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A Symposium

TOWARD THE DEVELOPMENT OF A GEOSCIENCE

INFORMATION SYSTEM

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No attempt has been made to arrange the papers in subject order. Presentation here is in alphabetical order according to authors' surnames. Each paper is reproduced in the style submitted by the author. In retyping for uniformity of appearance, we have exercised no editorial prerogatives other than to correct obvious typographical errors.

Thanks are due to Kathleen Graves for typing the papers and reading proof, to Lee Lord and Thelma Stewart for proofreading the typescript, and to John Ness for advice and assistance with the printing.

R.W.G.

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BIBLIOGRAPHIC CONTROL AND THESAURI

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Abstract - The paper will focus on the current status of abstracting and indexing services in the geological sciences in terms of bibliographic control and thesaurus development. In order to provide the proper perspective, the problems of the control of serial publications and the bibliographic records generated by abstracting and indexing services will be discussed. Possible channels to solve these problems will be identified. These channels include standards that have either been approved or are under development nationally or internationally. Other national and international developments concerning the handling of serials and agreements on bibliographic control will be reviewed. Existing cooperative arrangements between abstracting and indexing services will be described. Current studies will be mentioned and resulting cooperative agreements based on these studies will be projected. A brief case history of thesaurus development in the U. S. will be given including the development to date of the Engineers Joint Council (EJC) Thesaurus and the Department of Defense Project LEX. The American National Standards Institute (ANSI) draft standard for thesaurus development and the UNESCO Guidelines for the Development of Monolingual Thesaurus will be mentioned. The current status of thesaurus development in geology through a Working Group of the International Council of Scientific Unions Abstracting Board (ICSU AB) will be described.

Introduction

I am very pleased to be invited to take part in this panel which is discussing the report "A Concept of an Information System for the Geosciences" prepared by the Committee on Geoscience Information of the American Geological Institute (1). The subject I have been assigned is bibliographic control and thesauri. In this paper I would like to describe briefly the organization for which I work, the National Federation of Science Abstracting and Indexing Services, to give the frame of reference for my remarks; then I would like to review the status of standards concerned with bibliographic control in publishing; mention thesaurus development activity especially in the geoscience field, and finally summarize briefly the status of geoscience abstracting and indexing services in the United States.

In the "Concept" report, an information system is defined as:

> "a functioning program for the efficient transfer of information, involving all conventional channels and services, updated to provide for the explosive growth of geoscience information during the past several decades, and employing new techniques introduced with the development of electronic data processing.
>
> Such a system will be composed of units that may be cross-linked (such as primary and secondary publications), or disparate (such as publications and data collections), but all units will have a common concern for the dissemination of information and will employ, wherever possible, standard methods for intellectual and mechanical input in order to ensure mutual compatibility."

This report was the subject of the lead article in the British journal Nature (Physical Science Section) in the February 22nd, 1971, issue (2). With characteristic British understatement, the story was headed "Three Cheers for the American Geological Institute". The paragraph that I found particularly significant described the report in these terms:

> "The AGI report is intended as a philosophical statement of the Committee's concern with information transfer in the geosciences and, as such, does not go into much detail. As a result it is, in one sense, merely a statement of the obvious, but as the obvious has not been stated quite so well before there is no harm in that --indeed it is to be positively applauded. [The system is intended to be] user oriented, operated for geoscientists by geoscientists and produced by members of the community who are aware of needs rather than by government bodies or commercial concerns whose motivations might not be in the best interest of the geoscience community. This is wielding the hammer with a vengeance, but is only a pointed recognition of the fact that many libraries and information systems these days contrive to give the impression that they are intended primarily for the fun or profit of librarians and information scientists."

I believe that my function on this panel is to speak to those techniques developed by the information scientist that can be usefully brought to any information system, namely, the techniques of bibliographic control and thesaurus development.

Federation Frame of Reference

The organization which I represent is the National Federation of Science Abstracting and Indexing Services which was founded in 1958 during the so-called "post Sputnik" era in the United States. At that time, the major society, institutional and government publishers of abstracting and indexing services decided to incorporate. The Federation is now a teenager and like most growing organisms, has experienced many growing pains since 1958. The aims of the organization was originally established, (these same aims have recently been reaffirmed by the members) are as follows:

To help members improve their services and operations, and to advance their prestige, nationally and internationally.

To undertake specific projects on behalf of members that no one single member service would undertake alone and that would be broadly useful to the majority of member services.

To act as national spokesman for the member services.

The Federation can boast of its largest membership ever. Incidentally, I would like to stress that membership in the Federation is institutional only and there are no individual members. At this time there are 19 voting members, 5 government services and 1 foreign affiliate. Estimates for 1971 show that the 25 members are producing over 1¼ million citations per year. Of the 25 members, 16 are producing some form of machine readable bibliographic data base. I estimate that Federation members are, therefore, producing over 1 million bibliographic citations in machine readable form.

Bibliographic Standards

The increase in the number of services developing machine readable data bases has caused increasing concern on standards and standardization requirements. In surveying the bibliographic requirements of abstracting and indexing services, the following standards are either available or in press at this time (3):

Standard on Indexes published by the American National Standards Institute (ANSI).

Guideline for the development of mono-lingual thesauri published by UNESCO.

Standard on Thesaurus development is in preparation at ANSI.

Guidelines for the development of Multi-lingual Thesauri in draft at UNESCO. (Currently being revised as a result of an attempt to apply the guidelines in the geoscience area.)

Standards on Abstracts in press with ANSI. (Accepted as an International Standards Organization ISO Standard.)

Interchange of Bibliographic Information on Magnetic Tape Standard in press with ANSI. (Also accepted as an ISO Standard.)

Standard for Abbreviation of Words in Journal Titles published by ANSI. An adjunct word list is available separately which has been internationally developed and accepted internationally. In addition, words not found in the word list may be obtained on application to National Clearinghouse for Periodical Title Word Abbreviation located in Columbus, Ohio.

There is a sad story in connection with the most important piece of the bibliographic description, namely, the standardization of the bibliographic reference itself. The American National Standards Institute has attempted to develop a standard which was rejected by the publishing and library community. The problem in this area appears to be that the requirements for adequately cataloging a given document and the requirements for the bibliographic description needed by primary and secondary publishers are different. Recognizing this problem Committee Z-39, which is responsible within ANSI for standards in the area of libraries and publishing, have separated the two areas of concern. A new committee has been formed under the chairmanship of Ben H. Weil (Esso Research and Engineering Company) to develop a standard for publishers. It is hoped that the efforts of this subcommittee will be successful and that a standard acceptable to the community will be developed in the near future.

In addition to standards and guidelines, there are a series of coding standards that have been developed for certain units of the bibliographic record. Journals may be identified by using the CODEN System developed by the American Society for Testing and Materials (4). This is a 5 digit alphabetic code with a sixth digit check character. The system is maintained at the Franklin Institute in Philadelphia and at this time is oriented to scientific and technical literature. Most of the producers of bibliographic machine readable data bases are using this system on identification.

