reflected by a dramatic drop in publication of maps in the USGS Geologic Quadrangle series over the past 10 years (figure 3).

Reasons for the decline are complex but are attributable in part to demands brought on by earth-science related crises, such as energy shortages, earthquakes, and volcanic eruptions, which have diverted efforts away from geologic mapping. In addition, over the same period, major scientific breakthroughs have caused geologists to shift their research emphasis from field mapping to theoretical and laboratory studies. While this shift was in progress, some older maps were becoming obsolete. New scientific concepts such as plate tectonics have required fundamental reinterpretations of older maps of many areas. In addition, computerized integration of geophysical, geochemical, and isotopic information increase the breadth of geologic analysis that can now be applied to an area, and modernized procedures are needed to manipulate this additional information and interpret its geological significance.

A survey of earth-science users by the National Research Council of the National Academy of Sciences in 1983 indicated that the greatest present and future need for all types of geoscience information was for detailed geologic maps. In addition, the National Academy of Sciences Committee Advisory to the USGS has strongly recommended that geologic mapping within the USGS be increased and organized under a coordinated geologic mapping program (National Research Council, 1987). In response to these recommendations and similar ones from other sources, the USGS has implemented the National Geologic Mapping (NGM) Program, which is dedicated to the revitalization of the primary geologic-map data base. The new program will (1) increase new geologic mapping, (2) coordinate increased Federal, State, and university mapping activities, and (3) augment development of new mapping and publication technologies.

The National Geologic Mapping Program

The new program consists of three components: (a) A Federal- mapping component consisting of U.S. Geological Survey (USGS) based projects, geologists, and funding (basically a modification of the mapping element of the previous Geologic Framework Synthesis [GFS] Program); (b) State-Federal Cooperative Geologic Mapping Program (COGEOMAP), and (c) modernization of mapping techniques and compilation procedures. A fourth component, (d) external contracts for mapping, is planned but cannot be initiated at current funding levels; it is designed mainly to encourage training in geologic mapping for graduate-level university geologists.

The NGM Program was created to increase the number and versatility of geologic maps produced in the United States in response to a growing national need, and to modernize the production of geologic maps. NGM began in Fiscal Year 1988 (starting October 1, 1987) by redirection of a previous program, Geologic Framework and Synthesis, whose broad research agenda included geologic mapping, geochronology, and an array of topical and processes investigations that did not require new mapping. Two published planning documents describe the program and give an overview of geologic mapping needs: (1) a circular entitled "National Geologic Mapping Program--Goals, Objectives, and Long- Range Plans" (USGS, 1987), and (2) an open-file report entitled "An Overview of Geologic Mapping Needs in the United States" (Rowley and others, 1986).

Federal-Mapping Component

The Federal-mapping component includes coordination, planning, and funding of USGS personnel and their projects. This component will emphasize the systematic production of high-quality, multipurpose geologic-quadrangle maps in areas of broad interest and need. Those topical mapping investigations that were ongoing under the GFS program in FY 1987 will continue under the new program in FY 1988.

The Federal-mapping component will utilize multidisciplinary teams to study areas where outstanding scientific, natural resource, geologic-hazard, and land-use problems have been identified. Workshops with invited representatives from State geological surveys, universities, other Government agencies, and industry will be convened to focus goals and strategies for completing each study unit. Geologic mapping in each study unit will be conducted principally by a coordinated team of USGS geologists; experts from State surveys, universities, and the private sector will be encouraged to participate. The mapping will include multidisciplinary efforts with paleontologists and isotopists, geophysicists, geochemists, and other specialists in geologic processes. Where possible, study units will be framed around deep-crustal seismic profiles; where profiles do not exist, seismic data acquisition will be incorporated into the study unit design. In most cases, the preferred products within a study unit will be 1:24,000-scale geologic quadrangles. As study units approach completion (about 5 years), participants will combine the results of individual projects, leading to products consisting of 1:100,000-scale geologic synthesis maps, derivative maps, and symposia volumes to conclude the NGM- supported study on the area.

Federal-state Cooperative Mapping Component (COGEOMAP):

A cooperative geologic-mapping program called COGEOMAP was established in 1985 between the U.S. Geological Survey and the State geological surveys. The cooperative program has grown from the participation of 18 states in 1985, to 29 in 1986, and 30 in 1987. Over the same 3 years combined State and Federal resources applied to the program grew from about $2 million to over $3.3 million per year. This program continues to receive popular support from the States and is now a firmly established component of the National Geologic Mapping Program. There is little doubt that continuation of COGEOMAP will lead to the publication of numerous high-quality geophysical and geologic maps. An excellent summary of COGEOMAP is given by Reinhardt and Miller in USGS Circular 1003 (1987).

Modernization of Mapping Component

Research under the modernization component is directed at developing new digital geologic mapping capabilities, digital data bases, and new geologic map production techniques. We anticipate that digitization and the creation of computerized data bases will speed the process of geologic mapping and will increase the cost-effective production of special purpose derivative maps. Current efforts include evaluation of presently available technology in digital cartography and selection of the most effective techniques for production of high quality geologic maps and associated derivative maps. A variety of approaches to digital cartography are being taken by independent researchers within the USGS. Sophisticated digitizing, editing, and plotting instruments are already operational and being shared by several USGS divisions. These expensive systems, however, are not completely suitable for geologic cartography, and the new approaches with less expensive desk-top equipment are being explored. In the year ahead, we intend that a combination of methods, some automated and some manual, will be selected from the best of the present experimental approaches in order to establish a unified procedure of geologic map production. This procedure is envisioned as a streamline progression from field compilation and analysis to timely publication of the printed map, one or more derivative maps, and a digitized data base that is distributed to or easily accessed by the user community as future needs may dictate.

A more specific effort currently in progress, is the conceptual design and implementation of a geologic work station for the field geologists not specalized in computer techniques. This concept seeks to develop a ditital data base early in the geologic mapping process, for integration into the Survey's National Digital Cartographic Data Base and for general application in other geographic information systems.

External Mapping Component

Universities will play a dual role in the National Geologic Mapping Program. They will continue to train graduate students in the science and art of field mapping and, with these same graduate students, may participate in mapping programs with the USGS and State geological surveys. If funds become available for the external mapping contracts component, the USGS will provide support to faculty and graduate students and may, in conjunction with appropriate States, publish maps resulting from their work.

Support of faculty and well-supervised graduate students will benefit the geologic profession by helping to train high-quality field geologists for the future. Direct benefits to the participants will include the timely publication and distribution of their maps.

Cooperative efforts with private industry will be encouraged where conflicts of interest are not an issue.

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COMPARISON OF LIBRARY COLLECTIONS IN GEOLOGY:
A MODEL BASED ON THE PACIFIC NORTHWEST CONSPECTUS

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Abstract--Geological holdings in library collections in Alaska, Idaho, Montana, Oregon, and Washington are analyzed based on data reported from the Pacific Northwest Conspectus Database Program. The Conspectus is an approach to collection evaluation developed by the Research Libraries Group; it is likely to become the standard methodology for comparing and analyzing library holdings in North America.

Fifteen geologic topics were selected from the Conspectus, from the broad Geology category level to more detailed subject levels such as Paleontology and Seismology. Reports provided by the Conspectus Database show collection strength information from the 26 libraries who have thus far submitted data at the broad Geology category level, and the 11 who have reported at the more detailed subject levels.

While the conspectus data is unverified by comparing volume counts, checking standard bibliographies, and other quantitative tasks, experience has shown that verification tends to confirm judgments reached in the initial shelf examination.

Based on this preliminary data from reporting libraries, Oregon State Univ., Univ. of Idaho, Montana State Univ., and Western Washington Univ. hold the most extensive geological collections, with other libraries showing strengths in particular subject topics.

At this early stage in its development, the Pacific Northwest Conspectus is shown to be a useful database for collection analysis and comparison among libraries, and as a tool on which to base cooperative collection development policies and interlibrary loan strategies.

Introduction

Analyzing and comparing collections of library materials, in a standard format on a national scale, has become practicable through the Conspectus methodology devised by the Research Libraries Group (RLG) and described by Nancy Gwinn and Paul Mosher in 1983.

The Conspectus approach to collection evaluation has been adopted by other groups as well, with the eventual goal of contributing to a national collection description scheme such as is now being carried out on a limited scope by the North American Collections Inventory Project. The application of this methodology to library holdings in geology was reported by the authors in their paper delivered at the 1985 Geoscience Information Section, and will be included in those proceedings (Triplehorn and Stephens, 198[illegible]).

Briefly, the Conspectus approach involves the evaluation of collections by shelf survey, using a standard list of criteria, to determine the functional level of the collection, expressed in uniform standardized terms. The RLG collection description scale consists of numerals from 0 through 5, with 0 being "out of scale -- library does not collect in this area," and 5 being a comprehensive collection: virtually all significant works on this subject are collected, regardless of language or format. Collections at the 4 and especially the 5 level are considered nationally significant.

The Alaska Collection Development Steering Committee added a, b, and c sublevels to this scale, as shown in Table 1, to help make the scale more usable for libraries in a range of types and sizes. This modified scale was adopted by the Library and Information Resources for the Northwest (LIRN) program of the Fred Meyer Charitable Trust, for its region-wide collection survey project. The Resources and Technical Services Division of the American Library Association is considering similar scales for adoption.

Table 2a shows the evaluation criteria devised by the Alaska Collection Development Steering Committee, to help assure uniformity of evaluations among libraries using this approach. These criteria have also been adopted by the LIRN program. Table 2b is the list of the RLG language codes, used in conjunction with the 0-5 collection level scale to describe language composition of collections. For example, "3aF" means a basic study level collection which includes selected non-English language material, in addition to English.

The Pacific Northwest Conspectus Database

As mentioned above, the Alaska Committee and the LIRN program are working with the RLG Conspectus methodology. Alaska is establishing a statewide program for cooperative collection development based on Conspectus findings. The LIRN program provided training for collection evaluation throughout the Pacific Northwest, and a structure for collecting and reporting the data. The LIRN program has now been phased out. The collection survey data collected under its auspices continues to grow as the Pacific Northwest Conspectus Database Program, administered by the Oregon State Library Foundation through funding provided by the Trust and the state library agencies of Alaska and the Pacific Northwest states.

Reports from the Pacific Northwest Conspectus Database are now available in a variety of formats, and reports from libraries who have submitted data in the Geology category form the basis for this paper. Geological holdings of some 30 reporting libraries in Alaska, Idaho, Montana, Oregon, and Washington were analyzed, from the Geology category level to more detailed subject levels.

The data-gathering and reporting format of the Pacific Northwest Conspectus is hierarchical and based on the Library of Congress (or Dewey) classification. It is designed at three levels: the division level is the broadest term, e.g., "Geography and Earth Sciences," the category is the next-broadest term, e.g. "Geology," and the subject is the most detailed level, e.g. "Seismology."

This paper concerns academic and special libraries using the Library of Congress classifications, and reporting collection levels of 2a (Basic Information) or higher at the Geology category level. Reports supplied by the Pacific Northwest Conspectus Database Program on September 24, 1987 show 16 libraries in this group, as detailed in Table 3. Five libraries report strong collections in the Geology category, at the 3c (Advanced Study) or 4 (Research) levels.

In addition to the LC libraries dealt with here, 15 Dewey libraries report holdings of 2a or higher in at least some subjects within the Geography and Earth Sciences Division. These include one 3a and two 3b's, with no 4 or 5-level collections.

In Table 3, "CL" is the current collection level. "AC" is the acquisition commitment (the level at which the library is currently collecting, and to which it is committed until it advises otherwise). GL is collection goal (the level the collection should be to support the mission of the library and its parent institution). The alphanumeric level indicators are explained in Tables 1 and 2b.

The majority of libraries in this category were academic libraries with only one State library and three special libraries reporting. Only three of the eight universities that have Geology Ph.D. programs in the Pacific Northwest are represented: Oregon State, Univ. of Idaho and Univ. of Alaska.

For the five libraries reporting 3c or 4 collections in Table 3, Table 4 indicates degree programs, faculty, and graduate assistants as listed in the Directory of Geoscience Departments. United States and Canada, Fall 1986. This compares the university programs in Geology which these collections support.

As Table 3 shows, Oregon State and the Alaska State Library have set their collection goals at 4F and 2aE respectively, while the Univ.of Alaska Fairbanks has set a collection goal of 3cF. The blanks for other libraries indicate they have not yet decided, or at least have not yet reported, collection goals for Geology. Note that five libraries report their acquisition commitment, or current collecting activity, is lower than their current collection level: Eastern Washington, Alaska Fairbanks, Montana State, Oregon State, and Puget Sound. Perhaps tighter materials budgets resulting from the decline in state revenues based on oil, mining, and agriculture account for this. The situation does not bode well for the future of research collections in the region, unless cooperative collection planning can be undertaken to assure continuing strong collections in the region as a whole.

Table 5 shows reportings for the subject Mineralogy. Oregon State shows the strongest collection. Alaska Fairbanks shows a 3bF collection, or Intermediate Study level, adequate for curriculum support. Alaska also shows a very low current acquisition rate of 1bE, due to the stringent prioritization required by budget cuts, but a collection goal of 3cF. Comments can be very useful in some cases, and Idaho State has included a helpful comment with their report.

Table 6 shows libraries reporting in Aerial Photography. With the new Side-Angle Radar installation at Alaska Fairbanks, that library will be increasing its commitment from 2bE to 3cF, in conjunction with the Geophysical Institute Library.

Three libraries report strong holdings of 3c (Advanced Study) in Dynamic and Structural Geology, as shown in Table 7. Both Alaska Fairbanks and Eastern Washington show a significant drop from their current collection strength to their current commitment, and again, Idaho State's comments are of interest.

Strong collections in Seismology are shown in Table 8, with the University of Alaska Geophysical Institute and Oregon State both showing Research level collections.

Subsequent tables show collection level comparison for the following subject lines: 9, Stratigraphy; 10, History of Geology; 11, Geochemistry; 12, Mathematical Geology; 13, Structural Geology; 14, Petrology (General); 15, Regional Geology (General); 16, Regional Geology-United States; 17, Paleontology; and 18, Periodicals.

In these examples, Alaska Fairbanks has included in the comment field a volume estimate based on the volumes on the shelf when the evaluation was done. The estimate is based on a formula of 10 volumes per linear foot, adjusted as necessary. For example, a shelf of thin pamphlets would obviously have a higher density. While this number is not provided as a standard and needs to be verified subsequently by a shelflist count, it serves in the meantime as a rough quantitative measure which would be useful if other libraries provided counts.

Use of Conspectus Information

The intent of this collection survey program is three-fold. One is to provide the individual library with information on the nature of its collections, which can then be useful in a variety of ways, from accreditation to budget justification. The second is to obtain data which will enable comparison with collections in other libraries, at whatever level of detail is appropriate. The third use is as a networking tool: using this data to to identify areas in which cooperative collecting can be undertaken and unnecessary duplication prevented. Each library then can concentrate more resources on its core collection, with better knowledge of where peripheral materials can be found and borrowed when the need arises.

An example of this cooperative collecting based on individual strengths is a project for coordinated collection development in science and engineering serials, one of a number of projects funded by the Fred Meyer Charitable Trust in the Pacific Northwest. This project, which involves the land grant universities in Alaska, Idaho, Montana, Oregon and Washington, is intended to broaden the spectrum of science serials available in the region by coordinating the purchase and cancellation of individual titles, and by facilitating document delivery from one library to another.

Verification

The collections data as reported is not yet verified through strictly quantitative measures such as checking standard bibliographies, comparing shelflist counts, journal subscriptions, etc. However, verification exercises by RLG and others have tended to confirm the professional judgment of librarians in appraising collections on the shelf. This remains to be shown in the specific case of Pacific Northwest Conspectus data, and plans are being considered to undertake verification studies.