A Standard Serial Number (SSN) is to be implemented in 1972. This system will consist of an 8 digit numeric code with a ninth digit check character. This system is based on the recently published ANSI standard (3). It will be incorporated in Ulrich's Periodical Directory published by the Bowker Company. It is my understanding that the system will eventually be maintained by the Library of Congress which will act as the national center in the United States. International coordination will be maintained by the International Serials Data System (ISDS) located in Paris. I would draw your attention in passing to the situation faced by publishers of machine data bases who will soon have available two separate codes for the identification of the same bibliographic entity, namely, a given journal title.

There are also, of course, standards on transliteration both published and in development for several languages. Codes are also being established for countries, languages, etc. (3). Coding activity is so active at the moment that we may soon need a code to identify codes.

Although standards are considered a necessary though tedious area of concern, they are becoming increasingly necessary as more mechanized systems are developed. One of the problems in standardization activities is publicizing and implementing standards once they have been developed. It is hoped that associations of editors and publishers will strive to spread the word on standards within their community of members. Such editorial groups as the Association of Earth Science Editors (AESE) could be particularly helpful in this; also, international editorial groups, such as the European counterpart of AESE, EDITERRA which was formed in Prague in 1968. I understand that a current project for EDITERRA is the development of an editors' handbook and this would be one way to spread information on standard activities related to publishing practices.

Thesauri Development

If a file cabinet can be defined as a place where a secretary can lose information alphabetically, a controlled vocabulary indexing system might be defined as a way in which an information scientist can lose information systematically.

Incidentally, by thesaurus I mean a controlled vocabulary system developed from the original concept of Roget's Thesaurus. In this kind of vocabulary system specific relationships between terms such as "related", "broader" and "narrower" are established and synonyms are strictly controlled. It might be appropriate to mention a case history based on a specific thesaurus project. The Engineers Joint Council (EJC) Thesaurus was published in the mid 1960s. This Thesaurus was developed from its forerunner, the ASTIA Thesaurus, prepared by the Armed Services Technical Information Agency. The purpose of the EJC Thesaurus was to provide for the discipline of engineering a controlled vocabulary list which could be of use by any discipline within the field of engineering as a basic list of terms. In terms of practical implementation in the field of electrical engineering, plastics, paper and pulp industries and I believe also metals, only 30% of the terms needed by these subdisciplines appeared in the EJC Thesaurus. In effect, 70% of the terms needed had to be added to the basic list.

Following EJC, an attempt was made to develop an overall scientific thesaurus under the name PROJECT LEX. This might be called the "locked room" way to build a thesaurus. Namely, a group of specialists in a given scientific area were locked in a room for a week, the key thrown through the window, and a thesaurus appeared as a result. In this project, about 16 mechanized vocabularies were collected, merged and then subjected to detailed study and scrutiny by specialized groups of scientists, technologists and lexicographers. Considering the history of the EJC Thesaurus and PROJECT LEX, and the use that seems to be made today of these two thesauri, it is my personal opinion that vocabularies need to be developed for the specific subject area and that the day of a universal scientific vocabulary or classification scheme has passed.

Turning now to thesaurus development in the geoscience field, the "Concept" report states that:

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

This work was then coordinated with that of the International Council of Scientific Unions/Abstracting Board Working Group in Geology and the activities of the International Union of Geological Science (IUGS). As a result, a Working Group was formed with representatives from:

American Geological Institute
Bureau Recherches Geologiques Minereaux (France)
Center Nationale Recherches Scientifiques (France)
GeoFond (Czechoslovakia)
Bundanstaldt für Bodenforschung (Germany)
Geological Survey (Canada)

The chairman of the Working Group regrets that, to date, no Russian representative has attended the Working Group meetings. The Working Group decided to concentrate on the area of structural geology and is developing a multi-lingual thesaurus in French, English, German and Czechoslovakian. It should be stressed that this is intended as a pilot project. In developing the multi-lingual thesaurus, the Working Group attempted to use the draft guidelines prepared by UNESCO and mentioned above. In trying to implement the guidelines, the Working Group found several difficulties and the draft is now back on the drawing board at UNESCO being revised as a result of practical experience. The Working Group is to hold a meeting in February, 1972, and expects to report the results of its efforts together with the vocabulary, which will probably consist of approximately 200 terms, at the International Geological Congress to be held in August, 1972.

Current Status of United States Services

In 1953, the American Geological Institute (AGI) commenced publishing of Geological Abstracts. In 1959, the name of the service was changed to Geoscience Abstracts. This was a monthly publication and according to the recently published FID Directory (5), produced about 5,000 abstracts per year. The Geological Society of America (GSA) commenced publication annually in 1933 the Bibliography and Index of Geology Exclusive of North America with approximately 6,500 abstracts as of 1963 (6). This publication became a monthly in 1967. The oldest publication is Bibliography of North American Geology and has been published since 1896 by the U.S. Geological Survey (USGS). This annual publication carried approximately 4,000 references as of 1963 (6). In addition, the U. S. Geological Survey and the Bureau of Mines publish Geophysical Abstracts. This monthly publication started in 1929, carried approximately 4,200 abstracts in 1969 (5).

A meeting was held in 1966 of AGI, GSA, and USGA and resulted in an agreement to merge the AGI and GSA effort under National Science Foundation support in 1967 and produce on a monthly basis rather than annual the Bibliography and Index of Geology Exclusive of North America with approximately 20,000 references per year. Geoscience Abstracts, therefore, ceased publication in 1966 while USGS activities continued. During 1967 and 1968, AGI prepared the input in machine readable form with GSA printing and distributing the Bibliography. In 1969, for various reasons, one that of economics, it was decided that abstracts be dropped and annotated references and indexes only be supplied. At the same time, it was decided to extend the coverage to worldwide literature. In 1970, it was recognized that the cost of computer data base could not be met solely by Bibliography sales. AGI and GSA, therefore, agreed to split the operation in the following way. AGI continued to produce the machine data base under the name GEO•REF independent of GSA. GSA then became a "favored customer" of AGI and draws the input for the Bibliography from GEO•REF. This leaves AGI free to develop independently tape sales, specialized bibliographies, selective dissemination of information (SDI) services, retrospective searches, and indexes, etc. AGI has in fact already established many such arrangements to produce specific services using the GEO•REF base. In mid 1971 USGS, recognizing the duplication of services, decided to cease to produce its services after 1971 (7).

Conclusion

The "Concept" report displays an approach to information system development which takes into account all aspects of the information system in a sensible and logical order. It is particularly encouraging to see that the special problems of the information scientist are not overlooked. I also am encouraged that the report is concerned with the role of the library in the information system. An information service may establish the best bibliographic control and thesaurus for its area of concern but without document access, namely, the library, the service would be of little value to the ultimate user. The information scientist and the librarian are necessary members of any team establishing an information system. Unfortunately, some information system developers do not recognize this. I worked at the American Institute of Physics before taking my current position with the Federation. Although the American Institute of Physics' staff has many knowledgeable and concerned physicists in the information program who recognize the importance of bibliographic skills, I regret to say that on the day I left to take up my current position, one of the least knowledgeable physicists congratulated me on my vast promotion--he had heard that I was leaving to become a secretary! I am glad that this attitude of mind does not prevail in the geoscience community.

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(1) American Geological Institute, Department of Geoscience Information. A Concept of an Information System for the Geosciences, Washington, D. C., 1970, 23 p.

(2) Three Cheers for the American Geological Institute. Nature (Physical Science Section), 229 (no. 8, p. 217), February 22nd, 1971.

(3) More information is available from the American National Standards Institute, Z-39 Committee, Chairman - Jerrold Orne, University of North Carolina, Chapel Hill, North Carolina.

(4) American Society for Testing and Materials. CODEN for Periodical Titles. 2 vols., Philadelphia, 1970. (ASTM Data Series DS 23A-S1 and B)

(5) International Federation for Documentation. Abstracting Services, Volume 1, Science, Technology, Medicine and Agriculture, The Hague, Netherlands.

(6) National Federation of Science Abstracting and Indexing Services. World's Guide to Abstracting and Indexing Services in Science and Technology, 1963, Philadelphia, Pa., Out-of-Print.

(7) Discussion with Joel J. Lloyd, American Geological Institute, November, 1971.

FOREIGN LITERATURE AND TRANSLATIONS IN EARTH SCIENCE[1]

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Abstract - More than 50 percent of the total abstracted geologic literature is in Russian, followed by English at about 30 percent, and French, German, and Japanese from about 8 to 2 percent. Communist Chinese publications ceased as a result of the Cultural Revolution and have not resumed.

Less than 2 percent of American earth scientists read and use Russian literature in the original to any significant extent. About 30 percent know some French, German, and Spanish, but only a much smaller proportion uses these languages in practice. The most important sources of knowledge about foreign work are translation journals, almost exclusively from Russian, and foreign scientists who write in American and international journals. Less than 0.5 percent of Russian earth science books are translated or known in the United States.

Scientific provincialism is strong and increasing in the United States, owing to or demonstrated by the publications explosion and squeeze on libraries and scientists, weakening or abandonment of language requirements in universities, and cessation of all broad earth science abstracting services in English.

Suggestions for improving communication of foreign literature include earlier exposure to languages in schools and stress on critical use rather than perfunctory examinations. A "critical mass" of linguistically competent and active scientists is necessary to find the important, not merely important-sounding, titles in the literature morass and introduce them into widely read earth science media.

1/ Publication authorized by the Director, U.S. Geological Survey
Contribution No. 2832 of the Woods Hole Oceanographic Institution.

INTRODUCTION

Prefacing a talk on "The next industrial revolution", Athelstan F. Spilhaus (Sr.)[2] commented that control of population growth was a prerequisite for any viable plan affecting society or involving social engineering. Having said that, however, Dr. Spilhaus remarked that he would not refer to this problem again. In like manner, I believe that the problem of keeping up with foreign literature cannot be separated from the problem of the explosion of scientific literature in general (fig. 1). One of the most disheartening aspects of this problem is the pandemic proliferation of what I call Floreyism to the working level of science. Floreyism is an attitude or phenomenon exemplified by a comment attributed to Sir Alexander Florey, pioneer in the use of antibiotics in medicine: "Like many Fellows of the Royal Society, I write, but do not read". Like Dr. Spilhaus, however, I will leave this topic now, or touch on it only peripherally in assessing what we can do to cope with foreign literature until the doctor comes.

Because of the limited attention span of most readers of current scientific literature (including myself) I have placed RECOMMENDATIONS immediately after this introduction. The background on which the suggestions are based is provided in the body of the paper. Throughout the paper source organizations are referred to in short form. Addresses are provided in Appendix III.

I am obliged to many individuals for discussion, data and other assistance; among those, with apologies to those not mentioned, are: T. J. Rafter of the American Geological Institute in Washington, A. F. Spilhaus, Jr. of the American Geophysical Union in Washington, G. Ward and L. Cima of the National Science Foundation, Washington, P. Kiefer of Plenum Press, N.Y. City, S. Juhasz of the Southwest Research Institute, San Antonio, Texas, K. O. Emery of the Woods Hole Oceanographic Institution, Woods Hole, Mass., G. Goodwin and D. Hastie of the U.S. Geological Survey Library, Washington and my fellow members of the Book Translation Committee of the

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2/ Lecture given at the Student Center of the Woods Hole Oceanographic Institution, Woods Hole, Mass., Aug. 1971.