Conclusion

This paper has been an overview of the Pacific Northwest Conspectus results to date in Geology. Western Washington, Univ. of Puget Sound, Univ. of Idaho, Oregon State and Montana State appear to have the most extensive geologic collections, with other libraries reporting strengths in specific geological topics. It should be noted that just one-third of the Ph.D. granting institutions have participated in this study so far, and this must be recognized as a major weakness of the project. The lack of accepted verification tools, such as an up-to-date standard bibliography, will also have to be remedied in the future, to provide additional confidence in the reliability of the reported collection level information.

References

Gwinn, Nancy E., and Paul H. Mosher: (1983) Coordinating collection development: the RLG Conspectus, College and Research Libraries (March 1983), 44:128-40.

Triplehorn, Julia, and Dennis Stephens: (1987) Evaluation of a geoscience library collection, Geoscience Information Society Proceedings, v. 16, p. 107-112

Table 3: Category Report for Geology

Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - CATEGORY - GEO088.5 Geology

LIBRARY	CL	AC	GL	COMMENTS
Alaska State Library	2aE	2aE	2aE	strength in Alaska geology: 2b. AK earthquake mat. Geological survey mat in US depository.
Alaska Resources Library	2aE	2aE		northern regions, Canadian & Alaska
U.S. Bureau of Mines	2aE	2aE		
University of Alaska Fairbanks	3bF	2bE	3cF	6000 v. Much retrosp mat'l. Predominate foreign language is Russian.
Boise State University Library	3aE	3cE		
University of Idaho	4 F	4 F		strong research col. Esp North Amer regional, mineralogy, mining, petrology & stratigraphy.
Montana State University	3cE	3bE		
Southern Oregon State College Lib.	2bE	2bE		Bachelor program-newer program than geo.-three faculty-recent coll.-emphasis on region.
U.S. EPA Library	2aE	2aE		Government Documents.
Oregon State Univ. - Kerr Library	4 F	3cE	4 F	
Lewis & Clark College - Watzek Lib.	3aE	3aE		
Western Washington Univ-Wilson Lib.	3cF	3cF		
Eastern Washington University	3bE	3aE		
Whitworth College Library	2bE	2bE		
Univ Puget Sound - Collins Library	3cE	3aE		bulk before 1967 with titles throughout 1960s to date.
Whitman College-Penrose Library	3bE	3cE		strengthened by USGS Govt Doc deposit collection.

Table 4: University Program Comparison

	Degrees	Faculty	Grad. Assist.
University of Puget Sound	B	5	?
Montana State University	BM	15	18
Western Washington University	BM	16	8
Oregon State University	BMD	17	17
University of Idaho	BMD	20	5

Table 1: Collection Level Indicators

PACIFIC NORTHWEST COLLECTION ASSESSMENT

(Developed by the Alaska Statewide Collection Development Steering Committee*)

0. Out of scope: The library does not collect in this area.

1a. Minimal, with uneven coverage: Unsystematic representation of subject.

1b. Minimal, but chosen well: Few selections made, but basic authors, core works, and ideological balance are represented. Can support fundamental inquiries.

2a. Basic information level: A collection of up-to-date general materials that serve to introduce and define a subject and to indicate the varieties of information available elsewhere. It may include dictionaries, encyclopedias, historical surveys, bibliographies, and periodicals in the minimum number that will serve the purpose. A basic information collection can support school instruction and routine public inquiries, but is not sufficiently intensive to support higher-level academic courses or independent study or the wide-ranging recreational reading demands of a highly educated general public.

2b. Augmented information level: As above, except more major periodicals, selected editions of important works, wider selection of reference materials.

3a. Basic study level: Includes the most important primary and secondary literature, a selection of basic representative journals/periodicals, and the fundamental reference and bibliographical tools pertaining to the subject. Adequate for curriculum support for basic undergraduate instruction. Adequate for independent study and for the lifelong learning needs of the general public, with coverage at all appropriate reading levels.

3b. Intermediate study level: As above, except a wider range of basic monographs, wider selection of the more important writers and secondary materials, stronger journal/ periodical support. Collection adequate to support college-level term paper writing.

3c. Advanced study level: As above, except adequate for honors undergraduate or most graduate instruction or sustained independent study; adequate to maintain knowledge of a subject required for limited or general purposes but not strong enough for original research in a subject. It includes complete collections of the works of secondary writers, a selection of representative journals/periodicals, and all the reference tools and fundamental bibliographic apparatus pertaining to the subject.

4. Research level: A collection that includes the major published source materials required for dissertations and independent research, including materials containing research reporting, new findings, scientific experimental results, and other information useful to researchers. It is intended to include all important reference works and a wide selection of specialized monographs, as well as a very extensive collection of journals and major indexing and abstracting services in the field. Older material is retained for historical research.

5. Comprehensive level: A collection in which a library endeavors, so far as is reasonably possible, to include all significant works of recorded knowledge (publications, manuscripts, other forms), in all applicable languages, for a necessarily defined and limited field. This level of collection intensity is one that maintains a "special collection." Older material is retained for historical research.

*Adapted from RLG Collection Development Manual, 2nd ed.

Table 2a: Criteria for Evaluation

Criteria for Assessing Collections

1. Chronological coverage: Are older and newer materials consistently represented? Should they be?

2. Language coverage: How extensive is appropriate or significant foreign language coverage of the subject in the collection?

3. Principal authors: Are the standard, chief, or more important authorities and authors included?

4. Principal works: Are the classic, standard, essential and important works in the collection?

5. Primary sources: Are critically edited original texts and documents included? How extensively?

6. Criticism/commentary/interpretation: How complete is secondary monographic or critical treatment?

7. Complete sets: Are sets and series well represented in the collection? Are they complete?

8. Periodical coverage: How extensive is periodical coverage of the subject? Are the chief titles included?

9. Number of volumes: Count of shelf-list, or approximation based on 10 vols per foot of shelf occupancy.

10. Circulation data: Circulation records may need to be checked to add to assessments above. In addition, circulation or use data may be helpful in assigning collection goals.

Table 2b: Language Codes

Language Coverage Codes

E - English language material predominates; little or no foreign language material in the collection.

F - Selected foreign language material included, in addition to the English language material.

W - Wide selection of foreign language material in all applicable languages.

Y - Material is primarily in one foreign language.

Table 5: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO109 Mineralogy

LIBRARY	CL	AC	GL	COMMENTS
U.S. Bureau of Mines	3aE	3aE		
University of Alaska Fairbanks	3bF	1bE	3cF	260 v.
Boise State University Library	3bE	3cE		
Idaho State Univ - Oboler Library	3bF	3bF	3cF	very good overall balance. German & Russian languages have minimal representation.
Montana State University	3aE	3aE		
Southern Oregon State College Lib.	3aE	3aE		
Oregon State Univ - Kerr Library	4 E	4 E	4 E	
Eastern Washington University	3bE	2bE		
Evergreen State College	2aE			

Table 6: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO092 Aerial Photography

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	2aE	2bE		
University of Alaska Fairbanks	3aF	2bE	3cF	15 v. Includes Remote Sensing
Boise State University Library	3aE	3aE		
Idaho State Univ - Oboler Library	3aE	3aE	3aE	all books less than 7 years old.
Oregon State Univ - Kerr Library	3bE	3bE	4 E	
Eastern Washington University	3cE	3aE		

Table 7: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO114 Dynamic & Structural Geology (General)

LIBRARY	CL	AC	GL	COMMENTS
U.S. Bureau of Mines	2aE	2aE		
University of Alaska Fairbanks	3cF	1bE	3cF	200 v.
Univ of Alaska - Geophysical Inst.	2aE	3cE		
Boise State University Library	3bE	3cE		
Idaho State Univ - Oboler Library	3bE	3bE	3bE	geophysics strong. Many undergraduate & graduate texts. QE508 (Radiation Dating) is good.
Montana State University	3aE	3bE		
Southern Oregon State College Lib.	3aE	3aE		
Oregon State Univ - Kerr Library	3cE	3cE	4 E	
Eastern Washington University	3cE	2bE		

Table 8: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO117 Seismology

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	2aE	2bE		
University of Alaska Fairbanks	3bF	1bE	3cF	90 v.
Univ of Alaska - Geophysical Inst.	3cE	4 E		
Boise State University Library	3aE	3cE		
Idaho State Univ - Oboler Library	3cE	3cE	3cE	especially North American earthquakes.
Montana State University	2aE	2aE		
Southern Oregon State College Lib.	2bE	2bE		
Oregon State Univ - Kerr Library	4 E	4 E	4 E	
Eastern Washington University	3bE	2bE		

Table 9: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO122 Stratigraphy

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	2aE	2bE		
University of Alaska Fairbanks	3cF	2bE	3cF	290 v.
Boise State University Library	3bE	3cE		
Idaho State Univ Oboler Library	3cE	3cE	3cE	excellent. Over 80% of collection is less than 7 years old.
Montana State University	2aE	2bE		
Southern Oregon State College Lib.	2bE	2bE		
Oregon State Univ - Kerr Library	4 F	3cE	4 F	
Eastern Washington University	3cE	3aE		
Evergreen State College	2aE			

Table 10: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO091 History

LIBRARY	CL	AC	GL	COMMENTS
U.S. Bureau of Mines	2aE	2bE		need the revised edition of classical work.
University of Alaska Fairbanks	3bF	2bE	3bF	125 v. Not all history in this class.
Univ of Alaska - Geophysical Inst.	3aE	2aE		
Boise State University Library	3aE	3cE		
Idaho State Univ Oboler Library	3bE	3bE	3bE	good balance between undergraduate and graduate levels.
Montana State University	3bE	3aE		
Southern Oregon State College Lib.	2aE	1bE		
Oregon State Univ - Kerr Library	3bE	3bE	3bE	
Eastern Washington University	3cE	3aE		
Evergreen State College	3aE			

Table 11: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO115 Geochemistry

LIBRARY	CL	AC	GL	COMMENTS
U.S. Bureau of Mines	2aE	2aE		
University of Alaska Fairbanks	3bE	1bE	3cF	66 v.
Boise State University Library	3aE	3cE		
Idaho State Univ Oboler Library	3cE	3cE	3cE	especially Applied Geochemistry.
Montana State University	2bE	2bE		
Oregon State Univ - Kerr Library	3cE	3cE	4 E	
Eastern Washington University	3bE	2bE		

Table 12: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO093 Mathematical Geology

LIBRARY	CL	AC	GL	COMMENTS
Univ of Alaska - Geophysical Inst.	2aE	3aE		
Boise State University Library	3aE	3aE		
Idaho State Univ Oboler Library	3aE	3aE	3aE	good.
Oregon State Univ - Kerr Library	3bE	3bE	4 E	
Eastern Washington University	3cE	3aE		

Table 13: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO121 Structural Geology

LIBRARY	CL	AC	GL	COMMENTS
University of Alaska Fairbanks	3cF	2bE	3cF	110v.
Univ of Alaska - Geophysical Inst.	2aE	3cE		
Boise State University Library	3bE	3cE		
Idaho State Univ Oboler Library	3bE	3bE	3bE	many textbooks. Sketchy regional coverage.
Montana State University	2aE	2bE		
Southern Oregon State College Lib.	2bE	2bE		
Oregon State Univ - Kerr Library	4 F	4 E	4 F	
Eastern Washington University	3bE	3aE		
Evergreen State College	2aE			

Table 14: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO110 Petrology (General)

LIBRARY	CL	AC	GL	COMMENTS
U.S. Bureau of Mines	2aE	2aE		
University of Alaska Fairbanks	3bF	1bE	3cF	90v
Boise State University Library	3bE	3bE		
Idaho State Univ Oboler Library	3bF	3bE	3cF	
Montana State University	2bE	2bE		
Southern Oregon State College Lib.	3aE	3aE		
Oregon State Univ - Kerr Library	3cE	3bE	4 E	
Eastern Washington University	3bE	2bE		

Table 15: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO098 Regional Geology (General)

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	2bE	2bE		
University of Alaska Fairbanks	4 E	2bE	4 E	2900 v. Lots of old geological surveys of various states.
Boise State University Library	3aE	3bE		
Idaho State Univ Oboler Library	3aE	3aE	3aE	good balance in section. Very few regions are not covered.
Montana State University	3aE	3aE		primarily US.
Southern Oregon State College Lib.	2aE	2aE		
Oregon State Univ - Kerr Library	4 E	4 E	4 E	
Eastern Washington University	2aE	1bE		

Table 16: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO099 Regional Geology - United States

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	3aE	3bE		Alaska only.
U.S. Bureau of Mines	2bE	2bE		QE83-84 Alaskan geology = 4; extensive collection of historic & current works in Alaska.
University of Alaska Fairbanks	4 E	2bE	4 E	1750 v.
Boise State University Library	3bE	3cE		
Idaho State Univ Oboler Library	3cE	3cE	3cE	excellent, especially Mountain West states. Very current.
Montana State University	3aE	3aE		primarily documents.
Southern Oregon State College Lib.	2aE	2aE		mostly Calif. & Oregon, some theses, USGS Professional Papers, Circulars, Bulletins, etc.
Oregon State Univ - Kerr Library	3cE	3cE	4 E	
Eastern Washington University	3cE	3aE		
Evergreen State College	3bE			

Table 17: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO123 Paleontology (General)

LIBRARY	CL	AC	GL	COMMENTS
University of Alaska Fairbanks	3bE	2bE	3cE	350 v.
Boise State University Library	3bE	3cE		
Idaho State Univ Oboler Library	3bE	3bE	3cE	all Palentology areas are good.
Montana State University	2aE	2aE		
Southern Oregon State College Lib.	2bE	2bE		
Oregon State Univ - Kerr Library	4 F	3cE	4 F	additional materials on paleozoology, & paleobontany & palynology found elsewhere.
Eastern Washington University	3cE	3aE		
Evergreen State College	3bE			

Table 18: Academic & Special Libraries (LC) with Assessments of 2a or Greater

Line Item Report - SUBJECT - GEO090 Periodicals

LIBRARY	CL	AC	GL	COMMENTS
Alaska Resources Library	2aE	2aE		
U.S. Bureau of Mines	2bE	2bE		
University of Alaska Fairbanks	2bE	2bE	3cF	64 current paid subscriptions.
University of Alaska-Geophysical Inst.	3aF	3bF		40
Boise State University Library	3cE	3cE		
Montana State University	3cE	3bE		
Southern Oregon State College Lib.	2bE	2bE		
Oregon State Univ - Kerr Library	4 F	4 F	4 F	
Eastern Washington University	3cE	3cE		

PUTTING REFERENCE LISTS IN THEIR PLACE: MACINTOSH SOFTWARE FOR MANAGING BIBLIOGRAPHIC DATA

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Abstract--Managing reference lists on a Macintosh can save considerable time in the production of formatted reference lists for inclusion in bibliographies in articles written for publication, bibliographies for classroom use and vita. Data base software available ranges from general data base management software to data base software customized for bibliographic data. The characteristics of both types of software are examined with the advantages, disadvantages and limitations of using either type of software for this purpose.

For the researcher, formatting references in accordance with the myriad of bibliographic requirements held sacred by scientific journals can be very time-consuming. Word processing software can make rewriting and rearranging text very easy, but it only allows the writer to cut and paste citations from an earlier paper into the paper being written, after which it is necessary to tinker with the citations to get them into the new format required.

Over the last few months, it has become clear that Macintosh users are seeking a solution to this problem. I've had numerous conversations with Mac users seeking software that might simplify the production of references. Being familiar with other Macintosh software, they know exactly what they would like: a "desk accessory" - much like a spelling checker - to identify, complete and format the citations in the style needed for a variety of publications. Mapped out, their ideal system would look like that pictured in Figure 1.