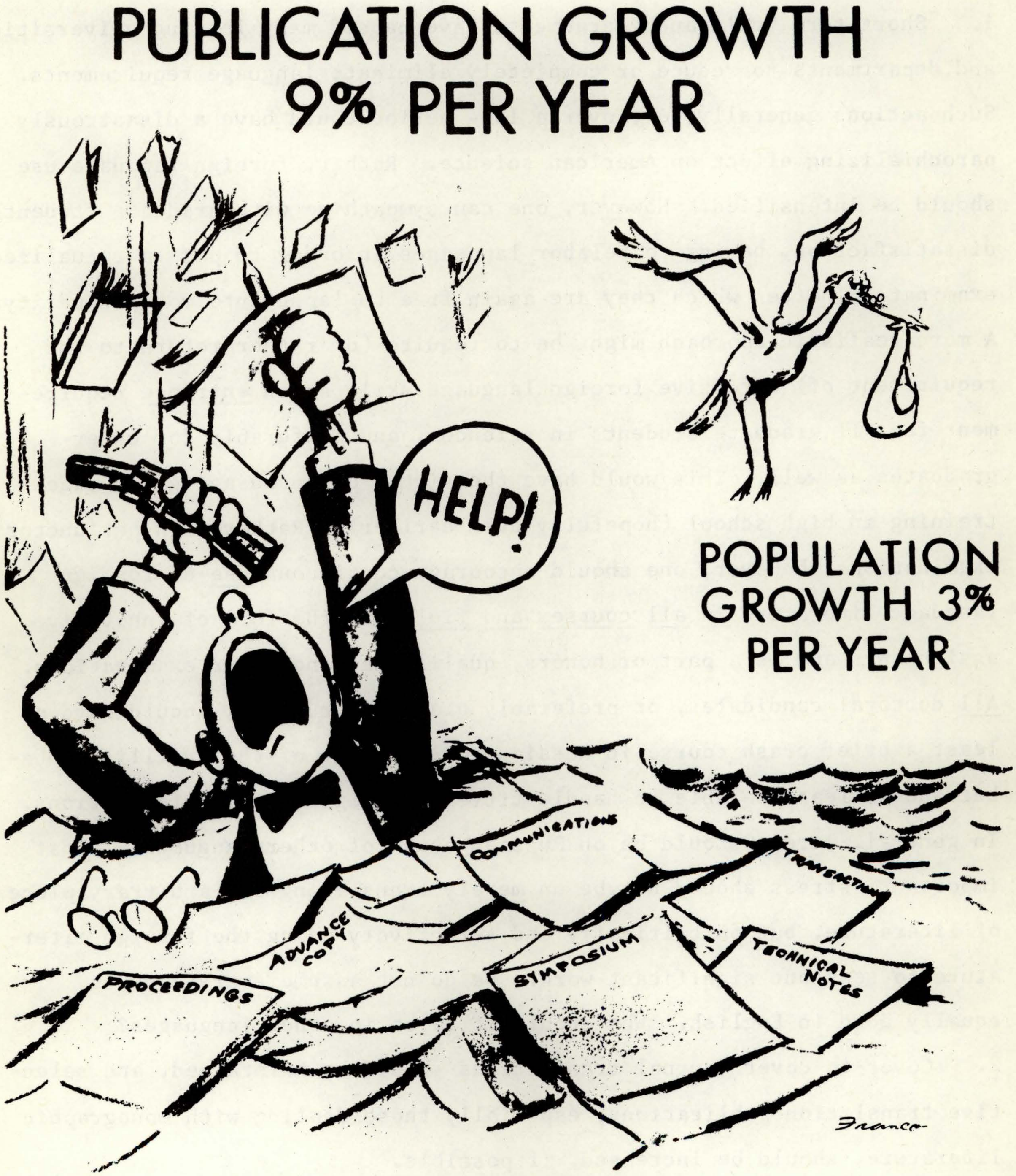

Figure 1. From Juhasz and Amminger, 1966 in Applied Mechanics Review.

Geochemical Society, particularly E. Ingerson, University of Texas, Austin and J. W. Clarke of the U.S. Geological Survey, Washington.

RECOMMENDATIONS

1. Short-term "relevance" arguments have caused many leading universities and departments to reduce or completely eliminate language requirements. Such actions generally, or, over a long period could have a disastrously parochializing effect on American science. Rather, foreign language use should be intensified. However, one can sympathize with graduate students' dissatisfaction, having to belabor languages in order to pass a ritualized examination, after which they are again free to lapse into monolinguality. A more realistic approach might be to require (or rather return to the requirement of) effective foreign language skill as an <u>entrance</u> requirement for all graduate students in sciences, and preferably for undergraduates as well. This would have the virtue of encouraging language training in high school (hopefully even earlier). Rather than perfunctory examinations, however, one should encourage continuous <u>use</u> of foreign language literature <u>in all courses and fields</u> in the form of innovative assignments and as a part of honors, qualifying, and other examinations. <u>All</u> doctoral candidates, or preferably graduate students, should have at least a brief crash course in Russian to lose fear of the Cyrillic alphabet and at least be able to handle titles and figure and table captions. In general, stress should be on Russian ahead of other languages. Most important, stress should not be on merely translating any arbitrary piece of literature, but on critically and selectively using the foreign literature to seek out significant work. We do not assume everything is equally good in English. Why should it be so in other languages?

2. Cover-to-cover journal translations should be maintained, and selective translation publications, especially those dealing with monographic literature, should be increased, if possible.

3. Critical reviews of foreign literature are badly needed, but are most effective as parts of a general review. When foreign work is reviewed separately, lack of a familiar frame of reference tends to render

the treatment rather distant and less "pertinent".

4. More cooperation among earth science libraries with regard to selective archiving of foreign and especially Russian institutional publications could reduce costs, space problems, and improve coverage. A great help would be wider ability to loan such material than is now possible.

5. As of 1972, there exists no comprehensive earth science abstracting service in English. I believe such a resource is crucial at a time when libraries cannot maintain reasonably complete archives, even within specialties. Indexing lists are good, but not good enough, for one need only observe that most researchers either cannot or will not loan or purchase reproductions of most titles in their speciality that appear in index lists. Probably even the most carefully tailored "profiling" service (Schneider, 1971) will not be able to deliver to scientists the time necessary to cope with the mass of material that could be pertinent, based on title alone. One needs the first-stage culling device, source of preliminary data, and the creative browsing aid that a good abstracting service provides. More flexible abstracting, including even illustrations, would upgrade interest for this service. However organized, broad-based, internationally inclusive abstracting should be resumed as soon as possible. A partial Federal subsidy to encourage and help facilitate continuing maintenance of adequate abstracting in all major scientific fields is a perhaps legislatively difficult but long overdue step.

WORLD EARTH SCIENCE LITERATURE PRODUCTION

Few assessments of the distribution of world geological literature and its use appear to be available. One of the most significant of these, based on Referativny Zhurnal (the Russian abstracting service), used the intriguing assumption that titles listed under the letters "Pe-Pf" form the same proportion of total names (about 1.1 percent) for all major non-oriental languages (Hawkes, 1966). Using this sampling technique for 340 geology titles in 1961, Hawkes' survey arrived at the then startling conclusion that Russian language works exceeded all English language publications by 30 to 27 percent respectively, of world geology papers, excluding oriental-language titles (Table 1). An even more pronounced Russian dominance was reported by Yaalon (1966) for earth chemistry papers (Table 2) cited in Chemical Abstracts. The table revealed that the Russians, closely followed by Australians and Czechs, also led strongly in earth chemistry papers per million population (1959-61 and 1963-65).

As may be seen in Table 3, a recheck of 1969 literature based both on the Bibliography and Index of Geology and Referativny Zhurnal (Geologiya) shows not only that the earlier indications are right, but the Russians have increased their lead in papers since 1961. A comparison of the 1969 data, using both Hawkes' "Pe-Pf" technique and more extensive samplings, shows that, whereas Bibliography and Index of Geology reported slightly more English-language items and larger numbers of French, German, Japanese, and Portuguese works than R. Zh., it missed two thirds of Russian and Slavic titles reported by R. Zh. Though not surveyed for this paper, the French Bulletin Signaletique and Bibliographie des Services de la Terre are, according to Craig (1969) close to R. Zh. in comprehensiveness of coverage.

The total number of citations from R. Zh. increased from 32,000 in 1963 (Hawkes, 1964) to 40,059 in 1969. According to E. E. Zakharov, editor of Refernativny Zhurnal (Geologiya) (Zakharcv and Krustal'nyi, 1969), R. Zh (Geologiya) covers between 60 and 70 percent of the total world geological literature, estimated at 30,000, 45,000, and 60,000 items (for 1955, 1963, and 1969, respectively). Although Bibliography and Index is relatively new and still behind the other services in coverage, it moved up sharply from 25,000 items (exclusive of isolated abstracts and translations) in 1969 to about 32,000 in 1970. Examination of the Bibliography suggests that gaps are particularly pronounced for Russian monographs, sborniks (collected paper volumes) and institutional publications. These categories formed 67 percent of Russian output in 1961, as contrasted with only 30 percent of Western European production (Table 1c).

A measure of the comprehensiveness of Referativny Zhurnal which may yield indirect insight for earth science applications is available from a study of comparative coverage of the world physics literature by four major indexing services, as summarized by Tybulewicz (1969) (Table 4). The

TABLE 1

SURVEY OF NON-ORIENTAL WORLD EARTH SCIENCE DATA
(from HAWKES, 1966)

(a) 1961 GEOLOGIC-GEOPHYSICS LITERATURE (PERCENT OF NON-ORIENTAL)

RUSSIAN	30	BULGARIAN	1
ENGLISH	27	UKRAINIAN	1
FRENCH	11	PORTUGUESE	1
GERMAN	11	SPANISH	1
CZECH	5	HUNGARIAN	1
ITALIAN	4	SERBO-CROAT	1
ROMANIAN	3	OTHER	3

(b) SOURCE AREAS, GEOLOGICAL LITERATURE, 1961

NORTH AMERICA	18
WESTERN EUROPE	33
USSR	31
EASTERN EUROPE	14
OTHER	4

(c) PRINCIPAL TYPES OF PUBLICATION MEDIA IN 1961 EARTH SCIENCE LITERATURE

	NORTH AM.	W. EUROPE	USSR	E. EUROPE
PERIODICALS	55%	70%	33%	70%
PUBLICATIONS OF RESEARCH CENTERS, GOVT., ETC.	30	15	35	17
SYMPOSIA AND PROC. OF CONFERENCES	12	11	23	13
TEXTS & REFERENCES	3	4	9	0 (!)

TABLE 2

EARTH CHEMISTRY ARTICLES ABSTRACTED IN CHEMICAL ABSTRACTS
(From Yaalon, 1966)

	Percentage of Papers 1963-65	Papers/mill. Population 1959-61	1963-65
USSR	45.4	7.4	12.0
USA	16.5	3.7	5.3
GERMAN (W & E)	4.5	3.2	3.6
JAPAN	4.3	1.7	2.7
FRANCE	3.8	2.8	5.0
BRITAIN	2.6	2.3	2.9
CZECHOSLOVAKIA	2.6	6.5	10.2
AUSTRALIA	2.0	8.2	11.4
CANADA	1.7	5.4	5.8
INDIA	2.2	--	0.3
TOTAL WORLD PAPERS	5,470	1.5	2.0

Table 3. Language of geologic literature, in percentage of total, and in approximate absolute numbers (parentheses) calculated from sample distribution and total number of citations. Column 1 data are from Hawkes, 1966, using the "Pe-Pf" method mentioned in the text. Column 2 uses the "Pe-Pf" method for citations in Bibliography and Index of Geology for 1969. Column 3 uses a 10 percent sampling (every tenth page) from Bibliography and Index. Column 4 employs sampling of every fifth page in Referativny Zhurnal, Geologiya, 1969, Nos. 7-9.

Language	1. 1961 "Pe-Pf" method Ref. Zhurnal	2. 1969 "Pe-Pf" method Bibl. & Index	3. 1969 10 percent of sample Bibl. & Index	4. 1969 Ref. Zh. Geologiya
Russian	30	25	24(5,950)	57(22,800)
English	27	33	45(11,300)	26(10,400)
French	11	14	11(2,750)	5.2(2,080)
German	11	10	8.5(2,120)	4.5(1,800)
Polish	-	1	.7(180)	2.2(880)
Italian	4	3	1.3(320)	1.6(630)
Ukrainian	1.5	.5	.6	1.2
Spanish	.9	2	1.6	.9
Japanese	-	-	2.4	.8
Romanian	2.3	3	1.0	.5
Portuguese	.9	5	2.4	.4
Hungarian	.6	-	.1	.4
Serbo-Croatian	.6	1	.04	.3
Bulgarian	1.5	-	.04	.2
Finnish	1-	-	.04	.2
Swedish	-	1	.3	-
"Other"[1]	3[1]	-	.4	.3
No. in sample	340	217	2490	1327
Total citations (less unattached abstracts and translations)	-	25,000	25,000	40,000

[1] Danish, Georgian, Norwegian, Estonian, Azerbaidjanian, Flemish; Czech 0.5, 0.5, and 0.04 percent for column 1-3, respectively.

Table 4. Distribution of citations among major languages in three physics abstracting services for 1964. Percentage data are calculated from a figure in Tybulewicz, 1969. Bulletin Signaletique is excluded because it incorporates some mathematical and other subjects.

	Refer. Zh. Fizika	Physics Abstracts	Physikalische Berichte
English	59	67	67
Russian	19	17	14
German	7.2	6.7	9.6
French	6.1	6.4	6.2
Other	7.8	2.9	2.5
Total Abstracts	39,141	31,000	25,093

comparison reveals that *Referativny Zhurnal* contains about 13 percent less English language materials and about 10 percent more Russian citations than *Physics Abstract*, taken as a percentage of total coverage. This difference is not due to significant omissions of western titles, however, for *R. Zh.* actually cites substantially more English language items than *Physics Abstracts* and more German ones than *Physikalische Berichte*.

The proportion of Russian publications in other fields (Table 5), compared with their showing in geology indicates that the Soviet Union probably puts relatively more effort into earth sciences than any other area. The preponderance of Russian works is the more striking when one takes into account the fact that many western European countries publish a large part of their science papers in English, as do major Asian countries except Communist China, as well as many countries that are beginnig to develop an indigenous scientific activity. Some eastern European countries, especially Poland, Hungary, and Czechoslovakia, publish as much as 50 percent of their earth science papers in English.

An approximate breakdown of English language publication in geology by country of origin (from *R. Zh.*, 1969) shows the United States leading with 32 percent, followed by the United Kingdom, international congress publications, and international journals published in Holland and England, each at between 12 and 14 percent. Then follow Australia, India, and eastern Europe each at 5 percent, and Canada at 4 percent. Other sources contribute 10 percent.

In conclusion, even if we adjust the proportion of Russian earth science literature downward from the *Ref. Zh.* estimate (Table 3), say to 50 percent, and raise English language publications to 30 percent, the Soviet Union still comes close to outproducing the rest of the world combined and exceeds the United States in publications by more than a four to one margin.

The reason for Soviet emphasis on earth science partly relates to its importance as an essential tool to develop natural resources and national power. In 1946 the Chief Administration of Geology and Prospecting of the USSR became the All-Union Ministry of Geology and Mineral Resources. To my knowledge, the Soviet Union is the only country which has thus dignified a science by a titled place at the ministry level. Russian strength in earth sciences also has roots in outstanding Russian scientists who established their reputations before the October Revolution (1917), many of whom also played important roles after it. This group includes such men as V. A. Obruchev, A. P. Karpinskii, F. N. Chernyshey, N. I. Andrusov, I. M. Gubkin, Ye. S. Fedorov, and V. I. Vernadskii.