As always, when considering data base software, it is necessary to take into consideration such criteria as ease of construction, ease of maintenance, capacity, flexibility and the ability to input and export data. Researchers do not want to spend a lot of time setting up a reference list data base or maintaining it. In addition, when considering Macintosh data base packages, it is important that the software follow the standard Macintosh interface and utilize the Macintosh features that have led users to buy the Mac in the first place.

After testing a number of data base management systems over the past few months and following the new and upcoming software announcements in Macintosh publications, I do not believe the ideal Macintosh software for managing reference lists is available yet. But there are some products that produce good results.

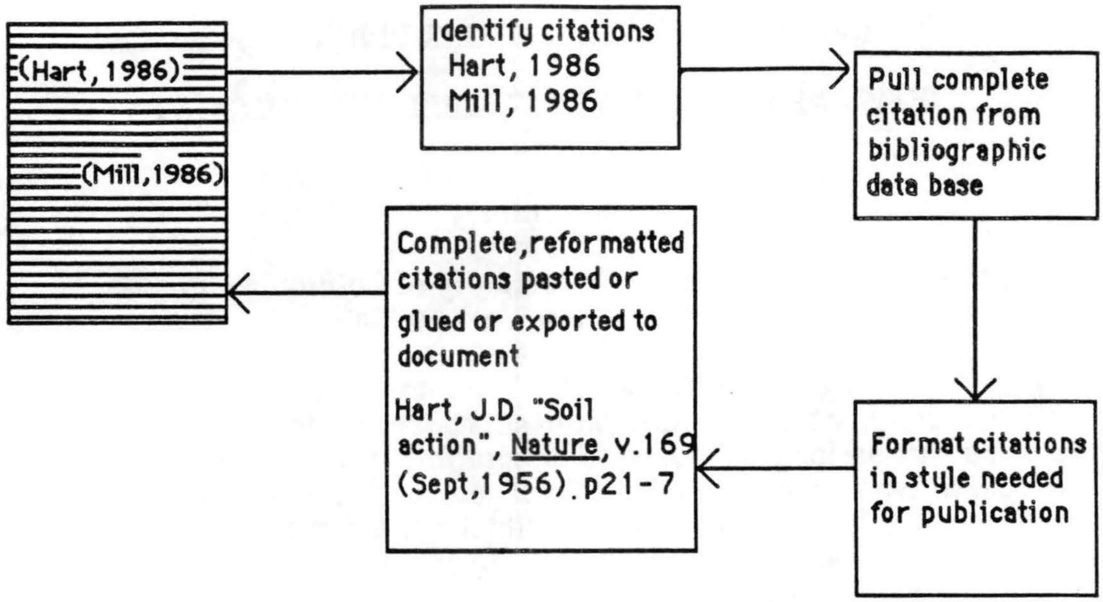

Figure 1: Idealized software system for managing reference lists.

I have evaluated a number of Macintosh software packages: Microsoft File, ProVue's OverVUE, Software Discoveries' Record Holder, Wight's Paperbase and Personal Bibliographic Software's Professional Bibliographic System to see how well they measure up to user hopes for a data base which would facilitate management of reference lists. I have worked through the programs, putting a set of citations up on the data bases and trying to make an end product like that envisioned by Mac users. Although I have not had the opportunity to test all data base management programs for this use -- software, of course, changes and improves very rapidly -- I can make some useful observations about what is presently available and what things you might consider in your decision to purchase a software program for this purpose.

The software I have examined for reference list management has ultimately fallen into two categories: general data base management systems and data base management systems specifically designed to manage bibliographic files. Each type poses its own set of problems in actual use. Rather than give a detailed review of each type of software that falls into these categories, I would like to make some general comparisons between these two types of data base management software. An examination of the problems encountered in using both types gives one an idea of the pros and cons of these two systems and also the type of problems that will be faced in developing the reference data base in general.

The Mac hackers and Mac users I have worked with all suggest that the general data base software developed for the Mac is increasingly powerful and should be able to be used for bibliographic citations with little problem. I have put up sample data bases on File, OverVUE, and Record Holder. Helix has also been recommended to me for this purpose, but I have worked with it for several hours and have still not gotten a data base up on the software. I think it may be useful for this purpose but too labor intensive to adapt. In general, I have found that there are major problems in adapting general data base management software for bibliographic purposes.

Figure 2, shows a portion of the bibliography that was used in evaluations. Just a brief digression, as this researcher's vita is a wonderful example: these references, copied exactly from the researcher's list, show what a software package cannot help you with. Management of your reference lists on a Macintosh or any other computer will not compensate for the fact that pages, volume numbers, author's initials, etc. are missing from citations. Likewise, if one inputs a journal abbreviation three different ways, one will not be able to search under the journal title unless all three variations are input. If incomplete or incorrect references are put in, incomplete and incorrect references will come out.

Despite the fact that the bibliography was a bit incomplete, it was a good one to use to test the software. It has a wide variety of types of references and is characteristic of marine geology, with the oceanographic interests of this particular researcher clearly apparent in all the citations to the Initial Reports of the Deep Sea Drilling Project. It is safe to say that other sub-fields within geology have a similar set of quirks and characteristic literature. The challenge was whether I could construct a data base that would accomodate this variety of references.

Hart, M.B. and G.S. Mountain, 1987. "Icthyolith Evidence for the Age of Reflector A^{u}". in: van Hinte, Wise, et al., Initial Reports of the Deep Sea Drilling Project, Vol. 93; U.S. Government Printing Office, Washington, D.C.

Mountain, G.S., 1987. "Underway Geophysics during DSDP Leg 95". In: Poag, Watts, et al., Initial Reports of the Deep Sea Drilling Project, Vol. 95; U.S. Government Printing Office, Washington, D.C.

Tucholke, B.E. and G.S. Mountain, 1986. "Tertiary Paleoceanography of the Western North Atlantic Ocean". In The Geology of North America: The Western Atlantic Region, P.R. Vogt and B.E. Tucholke (eds.); Geol. Soc. of Am. Sp. Pub.

Miller, K.G., G.S. Mountain, and B.E. Tucholke, 1985. "Oligocene Glacio-Eustacy and Erosion on the Margins of the North Atlantic"; Geology, Vol. 13, No. 1, p.10-13.

Shipboard Party, Leg 47A, Sites 397 and 397A, 1979. In: Initial Reports of the Deep Sea Drilling Project, Vol. 47; U.S. Government Printing Office, Washington, D.C.

Figure 2: Portion of vita used to test software.

As I designed the framework for references in the general data base management systems, it was first necessary to reinterpret the often excellent documentation into the information I needed to manage references. As has been suggested, these are general data bases and as such, they have good tutorials that use examples such as managing ticket sales at concert halls, restaurant evaluations and baseball players' batting averages. Although these examples did show how to construct data bases using the software in question, it was necessary to take quite a leap to the complexities of the reference list I was working from. The form I designed for inputting references into OverVUE is illustrated in Figure 3.

I found it very difficult to remember all the variations that may occur in references, despite the fact that I work with citations all day long. For example, in the case of the references in the list I was working from, it was necessary to accomodate entries for papers in journals, in edited volumes of a set, in monographs and a technical memorandum. It was also necessary to take into account all the places authors' names might occur: first, second, third authors of papers and books and editors as well.

It is even more difficult to both link these personal names so they can all be searched easily and also retain them in their proper fields so they can be formatted properly for a "report" or publication. For example, for greatest searching efficiency in OverVUE, it was necessary to construct a macro to run an author search, basically: search the 1st author field, the second author field, the third author field and the editor field for a personal name. None of the general database management systems could be run against a document. It was necessary and cumbersome to construct a sub-set of publications for a given paper. This is somewhat understandable when one remembers the spread sheet origins of these data bases. They are designed with locating sets of data--all the invoices for a date or client. It is quite a different process to locate the 10 unique citations whose only link is that they support the research in a paper you've written.

None of the general data base management systems I tested were able to produce an acceptable formatted printed copy for cutting and pasting into a document. All would have required extensive editing as can be seen in the OverVUE report shown in Figure 4.

The problems with the general data bases as far as reference list management goes can be summarized as: laborious to construct, cumbersome to search and unable to finally format references in the manner needed for publication. Many of these data bases have strong numerical orientations and often have spread sheet origins which make them difficult to adapt for long strings of text. It is also a formidable task to set up the framework of a bibliographic system from scratch.

Before I go on to the Macintosh data base software that has been developed specifically for bibliographic data, Record Holder Plus should be mentioned. I had used Record Holder in my experimentation and had found it to be a well-documented, effective data base software with the same problems for bibliographic management that I have mentioned above. I have recently purchased a copy of Record Holder Plus as the advertisements for it mentioned a new feature: a template specifically for bibliographic citations. Although I have not had the opportunity to give the software a complete test, I have examined the templates. Two versions of the bibliographic templates are included: one for books and one for articles in journals. Although this is a step in the right direction, these two formats are still inadequate for dealing with the variations that occur commonly in scientific papers, articles within books and technical reports to mention two of the most important. It is interesting that the producers of Record Holder Plus have acknowledged the problem of starting from the beginning when developing this type of data base. I think it will be clear from the

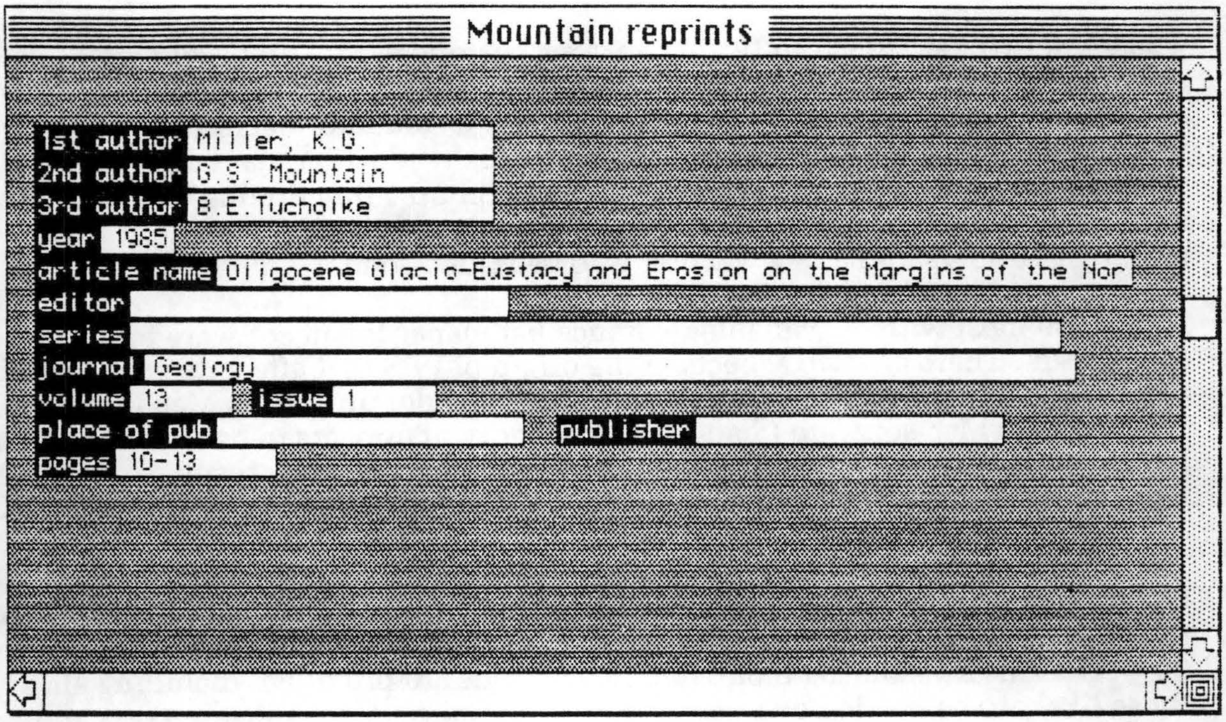

Figure 3. Example of <u>OverVUE</u> workform for inputting references.

Mountain, G.S. 1973.
"Proceedures for description of W.H.O.I. Sediment Cores
in:

WHOI Technical Memorandum

Vol7-73 , No. , p.

Mountain, G.S. B.E. Tucholke 1983.
"Abyssal Sediment Waves
in:A.W. Bailey (Ed.)
Seismic Expressions of Structural Styles
Studies in Geology Series, 15
Am. Assoc. Petrol. G,
Vol1 , No. , p.

Mountain, G.S. 1987.
"Underway Geophysics during DSDP Leg 95
in:Poag, Watts, et al.
Initial Reports of the Deep Sea Drilling Project

Government Printing , Washington, D.C.
Vol95 , No. , p.

Figure 4. Example of report produced in <u>OverVUE</u>.

examples that follow that there are other customized data bases that do a more complete job.

There are two Macintosh software packages customized for bibliographic citations, Professional Bibliographic Systems (PBS) and Paperbase. I have worked with Paperbase but have found it fails to follow a standard Macintosh interface, which makes it difficult to use and understand. In addition, its online documentation is so brief that I was unable to set up a functioning data base even after several hours of use. In its present state, I would not recommend it for use although I understand a new version is to be issued soon.

PBS is the most widely available reference list management software for the Macintosh. There are two aspects of the origin of PBS that affect its use. First, it was originally an IBM program and initially it did not utilize the Mac interface as well as other Mac software I had used. Secondly, it appears to have been written for researchers in the humanities and social sciences and, as a result, scientists are faced with an array of reference style alternatives that are rarely seen in science.

PBS actually gives the user a bibliographic framework within which to work. Nothing has to be designed from scratch. There are advantages and disadvantages to this structure. The user is faced with an amazing variety of workforms. Some 20 workforms for entering bibliographic citations are provided, including all those likely to be needed by a scientist such as journals, technical reports and dissertations as well as many templates unlikely to be needed in the sciences, such as works of art, motion pictures and audiovisual material.

Each workform includes the field necessary for creating a reference to the particular type of material: as many as 29 fields are provided to enter data including everything from packaging method to number of pages. Figure 5 shows a portion of the workform for a long (i.e. detailed) book reference. As the cursor is moved from field to field, the complete label of the field is shown at the bottom of the screen, making it unnecessary for users to remember all the designations--a helpful feature.

Initially, I thought these workforms were just too elaborate and would require too much work for most researchers. However, as researchers at my institution review the information I have provided, they have concluded that the fields that are not needed can be ignored and that it is easier to work from a complete set of possibilities than to try and think of all the possibilities from scratch. Simple crib sheets can also be made for staff as an aid to inputting.

In addition, PBS has proved to have superior capacity to search and print bibliographies. When doing an author search, PBS automatically searches all author fields. It is also rather simple to collect the subset of citations needed for a given paper. Formats required by the Modern Language Association, American Psychological Association and Science magazine are installed in the data base. More importantly, it is easy and fairly quick for the user to add formats that may be required by various publications. One's citations can be stored in the data base in complete form and then reformatted for the styles needed for publication.