Table 5. Language breakdown for major English-language abstracting and indexing publications in 1965. From Tybulewicz (1969). Data in percent.

	Physics Abstracts	Chemical Abstracts	Biological Abstracts	Engineer. Index	Index Medicus	Mathem. Reviews
English	73	50	75	82	51	55
Russian	17	23	10	3.9	5.6	21
German	4.0	6.4	3.0	8.6	17	8.7
French	4.0	7.3	3.0	2.4	8.6	7.8
Japanese	.5	3.6	1.0	.1	.9	.7
Chinese	.1	.5	1.0	.0	.4	.2
Others	1.4	8.5	7.0	2.7	16.1	6.4

AVAILABILITY OF TRANSLATIONS AND FOREIGN LITERATURE

Journals

World War II disrupted most, though not all basic science activity in the European conflict area. As a result of the war, Germany was toppled from its eminent positions in earth science and especially chemistry and physics. French science, though not so depleted by casualties and emigration as the German, was not reestablished nearly so quickly and aggressively as the Russian. However, prior to the death of Stalin in 1953 Russian literature was not always easy to obtain in the United States, and personal and correspondence contacts were few. Many libraries have gaps in their coverage from 1940 to 1953.

The first cover-to-cover translation of a Soviet journal, Zhurnal obschei khimii (J. General Chemistry) was already published in 1949, by Earl Coleman, founder of Consultants Bureau, Inc., now a division of Plenum Press. Coleman's firm has continued to be active in translation activities in the United States, including earth sciences. Following a pattern first elaborated by Robert Maxwell of Pergamon Press (Oxford), Consultants Bureau and Plenum pursued a new marketing and pricing strategy for books, based on institutions rather than individual scientists.

As may be seen in figure 2, however, it was not until the flight of Sputnik in 1957 that major interest in foreign, chiefly Russian literature arose. A considerable part of the pre-1957 "tail" in figure 2 is due to translations of earlier volumes of Russian journals after the dramatic demonstration of Soviet technological ability in space. This was the time of somewhat panicky concern about Soviet capability: "What does Ivan know that Johnny doesn't"?

The National Science Foundation has played an important role in sponsoring and subsidizing translation efforts, under the basic policy of stimulating ultimately self-supporting activities. Many of the items incorporated in the dashed curve on the left side of figure 2 represent journals that were dropped from NSF sponsorship but that were taken up by new (for example, professional society or private) agencies.

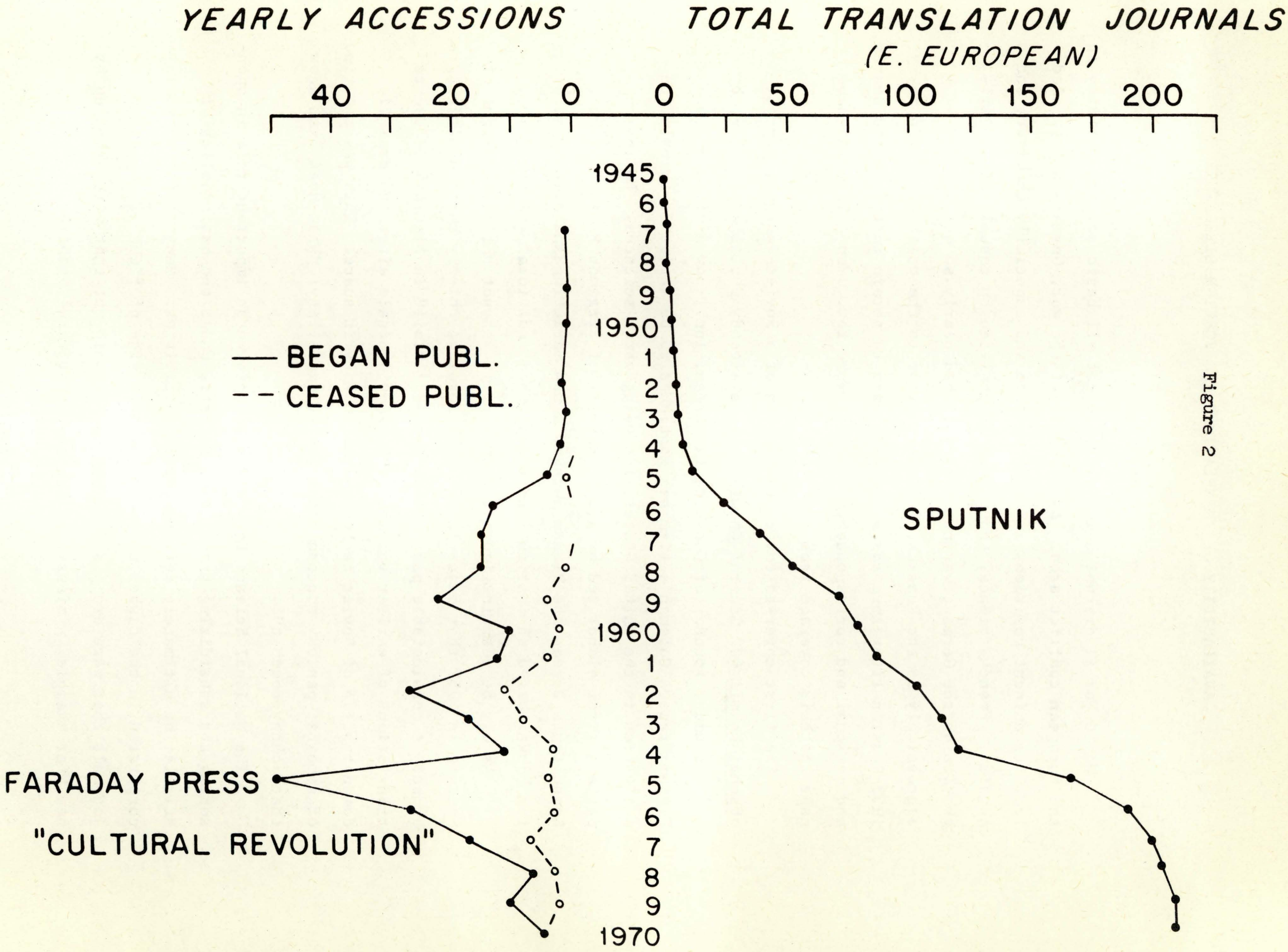
YEARLY ACCESSIONS
TOTAL TRANSLATION JOURNALS
(E. EUROPEAN)
40
20
0
0
50
100
150
200
1945
6
7
8
9
1950
1
2
3
4
5
6
7
8
9
1960
1
2
3
4
5
6
7
8
9
1970
BEGAN PUBL.
CEASED PUBL.
SPUTNIK
FARADAY PRESS
"CULTURAL REVOLUTION"

Figure 2

Although the Pergamon Institute (United Kingdom) under Robert Maxwell launched an ambitious effort at exploring the Soviet literature in 1957-58, most journal translation efforts remained in the United States, sponsored by the National Science Foundation, the professional societies, and private publishers. For the earth sciences, chief agents were the American Geological Institute, the American Geophysical Union, Consultants Bureau Inc., Associated Technical Services, and Scripta Technica. The strong accessions peak in figure 2 for 1965 marks the entry of another major private firm into the market, Faraday Press. This firm publishes no earth science literature, however.