This feature does have some limits: if, for example, two publications require that a

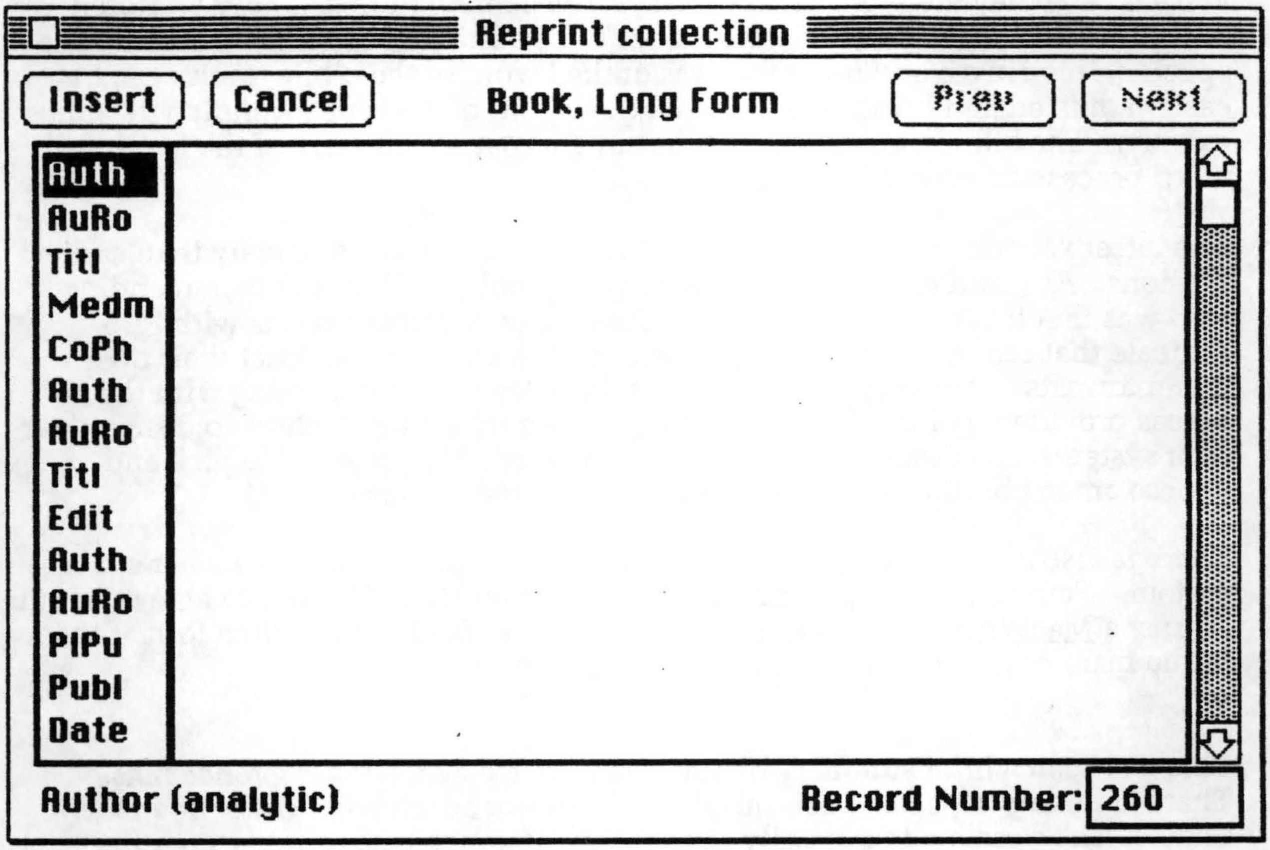

Figure 5. Portion of PBS "Book, Long Form" inputting workform.

Hart, M.B. ; G.S. Mountain. Icthyolith evidence for the age of reflector Au. in: van Hinte, Wise [and others]. Initial Reports of the Deep Sea Drilling Project; 1987; 93.

Tucholke, B.E. ; G.S. Mountain. Tertiary Paleoceanography of the Western North Atlantic Ocean. in: Vogt, P.R. ; B.E. Tucholke, eds. The Geology of North America: The Western Atlantic Region; 1986.

Christie-Blicke, N., G.S. Mountain, K.G. Miller and A.B. Watts. Seismic Stratigraphic Record of Sea-Level Changes. Washington, D.C.: National Academy of Science; 1986.

Figure 6. Portion of reference list produced using PBS.

journal be abbreviated two different ways, the abbreviation can only be stored one way in the data base and would have to be edited for alternative styles. The spacing, line length and other features of the layout of the bibliography can be easily adjusted and I was able to match the layout of my typed sample vita almost exactly. The bibliography can then be cut and pasted into any of the Macintosh word processing programs. (Figure 6).

The latest version of PBS(2.2) utilizes Mac interface more effectively than earlier versions. As I said earlier, one of the biggest problems I had in recommending PBS was that it provided too many choices. Recent conversations with PBS indicate that the next version of PBS will enable users to construct their own menu formats. I am very excited about this alternative; by working with the pieces provided by PBS, I think it will be very easy for researchers to design their own systems. To design a system from scratch is a big project. To pick and choose among bibliographic alternatives seems much more logical.

There is also an indication that developers hope to realize the researcher's ideal system. Personal Bibliographic Software indicates that PBS will be able to be run against a MacWrite or Word document, locate the citations and then format them in the manner needed for a particular publication.

This has been a brief summary of Mac software for managing reference lists. There are many aspects to this question I have not addressed. Users frequently ask if it isn't possible to optically scan typed reference lists to get around the tedious process of inputting references intially. The technology does not appear to make this possible at this point. The potential to import citations from other bibliographic data bases, such as those produced by libraries like OCLC and the RLIN data bases or commercially vended data bases such as GeoRef and GeoArchiv, is a question for a future paper. But this paper represents a beginning. The demon reference list may not be completely tamed yet, but efforts to make it behave more manageably are clearly underway.

Acknowledgements.
The author would like to thank Karla Pearce, Elida Stein, and David Fricke for proofreading and providing thoughtful comments on this paper.

INFORMATION SEEKING BEHAVIOR OF GEOSCIENTISTS

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Scientific societies and institutes as well as U.S. Business and industry are investing millions of dollars in online bibliographic and numeric databases alone, as well as more complex techniques such as expert systems. Such research and development efforts are predicated on the belief that we know how scientists actually seek information and how they wish to access it. However, in several respects we remain naive in this critical area.

The content of this poster presentation addresses the information seeking behavior among subdisciplines in the geosciences, i.e., geology and geochemistry, geophysics, engineering geology, and hydrology. The authors are conducting interviews with geoscientists from government, industry and academic institutions to determine the answers to such questions as: how do they locate recent papers of major interest to them; how do they find recent factual information needed in their work; what success and failures have they experienced when seeking information; and what kinds of access to both numeric and bibliographic data would be ideal for their needs.

The value of this study to the geoscience community will be the insight provided into how geoscientists actually seek and wish to seek information. Thus, the results should affect the ways by which information specialists and providers address the information needs of geoscientists.

PAPER TO BE PUBLISHED ELSEWHERE AT A LATER DATE.

PART III

POSTER SESSION

THE PROLIFERATION OF GEOLOGICAL SOCIETIES AND THEIR IMPACT ON THE GEOLOGICAL INFORMATION EXPLOSION

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Abstract -- The proliferation and growth of geological societies in the United States has been fairly steady since the late 1800's, averaging almost two new societies per year. Historical trends in the earth sciences and society have produced new "niches" for professional societies and challanged societies to yield to both internal and external pressures. Over the past 100 years, national political actions and the economic cycles within various industries have influenced societies on both regional and national levels. The current decline of the United States' mineral and petroleum industries and the growth of environmental and high technology industries have strongly influenced societies in the present.

A survey shows that nearly 45% of the geology-related literature is published directly or indirectly through societies; nearly 40% is produced by publishing companies, universities, industry, and individuals; and the remaining 15% comes from government sources. A study of national societies and a survey of regional societies show that despite high unemployment geological societies have continued to grow, with a 6% average annual increase in membership since 1985 and a 55% increase since 1980. Their location and services offered have contributed significantly to their success.

Societies should be responsible and accountable for the information they publish. Utilization of modern information technology and cooperation in resource sharing among libraries and societies needs promotion.

INTRODUCTION

This paper is intended to describe the proliferation and growth of geological societies; briefly describe the function of these societies and show what they offer the geoscience community; and show how societal and technological forces influence or impact on these societies. Analysis of published geological literature and data from simple searches on the GeoRef database depict trends in geological information including cycles within the petroleum industry and the geological information explosion. Additional information in this report is based on a survey of regional geological societies in the United States and unpublished membership data from the American Association of Petroleum Geologists (AAPG) and the Geological Society of America (GSA).

Proliferation of Geological Societies

The number and size of geological societies in the United States has continued to grow during the past 100 years. Today there are more than 200 geological societies in the United States and more than 600 worldwide. The rate of growth in the number of societies averages two per year in the United States and averages six per year worldwide. Each society in its own manner supports and promotes the exchange of geologic information.

Figure 1 shows the number of geological societies plotted in relation to their date of origin over the past 100 years. Four general catagories of geological societies are as follows:

1. National Societies - geological societies that represent the majority of geologists or specialists within a subdiscipline of geology on a national level. Examples include the GSA, AAPG, and the Society of Economic Paleontologists and Mineralogists.
2. Affiliated Societies - not geological societies per se, but many members are geologists, and may have sections for geologists included in the organization. Examples include the Society of Petroleum Engineers, the Society of Professional Well Log Analysists, and the American Institute of Mining and Metallurgical Engineers.
3. Regional Societies - geological societies representing a city, state, or region, sometimes affiliated with other regional or national societies.
4. State academies - multidisciplinary societies that are generally the oldest scientific societies in the United States. Initially they were patterned after the earlier scientific societies established in the United States and Europe. As new disciplines of science developed, sections of the major disciplines, such as geology, would splinter off from the main body to form separate subdivisions within these societies.

Many factors in history have influenced the economic demand for geologists, usually relating to energy. Until around 1982, the number of geologists employed in the United

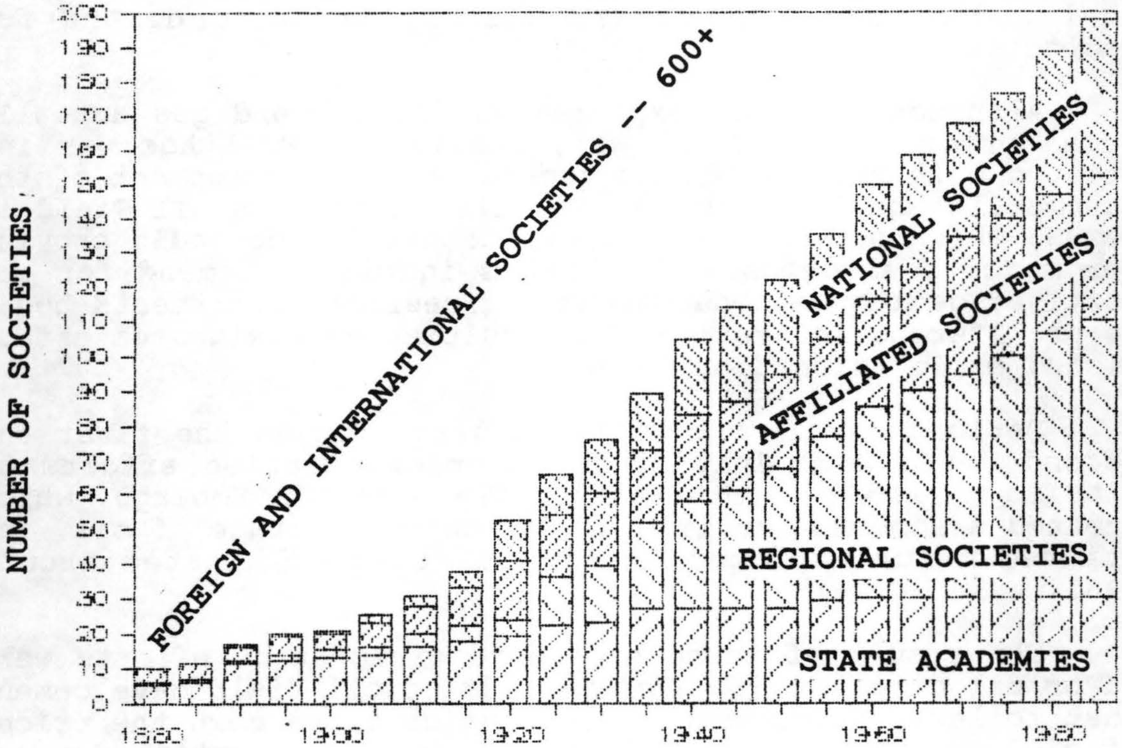

Figure 1. The proliferation of geological societies. The graph shows number of societies plotted in relation to their year of origin.

States had been doubling about every 15 years. Today there are about 65,000 geologists in the United States with about 70% employed by the petroleum industry.

Geologists were first employed by the eastern states to conduct mineral surveys, and were later employed by the federal government as members of exploration survey teams. The general impact of industrialization created demands for coal and mineral resources, thereby creating demand for geologists.

Although national exploration for oil and gas actually began prior to the Civil War, the Liquid Fuel Age was initiated with the concurrent technological development of the automobile and the discovery of the Spindletop Oil Field in Texas, which proved that subsurface oil fields could provide for major fuel demands. With this increased demand for expertise, geology and petroleum engineering departments began to proliferate in American Universities as businesses established exploration departments.

Periods of oil shortages occurred during the first and second World Wars initiating major exploration efforts to find so called "war minerals". The Arab Oil Embargo, which created a somewhat artificial worldwide shortage of oil, initiated major exploration efforts that culminated around 1980.

The result of these expensive exploration efforts were major oil discoveries. The periods of oil field development that followed produced oil gluts which drove down the prices of oil and gas creating widespread and long lasting depressions within the petroleum industry. The first oil glut occurred with the discovery and development of the East Texas Oil Field, the largest oil field in North America, in the early 1930's. Other oil gluts developed following the worldwide overdevelopment of oil fields in the late 1950's and 1960's, and again in the 1980's.

The general progress of science and technology has created an increased demand for geologists. As new discoveries and innovations continue, geologists must choose areas of specialization. Again, this is generally linked to economic stimuli, mainly in the petroleum industry. Today, rather than just being a "geologist" an individual may adopt a more specialized title such as a micropaleontologist, a palynologist, or organic geochemist, etc. When a technological advancement occurs it may create a demand for individuals with specialized training. As a specialized discipline grows in complexity and in the number of specialized professionals a new "niche" is created for a society. In addition, societal trends create niches for new societies.

Looking at the names of different societies that have formed during recent years we can see the flavor of this trend. For instance: Computer Oriented Geological Society, Association for Woman Geologists, Association for Black Geologists, History of the Earth Sciences Society, and the International Stop Continental Drift Society; each having a modern flair or modern cause behind its origin.

In addition, sheer geographic factors account for the large number of geological societies. Many societies seem to have sprung up around oil boom towns, mining districts, major metropolitan areas, academic institutions, and government research facilities. Regional Societies are the fastest growing segment of the geological society population, although they are usually smaller than the national societies and less stable since their members are usually employed by businesses controlled by economics associated regional or local resources. The current decline in the oil industry is forcing many geologists to relocate and/or start new careers, such as in computers, water, environmental science, or business. In addition, trends in resource sharing and consolidation are concentrating oil companies and geologists in major energy centers such as Houston, Denver, and San Francisco.

DISCUSSION

Published Geological Literature

Geological societies are the major melting pots of information outside established institutions and are the major sources of published geological information. Figure 2 shows that 45% of the priority core journals indexed by GeoRef are produced by societies. A look at the literature in any given area reveals thatgeological societies are usually always the dominant source of published information. Figure 3 illustrates a survey of the literature concerning the Wind River Basin area and shows the major divisions of geologic information sources. The missing element in the diagram is that information produced but not publishedy industry, which isthe major generator and consumer of geologic information. This information gap is somewhat remedied in that societies are the main vents from which industry releases geologic information to the public. On the other hand, because of economic factors, most of the information produced by industry remains proprietary and ends up buried in corporate central files.

Figure 4 is a graph showing the number of citations concerning the Wind River Basin area for five-year time periods starting in 1840. The graph shows the general acceleration in the number of geological publications through

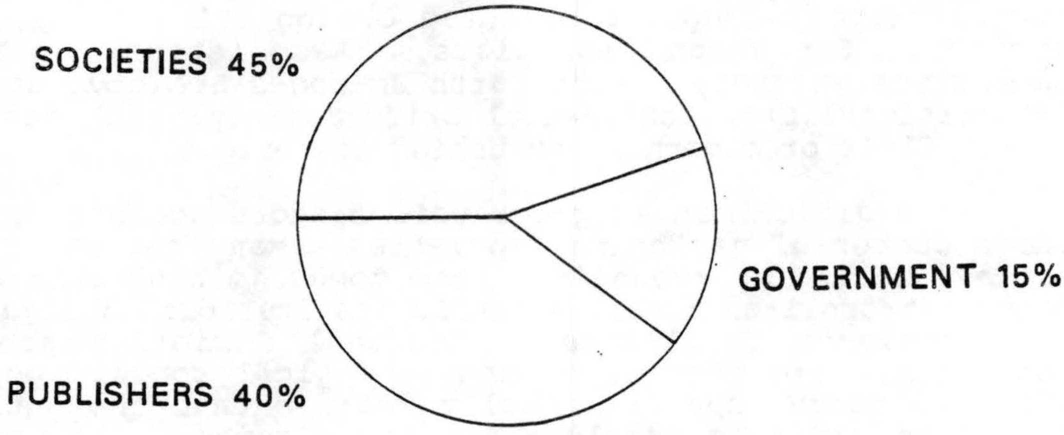

Figure 2. Sources of suggested first priority core journals indexed by GeoRef.

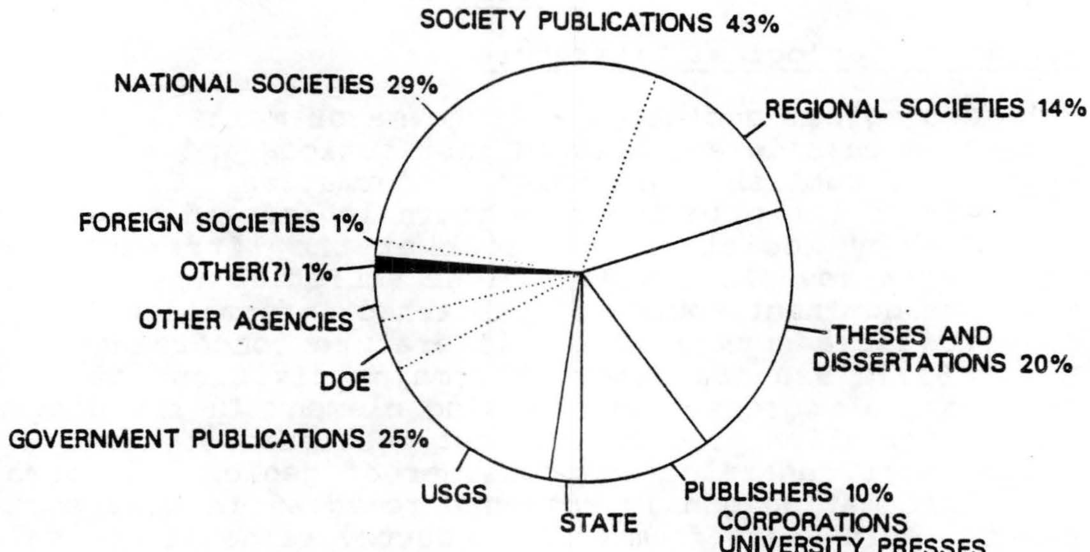

Figure 3. Sources of geological literature about the Wind River Basin area, Wyoming: sample - 1235 citations.

time. It also reflects the general cycles within the petroleum industry: the proliferation of publications following World War II, a saddle in the graph corresponding to the industry-wide recession during the 1960's, the surge in exploration following the Arab Oil Embargo, and the current recession during the 1980's. The bar representing the current time period (1985-1989) only includes the number of articles published up to the present. A realistic estimate for the entire period might show a mild decline in the total number of articles because of the current recession in the petroleum and mineral industries.

Figures 5 and 6 show similar plots for the Bighorn Basin and the Powder River Basin. These graphs also reflect the post war exploration boom, the recession of the 1960's, and the post oil embargo exploration era. For contrast, Figure 7 shows the data for the Grand Teton/Yellowstone National Park area. This graph is markedly different because the purpose or emphasis for geologic investigation in this area is different, being a natural history preserve/recreation area rather than a target for energy resource exploration.

Figure 8 shows the total number of citations in the GeoRef Database sorted by year of publication into five-year time periods. Figure 9 shows the distribution of citations for the entire state of Wyoming over the same time frame. These two diagrams reflect the general explosion of geological information but do not reflect the cycles of boom to bust within the petroleum industry seen in Figures 4-6, suggesting that the rate of publication of geological literature is not directly linked to the petroleum industry. Rather, the continuous change and growth of the earth sciences is more responsible for the geological information explosion.

The sheer number of geological societies does not necessarily reflect the impact that they have had on society, nor the impact social and economic changes have had on professional organizations. In addition, geological societies are in no way homogeneous, as reflected by analysis of data on selected societies and responses to a survey of regional geological societies conducted for this report.

Figure 10 shows the distribution of regional and national societies ranked by size. The numbers on the left represent the size of member populations within geological societies, while the bars on the right represent the number of societies in each size group. The largest societies are national societies, with the largest of these being Sigma Gamma Epsilon - a Greek-type honorary society that serves few purposes other than commending geologists for prefor-

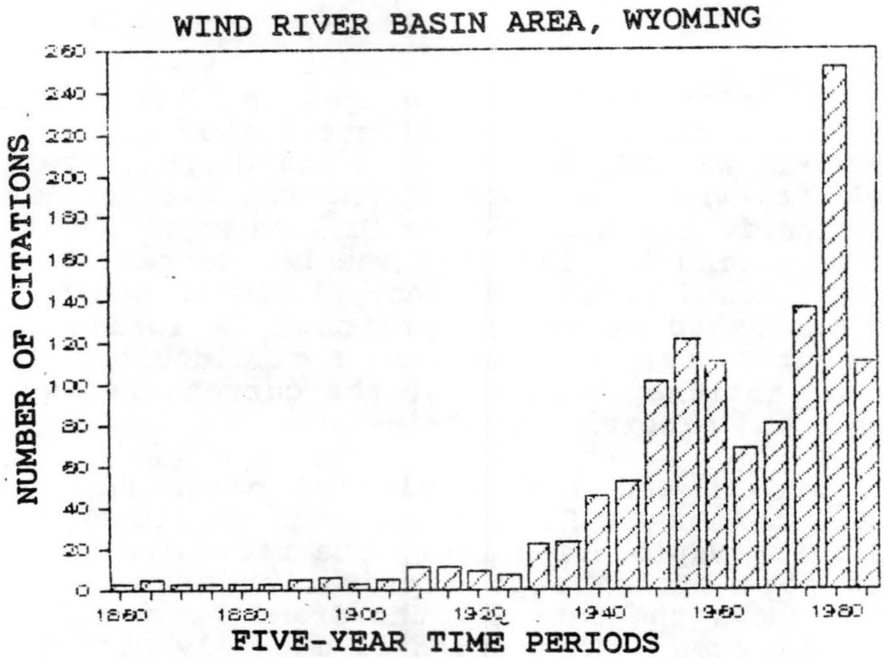

Figure 4. Total number of citations published during five-year time periods for the Wind River Basin area, Wyoming. Total number of citations: 1,355.

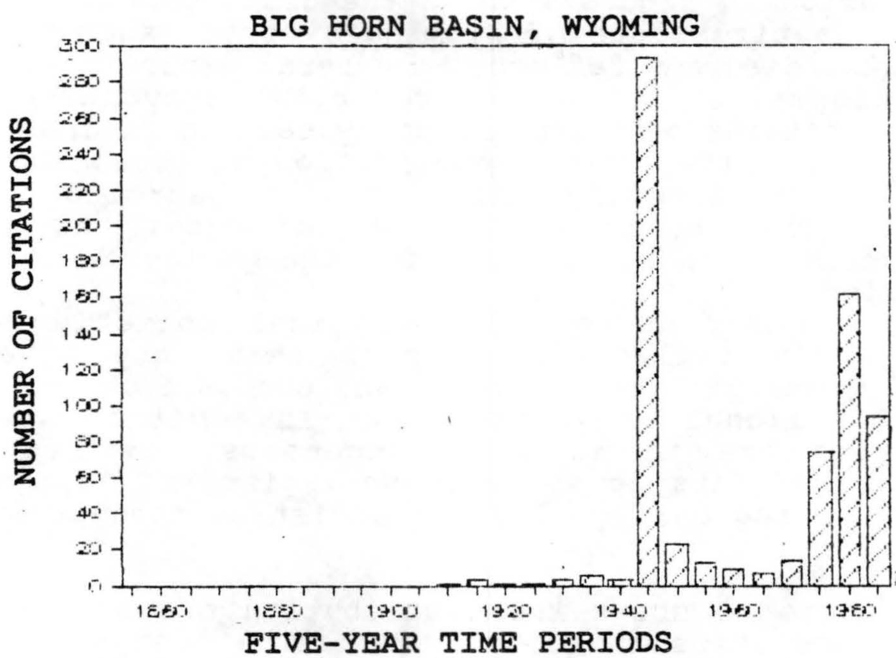

Figure 5. Total number of citations published during five-year time periods for the Bighorn Basin, Wyoming. Total number of citations: 701.

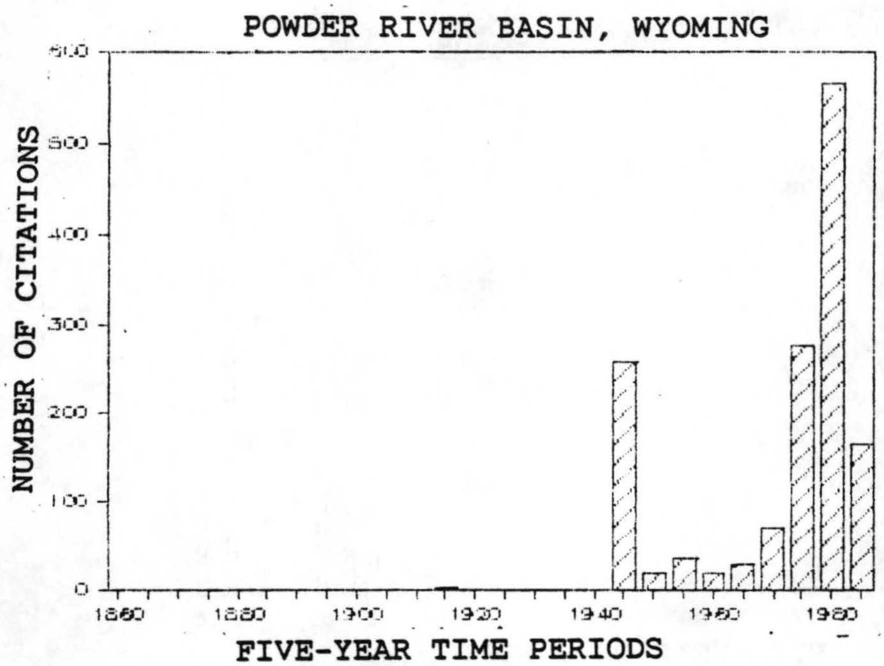

Figure 6. Total number of citations published during five-year time periods for the Powder River Basin, Wyoming. Total number of citations: 1,436.

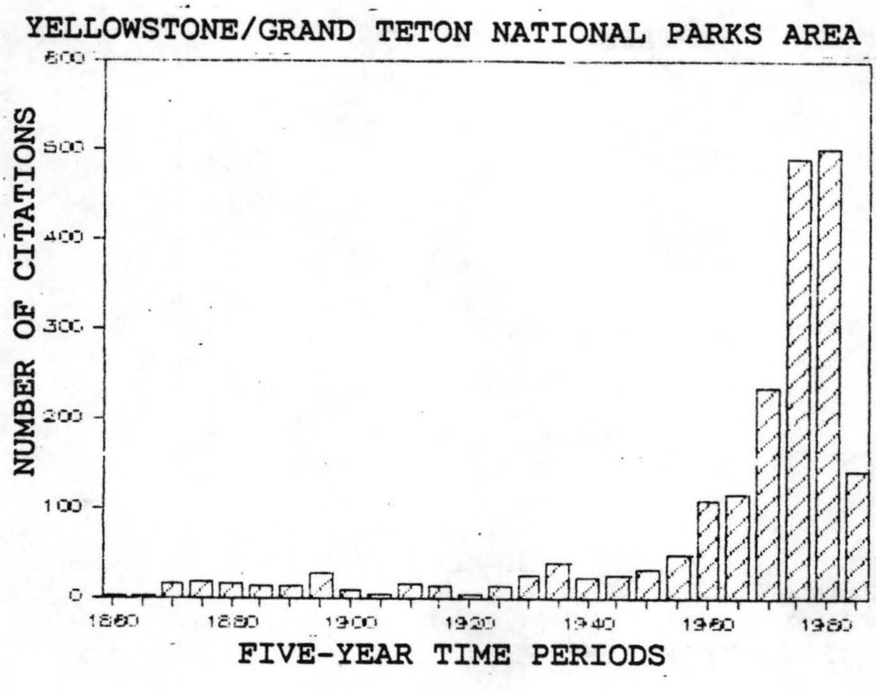

Figure 7. Total number of citations published during five-year time periods for the Yellowstone/Grand Teton National Parks area. Total number of citations: 1,920.

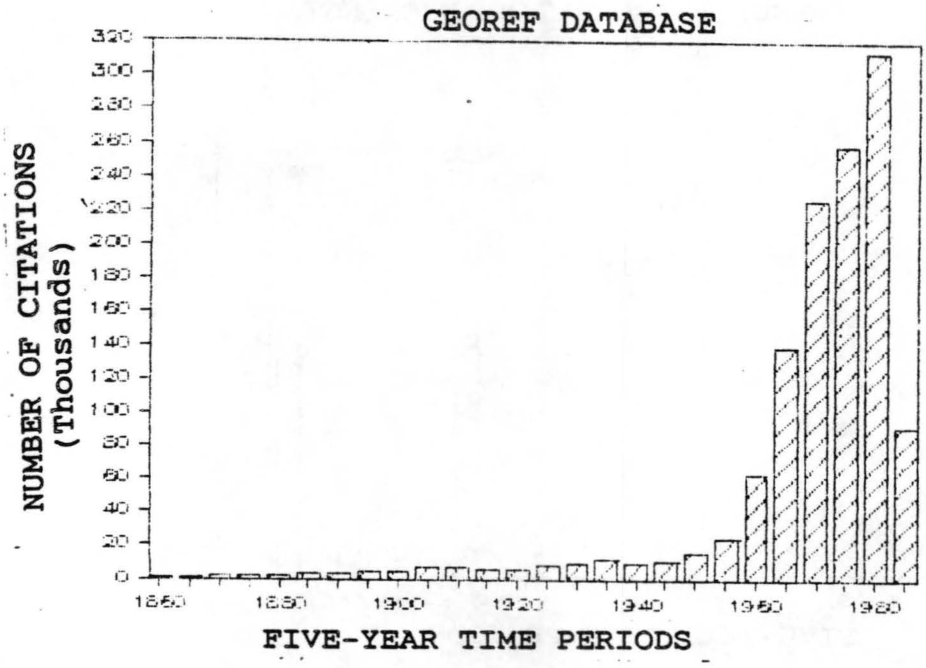

Figure 8. Total number of citations published during five-year time periods for all citations listing publication dates in the GeoRef database. Total number of citations: 1,231,531.