The presently available earth sciences journals (Table 6) cover many major subjects. They are, however, expensive to produce and more costly than corresponding English language publications. Interestingly, although all translated journals are now or soon will be self-supporting (or will cease to exist), nearly half of subscribers to many of the journals are said to be foreign institutions - - many from countries whose governments subsidize translations on a large scale, (for example, Canada and France).

From figure 2 one concludes that a plateau has been reached in total journal translation. For the earth sciences the plateau is already below the peak,[1] but even constant levels would mean declining coverage as a percentage of the whole Russian literature, which continues to expand each year. The National Science Foundation has indicated it will drop support for cover-to-cover translations as of 1971-2. Therefore, any new accessions will be solely under private sponsorship. The archiving crisis that many libraries are experiencing forms a potential barrier in the way of renewed translation-journal growth. Moreover, a threat to maintenance of even present levels of translation is present in the documented decline in United States interest in foreign literature, based on several lines of evidence. (See later)

1/ Defunct translations journals include Izvestiya Akad. Nauk, (Ser. Geol.); Izyestiya Akad. Nauk, (Ser. Geofiz.); Geokhimiya, Acta geologica sinica; Geologiya rudnykh mestorozhdenii; Meteoritica; Soviet Geology (Sovetskaya geologiya).

TABLE 6

EARTH SCIENCE JOURNALS IN TRANSLATION

(S) refers to journals publishing selectively. Others are cover-to-cover. Addresses of sponsoring organizations are listed in Addendum III.

Current

AMERICAN GEOPHYSICAL UNION

Byull. Soviet. Antarkt. Exped.
Geodeziya i aerofots'emka
Geomagnetizm i aeronomiya
Geotektonika i aeronomiya
Izvestiya Akad. Nauk, fizika atmosfer i okeana fizika zemli (Physics of earth)
Okeanologiya
Sovetskaya gidrologiya (S)

SOIL SCIENCE SOC. AMERICA

Pochvovedeniya (soil science)

BRGM (BUREAU DE RECHERCHE GEOLOGIQUE DE MINIERE)

Razvedka i okhrana nedr (Prospecting and conservation of natural resources)

DEEP SEA RESEARCH

(Ed. M. Sears); Abstracts and occasional whole articles translated from Russian

ECONOMIC GEOLOGY:

Occasional extracts and reviews of Russian geologica literature; at a low level since the death of C. F. Davidson.

AMERICAN GEOLOGICAL INSTITUTE

Doklady Akad. Nauk, (Earth Sci. sections)
Paleontologicheskii Zhurnal
International Geol. Review (S)
Geochemistry International (S)

PLENUM PUBLISHING CORP.

Prikladnaya geofizika (Applied Geophysics)
Litologiya i poleznaya iskopaemy (Lithology and Economic Deposits)
Geomorfologiya

J. W. CLARKE, PUBLISHER

Geologiya nefti (Petroleum Geology)

NATIONAL TECHNICAL INFORMATION SERVICE
NATIONAL SCIENCE FOUNDATION

Vestnik zavida za geoloska i geofizika istrazivanja (Bull. Inst. Geol. and Geophysical Research, Yugoslavia): Ser. A. geology; Ser. B., eng. geol. and hydrology; Ser. C geophysics

Book translations

Soviet monographic literature is far less well known in the United States and among Western scientists generally than journal literature (Manheim, 1966). Part of the reason is the fact that, unlike periodicals, book output is not regular and predictable, and most monographs cannot be acquired via the regular journal exchanges, which are common between major repositories in the United States and the Soviet Union. They can be obtained by advance order from the weekly accessions list, Novye Knigi (regularly published in translation in International Geology Review). More widely distributed books can be purchased from stocks arriving at a few booksellers in the United States, primarily Victor Kamkin, Inc., and Four Continent Book Corp. A small but dedicated group of earth scientists, including E. Ingerson, R. Fairbridge, F. Whitmore, P. Witherspoon, H. Hawkes and others were responsible for many of the earlier initiatives to promote communication of Russian monographic literature.

The list of about 100 Russian monographs in translation (Appendix II), while not exhaustive, includes most of the items readily available commercially and a few that are out of print. Regrettably, many of the items in the list are short works that carry a very high price and too often bear titles that promise more than the volumes deliver in authoritative results. Length alone is not a reliable criterion of usefulness, of course. For example, most of the 250 or so new or revised mineral classifications or names in Crystal chemical classification of minerals, by A. S. Povarennykh (1969, Plenum, 611 p.) have been rejected by both the Soviet and International commissions on mineral nomenclature (M. Fleischer, oral communication, 1971). Translation of such a work may do more harm than good, if an unnecessary element of confusion is added to an already staggering literature burden.

On the other hand, many fine works have been translated. Among them, The Vinogradov classic, Elementary chemical composition of marine organisms (1953) is still widely used today, though parts of it already appeared before World War II; the other Vinogradov volumes also contain distinguished contributions. The Vlasov and others (1966) volume on the

Lovozero Alkaline Massiv, the geological microbiology text by Kuznetsov and others (1963), and the Beloussov text on geotectonics (1962) yield important data and concepts previously unavailable in English at reasonable prices. The three-volume set by lithologist N. M. Strakhov (1696-71) is the first English-language edition of any book by the man who has authored or edited an astonishing proportion of the best Soviet work on sediments and sedimentary rocks. Through the efforts of the Book Translation Committee of the Geochemical Society, a 40-year-old text by one of the pioneers of geochemistry, V. I. Vernadskii, will soon be made accessible for the first time to English-speaking scientists.

A new group of Russian monographs, especially geochemical-mineralogic-petrographic in nature, became available in the course of the 1960's through the National Science Foundation's Public Law 480 program. This program subsidizes translations through soft currency reserves in countries that have received United States foreign-aid credits. So far, the Israel Program for Scientific Translations (IPST) has provided virtually all the translated monographs resulting from commissions by U.S. Government agencies, but I understand that funds within Israel have been virtually exhausted. Whether IPST will continue translation without subsidy remains to be seen. Soft currency reserves remain in Poland, Yugoslavia, and Egypt, but these countries have not been eager or able to turn their energies to Russian translation. Some possibilities are being explored in Pakistan and India.