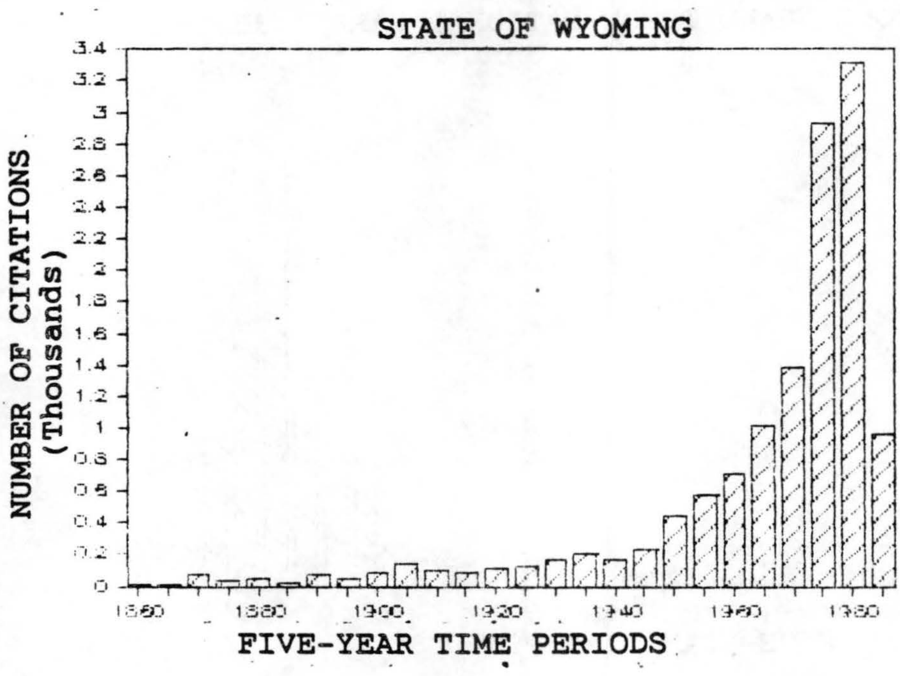

Figure 9. Total number of citations published during five-year time periods for the state of Wyoming. Total number of citations: 13,101.

mance excellence. The second two largest societies are the American Association of Petroleum Geologists (AAPG) and the Geological Society of America (GSA).

Comaprison of AAPG and GSA

Figure 11 shows a comparison of the members of GSA and AAPG with the percentages of their memberships by occupation. With GSA, there is a fairly even distribution of members in various occupational groups: one-third 1/3 - in oil companies or consulting and service companies, one-third in education or government jobs, and one-third consisting of retired members and students.

By comparison, AAPG, which is more than twice the size of GSA, is dominated by employees of oil companies and consulting and service companies. AAPG has an equal percentage of retired members and students, but a much smaller percentage of academic and government employees.

Figure 12 shows the distribution of members' ages within these two societies. Several notable features arise as indications of the impact of socioeconomic forces on these societies. First of all, GSA shows a fairly typical distribution for a society having a broad but even range of members distributed through various professions. The histogram is skewed, as could be anticipated, toward individuals in their late twenties and early thirties, when individuals are most intensely pursuing professional development. However, AAPG displays an anomolous distribution with two peaks, one with members' ages in the late twenties and early thirties, and another in the late fifties with a valley in between. These crests and troughs reflect the historical cycles seen within the petroleum industry, the crests correlating to the eras of major exploration following World War II and the Arab Oil Embargo, and the troughs to the periods of oil gluts or widespread depressions within the petroleum industry. The current widespread decline of enrollments in academic geology programs and unemployment in the petroleum industry will certainly be reflected by a decline in the amount of published geology literature in the near future.

Survey of Regional Geological Societies

Figure 13 shows the distribution of responses to a survey of regional geological societies in the United states; 76 out of 119 societies responded to the survey. Triangles represent regional geological societies whose memberships have grown over the past seven years, squares show

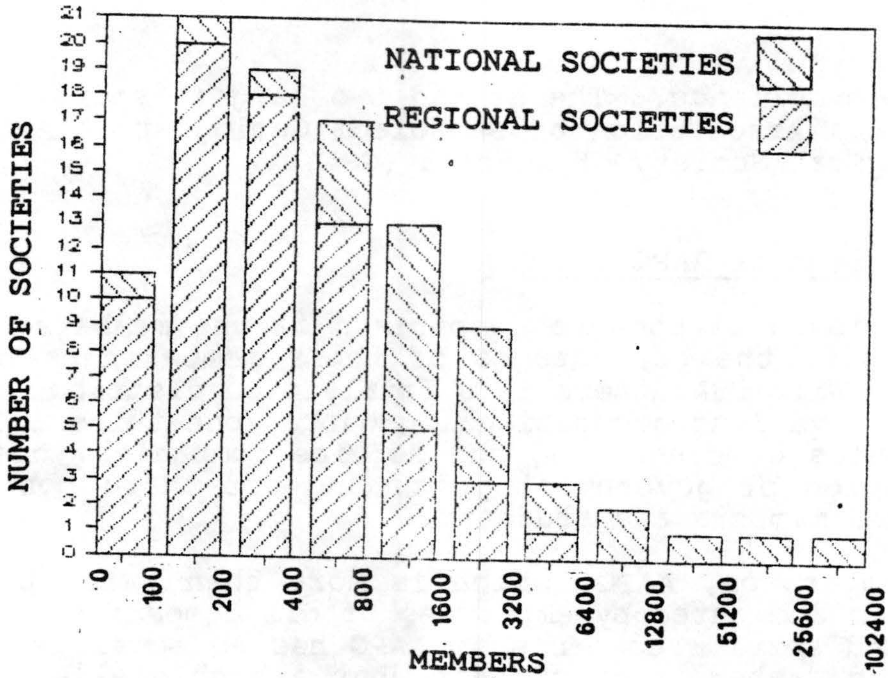

Figure 10. Number of geological societies ranked by size.

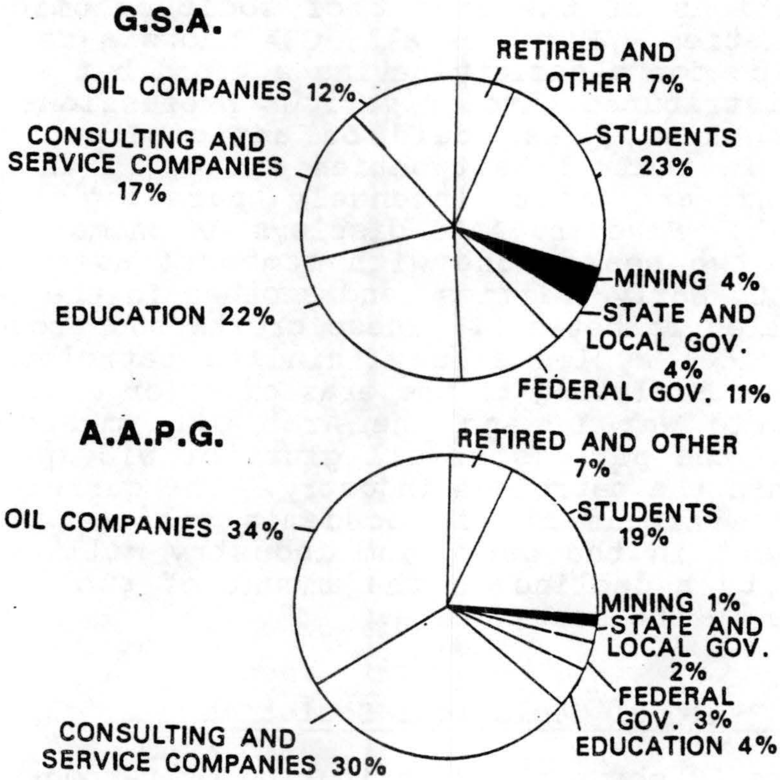

Figure 11. Comparison of members' occupations in AAPG and GSA.

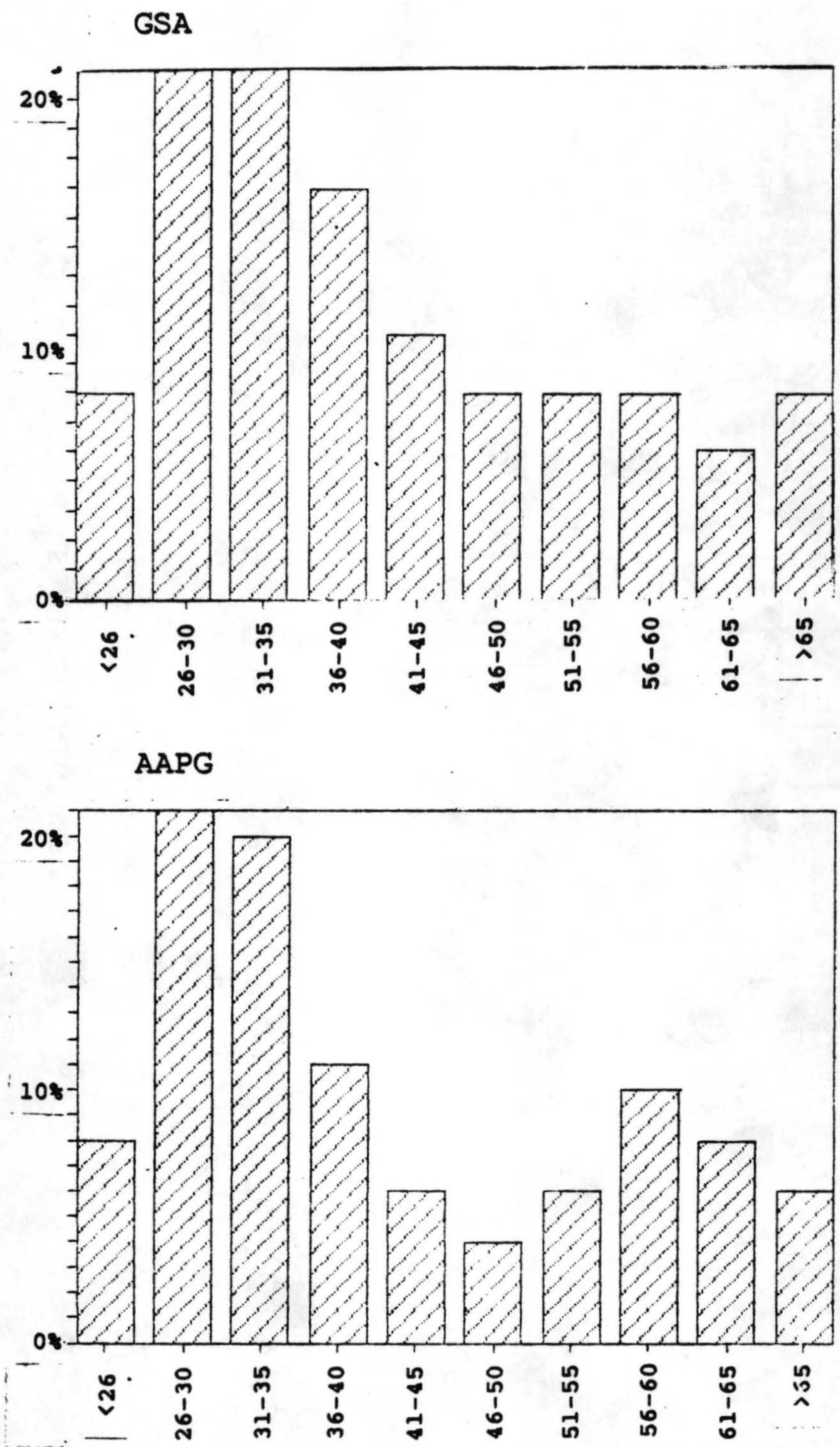

Figure 12. Comparison of member in GSA and AAPG: distribution by age.

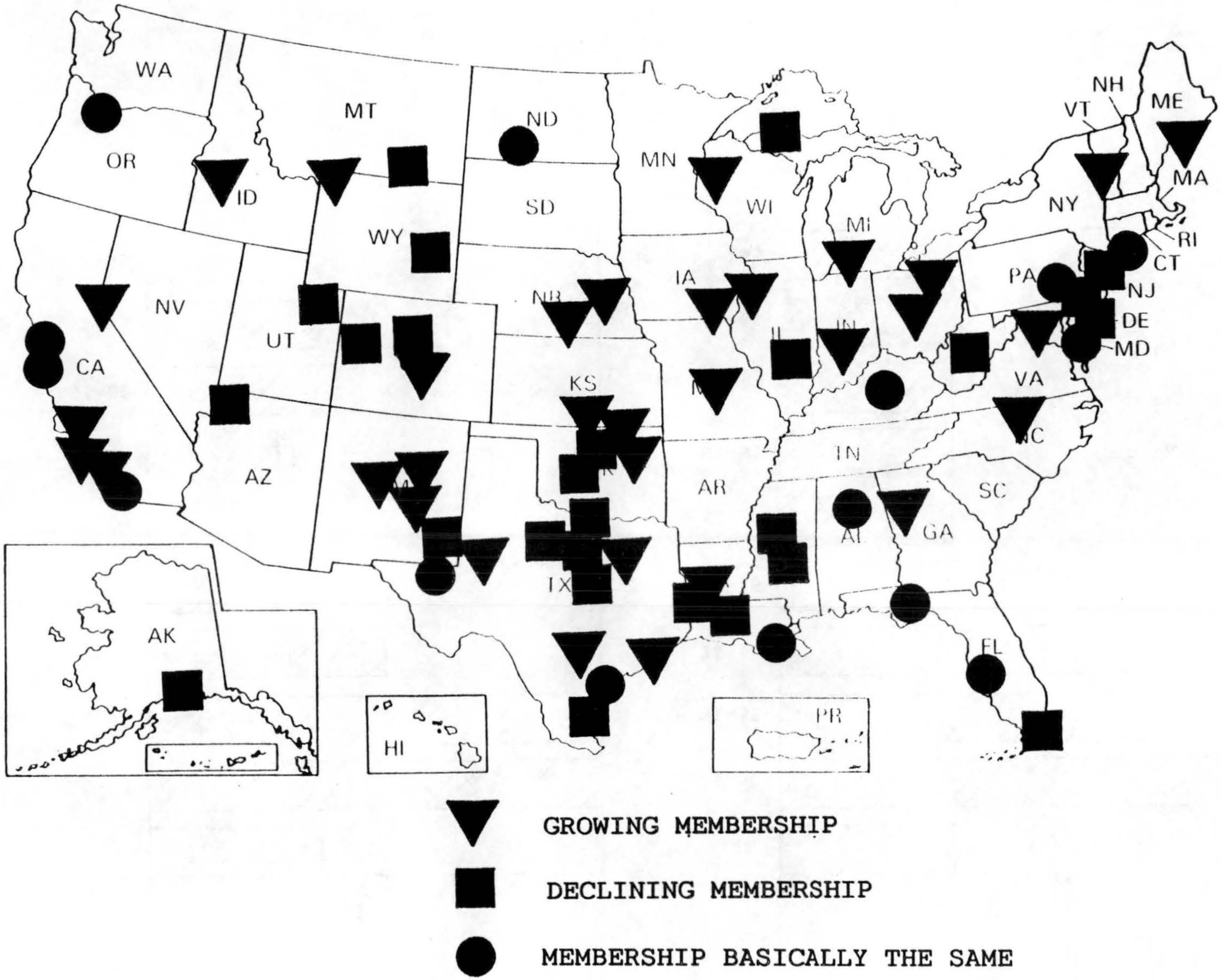

Figure 13. Distribution of responses to a survey of regional geological societies showing changes in membership since 1980.

societies that indicated that their memberships have decreased, and circles represent societies that indicated that their numbers have remained basically the same (+/-3%). The reasons these societies are growing or declining are complex, but overall this map reflects the general within the petroleum industry. The regions showing greatest decline in membership are the Gulf Coast, the central and southern oil districts of Texas and Oklahoma, the energy and mining districts of the Rocky Mountain Region, and the hub of energy companies in the New York - New Jersey region. Growing memberships seem to be restricted to larger metropolitan areas or areas of diversified employment for geologists, such as the Midwest or West Coast. Figure 14 shows the changes in membership of the regional geological societies that responded to the survey. A majority indicated that their memberships have grown significantly since 1980, but a majority also indicated that their memberships have remained unchanged or decreased during the past two years. Overall, societies' memberships have increased an average 6% since 1985 and 55% since 1980.

Services that societies currently offer, the projects that they undertake, and the manner in which they are operated are key factors in whether they are successful and growing. For instance, in addition to meetings, or offering annual field trips or conventions, the more successful societies, even in the more economically depressed regions, offer a wider range of services to their members. Figure 15 shows a variety of services that regional geological societies offer. Societies that offer continuing education opportunities, workshops, and employment referal services are currently more successful than those that do not. AAPG recently conducted a survey of its membership which indicated that as much as 25% of their members are currently unemployed. However, AAPG's membership has continued to grow, partly because the society provides members with continuous information about the industry and gives unemployed geologists an attachment to their profession.

The manner in which these societies operate and support themselves is another facet to their success or failure. A continuum exists among these societies. On one hand are those with several thousand members, staff personnel, and an office building. On the other hand are societies of several hundred members that are fully maintained and operated by one individual who keeps all the society's records in a shoe box. Figure 16 shows the number of societies that employ a staff and the number that maintain facilities. Figure 17 shows the variety of methods that regional societies use to support themselves, while Figure 18 shows how the societies ranked these sources of income. A particularly interesting note is that three societies indicated that they offered

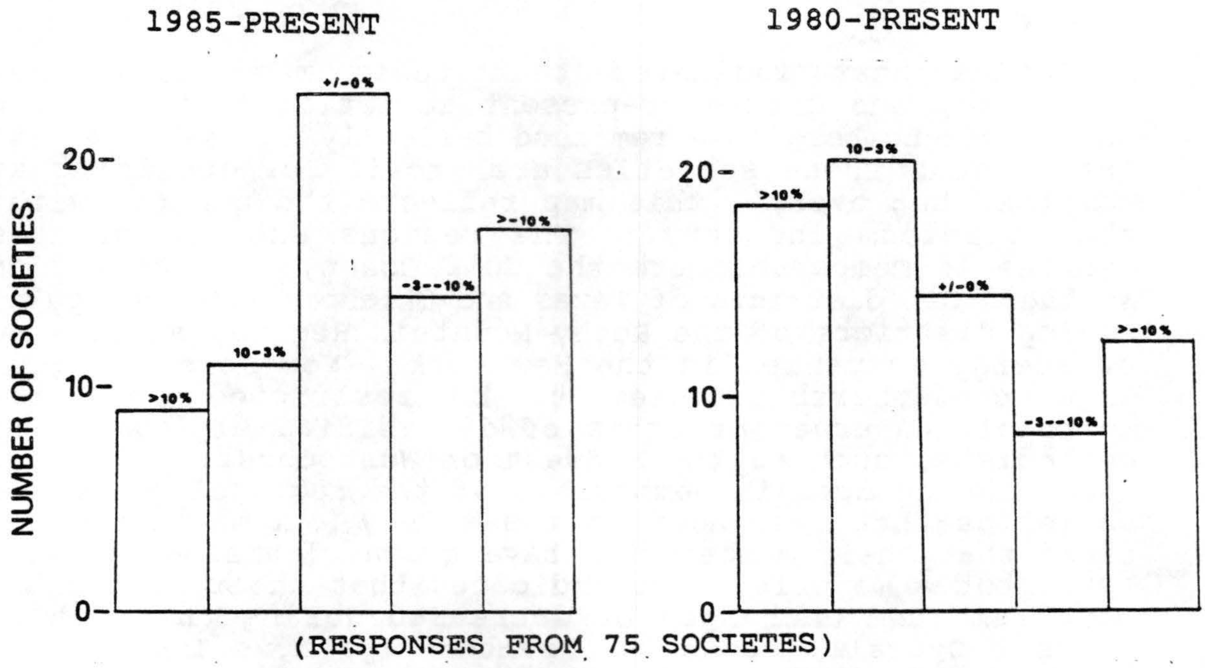

Figure 14. Changes in membership of regional geological societies: 1985 to present, and 1980 to present.

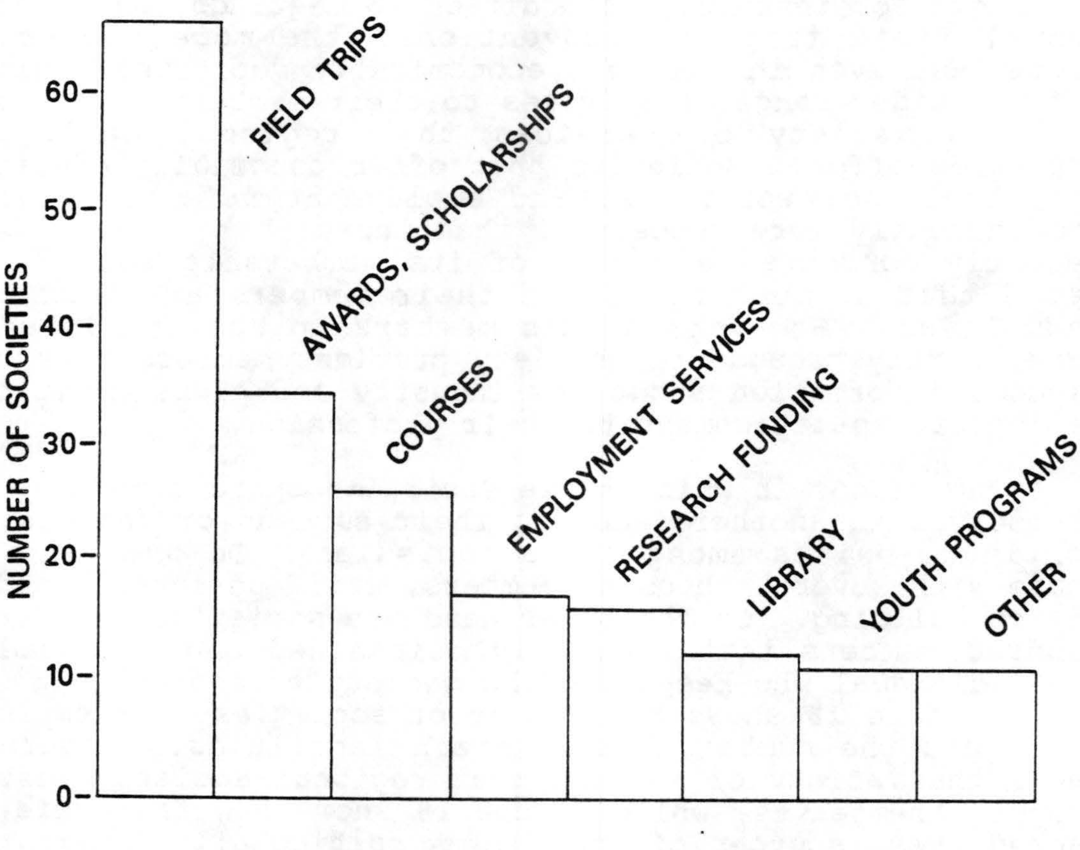

Figure 15. Services that regional societies offer.

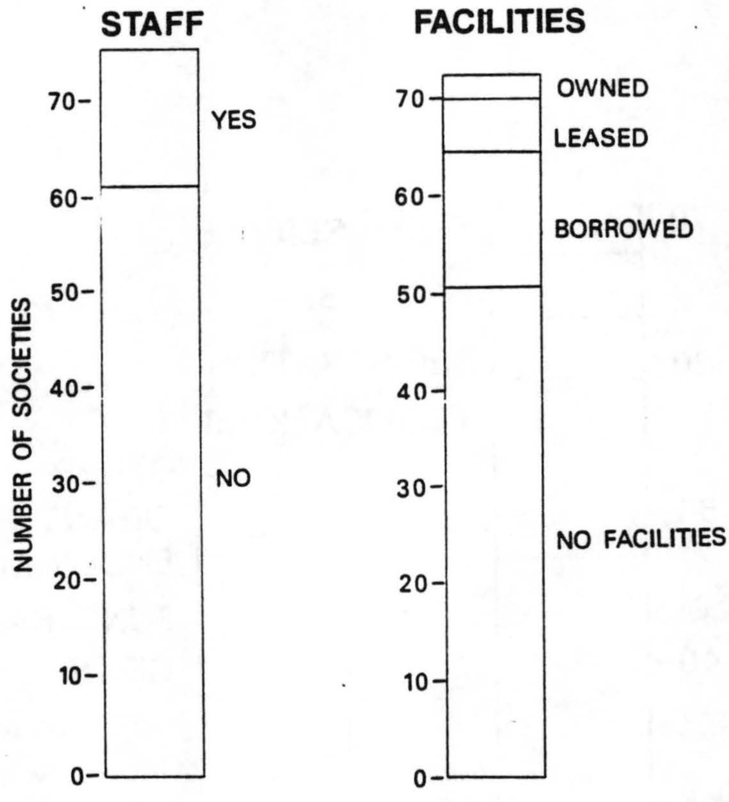

Figure 16. Regional Societies that employ a staff and maintain a facility.

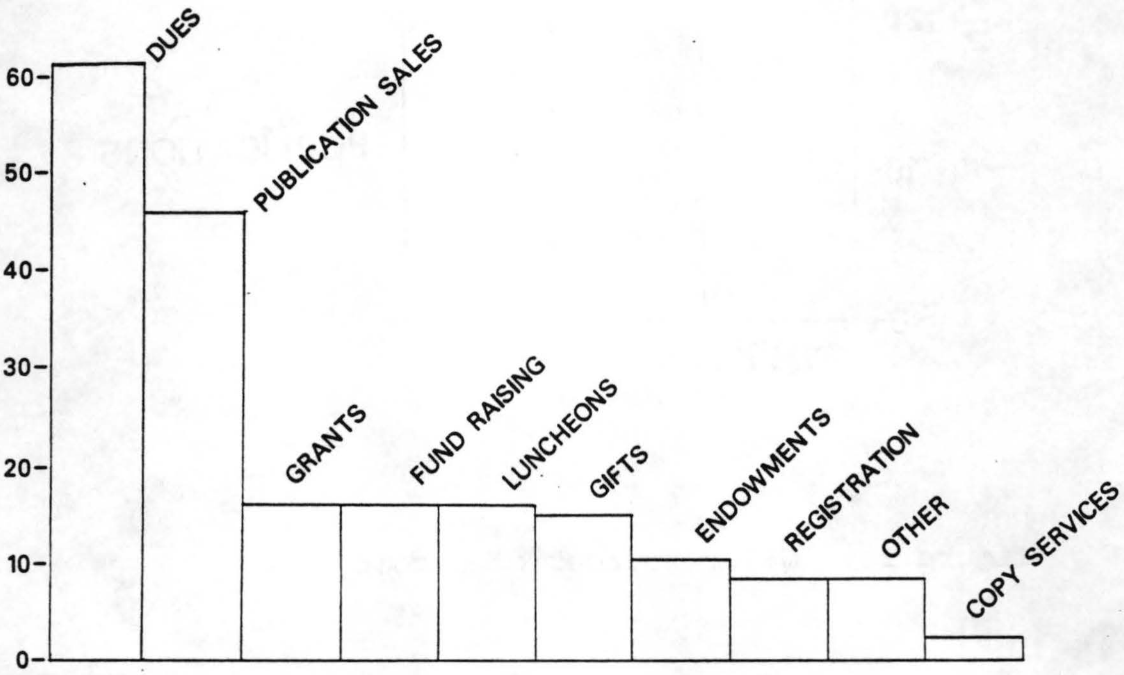

Figure 17. Methods geological societies use to support themselves.

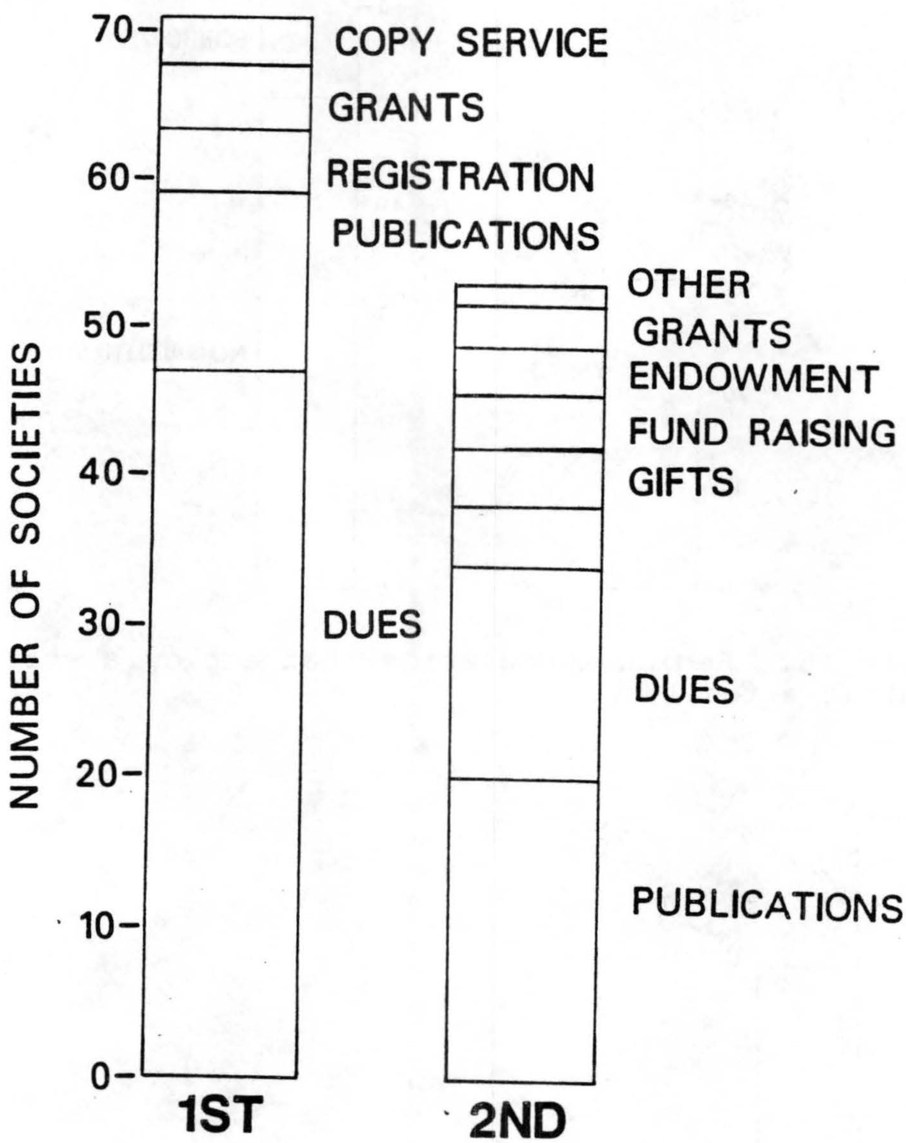

Figure 18. Major sources of income.

some sort of copier services and that this service generated their greatest income.

Figure 19 shows the variety of materials published by regional geological societies. Of the 75 societies that responded only 55 indicated that they publish. The numerous types of published materials revealed in this diagram illustrates the complexity of maintaining an exhausive geology collection. Figure 20 shows that publication sales by regional societies have generally increased over the past seven years, but have markedly decreased during the past two years. This recent decline probably reflects the current decline in the petroleum industry, but it may also reflect the declining purchasing power of libraries in general. A shortage of these regional publications is particularly distressing because in many cases they are the only public historical documentation of selected resources, special discoveries, or innovative technologies for oil or mineral exploration and production for a region.

The Impact on Geology Literature Collections in Libraries

The proliferation of geological societies is only one facet of the many problems facing librarians responsible for building geology literature collections. Figure 3 reflects the need to collect materials from many sources. Unfortunately, because of the explosion of information sources and the escalating expense of scientific journals, many American libraries are cancelling expensive, foreign, regional, and topical titles and are resorting to interlibrary loans rather than purchasing new titles or maintaining old titles. Without a systematic regional or national collection development effort, the net result may be that small to intermediate-sized libraries with geology collections will evolve to have very similar collections of "popular" geology titles, whereas the larger libraries that can still maintain these titles will be the recipients of growing numbers of interlibrary loan requests. The decrease in the number of institutional subscriptions of these titles may force publishers and societies to increase subscription costs or cancel their publication efforts. In addition, copyright infringement legislation may lead to more complications and expenses in interlibrary loan programs. All this will only increase the gap between the "information rich" and the "information poor".

Figure 20 shows that the sale of publications of regional geological societies has already decreased significantly over the past two years. This figure reflects that both membership and institutional subscriptions for these materials have fallen off during the current recession in the petroleum industry. Demand for these materials will

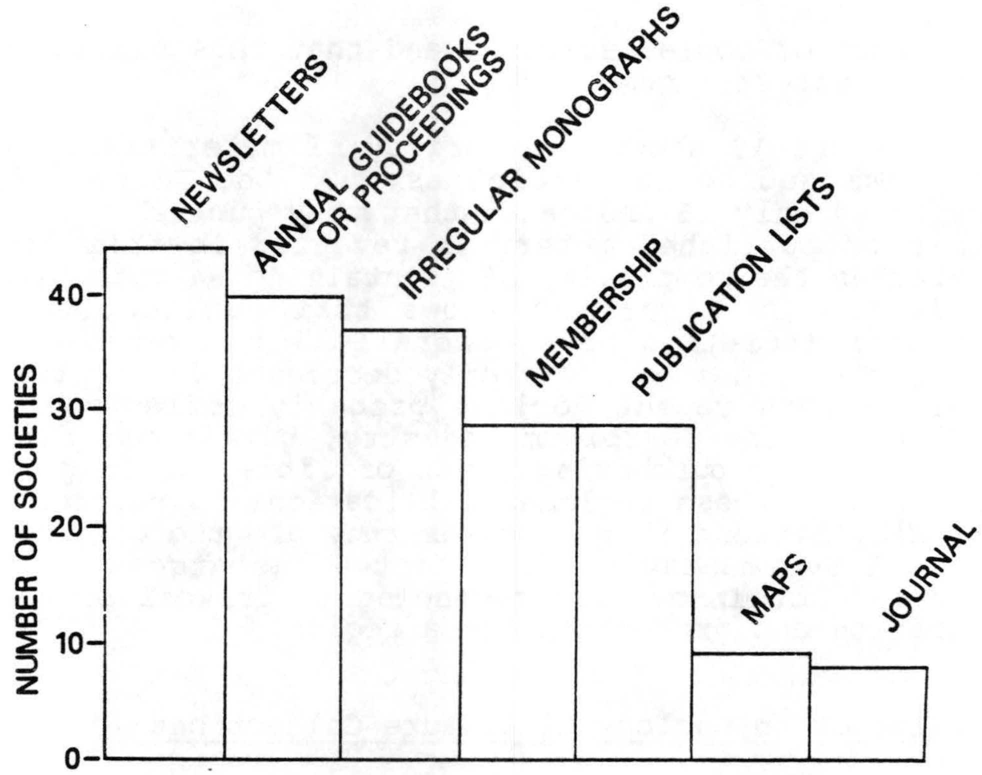

Figure 19. Materials published by regional geological societies.

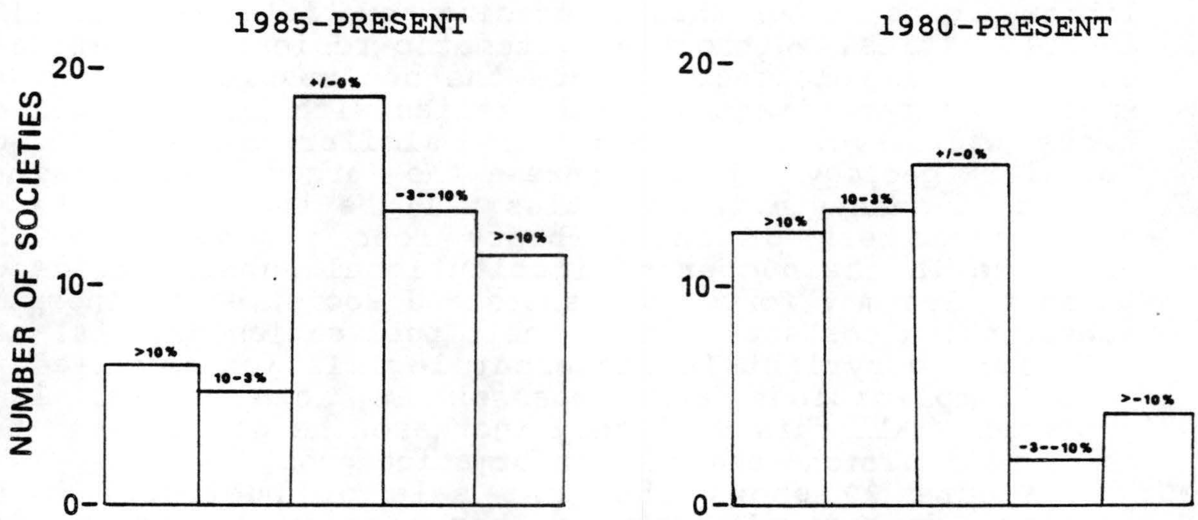

Figure 20. Changes in publication sales by regional geological societies.

certainly increase during the next oil boom.

CONCLUSION

Geological Societies play an important role in the exchange of information by allowing geoscientists to systematically, formally, and informally introduce and exchange ideas and data in a setting apart from established business, academic, or governmental institutions. There is considerable diversity in the means by which geological societies operate and support themselves, and in the services which they offer their members and the public.

The general growth and change of the geological sciences and economic demands for mineral and petroleum resources are responsible for the proliferation of geological societies. New societies will continue to evolve for new technologies and old societies will continue to cope with change. Although cycles within the petroleum industry have had an impact on the amount of geological information published through time by societies and other sources, the accelerating volume of published information in the geological sciences is not solely linked to the petroleum industry, but is more likely associated with the total diversity of the geological sciences and the general increase in the number of geoscientists and research funding across the board.

The impact of the recent recession in the petroleum and minerals industries in the United States is reflected in the decline of societies' memberships in the Rocky Mountain, Gulf Coast and Oklahoma, and New York City regions. In the Midwest and West Coast regions, memberships have increased significantly, possibly due to the diverse nature of employment for geoscientists in these regions.

If the current growth in the number of societies continues the dilemma of the proliferation of information sources will be compounded. With the continual growth in the number of information sources and the nationwide stagnation of library budgets librarians will be unable to develop their collections without gaps, making important regional publications difficult to find. Geological societies and other producers of public information should cooperate in resource sharing and gift and exchange programs with libraries, and make use of new information technologies as they emerge.

Librarians in charge of geological collections need to cooperate with other librarians within their region to study methods of resource sharing and "regional" collection development.

SOURCES OF DATA

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SURVEY OF REGIONAL EARTH SCIENCE RELATED SOCIETIES IN THE UNITED STATES

Part I

Please answer each question by checking the appropriate answer or in your own words in the space provided. If you cannot answer a question leave it blank. Feel free to add any comments that might clarify your answers.

1. What year was your society established? ________________

2. What is the number of members in your society? ___________

   Is this number an estimate? ___ Yes ___ No

3. Does your society employ a staff? ___ Yes ___ No

   If "YES", how many society employees work full time? _________
   How many society employees work part time? _________

4. Your society may hold meetings ranging from one every week to one a year. These meetings may be attended by members only or open to the public. For our purpose meetings include luncheons, workshops, conferences, etc., but do <u>not</u> include internal committee, staff, or board meetings.). Indicate which of the following possibilities best apply to frequency and type of meetings held by your society each year.

   Does your society have meetings? ___ Yes ___ No

   If the answer was "YES", these meetings would best be described as: (mark all types of meetings that best apply)

   ____ Weekly meetings?

   ____ Meetings once a month?

   ____ Irregularly announced meetings?

   ____ Annual Conference?

   ____ Annual Conference in conjunction with another society?

   ____ Other type of meeting (Describe briefly) ____________________

   ____

   ____

If your society has an annual meeting or conference it is generally held during the month of:

____January
____February
____March
____April
____May
____June
____July
____August
____September
____October
____November
____December
____No fixed date
____No Annual meeting

7. Please list the names of other societies with which your society is affiliated or holds joint meetings:

____
____
____
____
____
____

8. Some societies always meet at the same location; others do not have a set meeting place. Your society meets consistantly at:

____ no established location
____ an established location; the address is:

____
____
____
____

The standard meeting date/time: ____________________

9. A person interested in contacting the society by phone could contact:

Name: ____________________

Person's title: ________________

Phone: (   ) ________________

10. The correct address of your society is:

____
____
____
____

Part II.

1. Is your society currently offering: (mark all that apply)

____ Employment placement or referal services for members or non-members?

____ Continuing education coarses?

____ Funding for local geological research programs?

____ High school or youth oriented educational programs?

____ Field trips, annually or occasionally, to study the geology of the region in the vicinity of your society?

____ Awards or scholarships for high school or university students?

____ Awards for merit for accomplishments or research by members or other scientists?

____ Library facilities for members?

____ Other notable programs your society offers?

____

____

____

2. Your society financially supports itself by: (mark all that apply)

____ A. Endowments.

____ B. Membership dues.

____ C. Grants or subsidies from industries, universities, government agencies, or other organizations.

____ D. Publication sales

____ E. Gifts

____ F. Workshops, classes

____ G. Luncheons or special fund raising events.

____ H. Other ____________________.

3. Of the items you marked above, which item(s) provide the greatest income or support for your society (indicate with a letter from the list above).

____ First

____ Second

____ Third

____ Don't know

4. Does your society have an office facility? ___ Yes ___ No

If "Yes", this facility is:

____ fully owned by the society.

____ morgaged by the society.

____ leased by the society.

____ owned by another institution (company, university, state survey, individual, or other institution)

____ other ______________________________

5. If your society require members to pay membership fee(s), what kind are they and how much do they cost? (mark all that apply)

____ Annual professional member? $__________

____ Annual student member? $__________

____ Annual corporate or institutional member? $__________

____ Sustaining member? $__________

____ Life membership? $__________

____ Affiliate membership (spouse, etc.)? $__________

____ Other? ______________________ $__________

6. In your opinion, over the past two years (Jan.'85 - Jan.'87) your society's membership has: (mark one)

____ Increased significantly (>10% increase)
____ Increased moderately (3%-10% increase)
____ Remained basically the same (<3% increase or decrease)
____ Decreased moderately (3%-10% decrease)
____ Decreased significantly (>10% decrease)
____ Don't know

7. In your opinion, over the past seven years (Jan.'80 - Jan.'87) your society's membership has: (mark one)

____ Increased significantly (>10% increase)
____ Increased moderately (3%-10% increase)
____ Remained basically the same (<3% increase or decrease)
____ Decreased moderately (3%-10% decrease)
____ Decreased significantly (>10% decrease)
____ Don't know

8. Your society may publish a variety of materials. Does your society publish: (Mark all types of publications that apply. If your society does not publish ignore the following questions.)

____ Annual Proceedings or Guidebooks?

____ A monthly or quarterly journal?

____ Newsletters?

____ Publication lists?

____ Membership directory?

____ Irregularly published special volumes, books, atlases, or memoirs?

____ Maps?

____ Other ____

____

9. Do members of your society receive any society publications as part of their membership gratuities? (This includes journals, proceedings, or newsletters which average more than 15 pages at least once a year, it does <u>not</u> include meeting announcements or other irregular short publications.)

___ Yes ___ No

10. Are these materials published by the society available for purchase by libraries or other non-members of the society?

___ Yes ___ No

11. During the past two years (Jan,'85-Jan'87) the sale of these materials has:

____ Increased significantly (+10% increase)
____ Increased moderately (3%-10% increase)
____ Remained basically the same (<3% increase or decrease)
____ Decreased moderately (3%-10% decrease)
____ Decreased significantly (+10% decrease)
____ Don't know

12. During the past seven years (Jan,'80-Jan'87) the sale of these materials has:

____ Increased significantly (+10% increase)
____ Increased moderately (3%-10% increase)
____ Remained basically the same (<3% increase or decrease)
____ Decreased moderately (3%-10% decrease)
____ Decreased significantly (+10% decrease)
____ Don't know

Thank you for your cooperation.

APPENDIX

List of attendees
GIS Annual Business Meeting - October 27, 1987

Mary Ansari
Debbie Arens
Julie Bichteler
Bob Bier
Reggie Brown
Charlotte Derksen
Dona Dirlam
Marie Dvorzak
Jean Eaglesfield
Barbara Haner
Linda Hill
John Hutley
Claren Kidd
Midge King
Susan Klimley
Carolyn Laffoon
Joanne Lerud
Alison Lewis
Connie Manson
Peg Marshburn
Dorothy McGarry
Clara McLeod
Carol Messick
John Mulvihill
Jim O'Donnell
Sue Palmer
Cathy Pasterczyk
Barb Pearson
Hart Phinney
Julie Rinaldi
Carter Robinson
Unni Rowell
Janet Rudd
John Sellin
Miriam Sheaves
Janet Sorensen
Richard Spohn
Marilyn Stark
Dena Stepp
Phil Stoffer
Nancy Thurston
Rosalind Walcott
Dick Walker
Margy Walsh
Dedy Ward
Elaine Watson
Connie Wick
Louise Zipp

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v. 3 No volume title (1972 meeting; H.K. Phinney, editor)	published 1973	3
v. 4 Geoscience Information (1973 meeting; M.W. Wheeler, editor)	published 1974	6
v. 5 OUT OF PRINT -- see reverse		
v. 6 Retrieval of Geoscience Information (1975 meeting; V.S. Hall, editor)	published 1976	8
v. 7 Geoscience Information (1976 meeting; J.G. Mulvihill, editor)	published 1977	8
v. 8 Geoscience Information Retrieval Update (1977 meeting; R.D. Walker, editor)	published 1978	8
v. 9 Geoscience Information: Publication - Processing - Management (1978 meeting; J.H. Bichteler, editor)	published 1979	8
v.10 Collection Development in Geoscience Libraries (1979 meeting; R. Walcott, editor)	published 1980	15
v.11 Keeping Current with Geoscience Information (1980 meeting; N. Pruett, editor)	published 1981	20
v.12 The Future of the Journal (1981 meeting; M.W. Scott, editor)	published 1983	20
v.13 Geologic Hazards Data (1982 meeting; R.A. Brown, editor)	published 1984	20
v.14 Roles and Responsibilities in Geoscience Information (1983 meeting; U.H. Rowell, editor)	published 1984	20
v.15 Maps in the Geoscience Community (1984 meeting; C.M. Kidd, editor)	published 1985	20
v.16 Micros, Minis and Geoscience Information (1985 meeting; A.E. Bourgeois, editor)	published 1987	35
v.17 The User and Geoscience Information (1986 meeting; R.A. Bier, Jr., editor)	published 1987	35
v.18 Collections for the Future (1987 meeting; J.T. Eaglesfield, editor)	published 1988	35

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