Soviet books form a much larger part of the Soviet earth science literature than periodicals (Table 1), but the total number of "books" or "monographs" that appears yearly is rather hard to define. This is largely due to the difficulty in defining the status of sborniks, or volumes of collected papers on given subjects (a bread-and-butter mode of publication for most Soviet scientists). For example, <u>Redkiye elementy v. osadochnykh i metamorficheskikh porodakh</u> (Trace elements in sedimentary and metamorphic rocks) edited by K. A. Vlasov (1964, Nauka Press, Moscow) runs to 201 pages and contains nine articles. It is listed as being published under the aegis of the <u>Institut mineralogii, geokhimii i</u>

kristalokhimii redkikh elementov, but there is no serial number and hence the volume can easily be classified as a free-standing book. Somewhat more difficult is Sovremennye dvizheniya zemnoi kory (Recent movements in Earth's Crust), edited by I. P. Gerasimov (1963; Izdat. Akad. Nauk, SSSR, Moscow[1]), which contains 40 articles and 383 pages. It is listed as Sbornik No. 1, Rezultaty issled. po mezhdunarodnym geofiz. proektam (Results of researchs of the International Geophysical Projects) of the Soviet Geophysical Committee, Acad. Science of the USSR. Still more akin to serial publications is Istoriya geologo-geograficheskikh nauk (History of the geological-geographic sciences) edited by N. A. Figurovskii (1959; Izdat. Akad. Nauk, SSSR), v. 27, Trudy Inst. istorii estestvoznaniya i tekhniki (Trudy of the Institute of History of Science and Technology), 364 p. and 18 articles. Depending on definition, therefore, from 2,000 to more than 4,000 books appeared in the 1969 Referativny Zhurnal:Geologiya categories; the estimate excludes soil science, many aspects of geophysics, geography, oceanography, and other fields that are sometimes classed with earth science. It also excludes "tezisy doklad.", or conferences and proceedings in the form of many short summaries of papers. These summaries often run from two to three pages and may include figures and tables. Though the articles are often of purely local interest, trivial, or poorly documented, these volumes cover a large variety of aspects of a given theme and thus provide an excellent view of what is being done in a given subject. Young Russian scientists frequently get their first travel and publications exposure through such conferences. This type of publication is a good example of material not usually worth translation, but often very useful for title and figure scanning to ascertain where and by whom significant work is being done in a given field. Correspondence directed to individuals and institutions in such volumes may, with luck, elicit reprints and books very hard to obtain otherwise.

Even under the most favorable definitions, the proportion of Soviet books that has been translated each year is under 0.5 percent and does not

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1/ Izdatel'stvo Akademii Nauk, SSSR (Publishing House of the Acad. of Sciences of the USSR) is the previous title of the present "Nauka" Press, which is the official publishing organ of the Academy, with main branches in Moscow and Leningrad.

convey more than a very minor part of Soviet work potentially useful to Western scientists. Other implications of this tremendous communications gap are discussed later.

A selected list of translations from languages other than Russian (Appendix II) is mainly confined to French and German standard texts. These frequently represent labors of love by linguistically competent earth scientists of note, such as Albert Carozzi. In other cases internationally oriented firms commission English translations of the foreign language books, to be issued simultaneously or shortly after the original work. Few translations from Japanese have appeared, but many Japanese books have been written in English, as have books of other Asian countries. Output of books from Communist China seems to have been curtailed together with the virtual cessation of scholarly scientific periodicals since the Cultural Revolution. Only one layman's scientific journal has apparently reappeared as of this writing.

Translation clearing houses and archives:

A large number of individual articles and other translations is archived by two main agencies in the United States:

NTIS: (National Technical Information Service), successor to the CFSTI (Clearinghouse for Federal Scientific and Technical Information).

NTC: National Translations Center (Formerly Special Libraries Association Translation Center), John Crerar Library, Chicago.

These organizations make available reproductions of translations provided from both governmental and private sources. NTIS is the main repository of translations performed under Public Law 480 (soft currencies available in Israel, Egypt, Poland), which includes a number of books recommended by various government agencies. It also publishes the bimonthly U. S. Government Research and Developments Reports, which announces all translations, mainly from Russian and (formerly) Chinese sources. These are not, however, identified in a separate index.

NTC is the main repository of translations from all sources and maintains both author and subject index files on translations available in house, as well as some available from government and private organizations. From 1959 through 1966 NTIS and NTC jointly listed their holdings in Technical Translations issued by the latter. This ceased in January 1967, but all listings as well as translations extending back to the 19th century are incorporated in the volume, CITE (Consolidated Index of Translation into English). This volume, priced at $19.50 and encompassing some 142,000 items, is available from the Special Libraries Association. The NTC now publishes the Translations Register-Index, which lists some 300 new accessions each 2 weeks (subscription cost: $50 per year).

Abroad, translation and archiving functions are performed by many State agencies such as the Government of Canada through the National Research Council, Translations Section, the National Lending Library for Science and Technology of the United Kingdom, and similar organizations in other countries. (See below)

Two especially active groups dealing in part with earth science materials are the European Translation Centre, Delft, Holland, which has compiled a catalog of translated texts and issues a monthly accession list, as well as maintaining a file of translators, and Euratom, Centre for Information and Documentation. The latter organization publishes TRANSATOM Bulletin, available at $15 per year. Among the services provided by the Bulletin are lists of current translations from Russian, Serbo-Croatian, Polish, Czech, Hungarian, Romanian, Bulgarian, Chinese, and Japanese (prices varying from 10 to 27 Deutschmark per page of photocopied translation), indexes and up-to-date lists of cover-to-cover translated journals. The editor of Transatom, L. Kossovich, has made a valiant effort to ferret out even the most minor sources of translations in the world, and has listed them in the Bulletin. Though this effort has entrained some possibly unhelpful or defunct organizations in its net (for example, Office of Admissions and Records, University of Colorado, Regent Hall 12, Boulder, Colo., 80302; and Office of Scientific Research, Baltimore, Md. (sic) it appears to be the most detailed listing available.

As members of this symposium are clearly aware, an active role in translations is being played by the American Geophysical Union, the American Geological Institute and the Geological Society of America. Critical archival functions for earth science literature are performed by the Library of the U. S. Geological Survey, Washington, D. C., which has the most complete collection of earth-science literature in the United States. If all else fails, microfilms of original Russian materials can usually be obtained from the Publichnaya biblioteka, International Exchange Section (see Appendix III), Leningrad, USSR. In lieu of payment, copies or microfilms of American materials will usually be requested.

Abstracting - Indexing Services

The U. S. Geological Survey has decided to close out its Bibliography and Abstracts of Geology-Exclusive of North America and Abstracts of North American Geology, as well as Geophysical Abstracts, as of the end of 1971. This will leave English speaking readers with no broad abstracting service whatever for most of the field of earth science. American and English scientists may soon be in the strange position of needing to rely on foreign-language abstracting services to quickly review or research their own literature without consulting original sources!

Remaining English-language services will be the title listing and indexing services, Bibliography and Index of Geology, and Geotitles Weekly. The former, successor to the Geological Survey services mentioned above, is now handled by the Geological Society of America, in cooperation with the American Geological Institute. The latter is a publication of GeoServices, a British firm, which also issues Geocom Bulletin, a monthly newsletter reporting new ideas and developments in geoscience methodology, and Geoscience Documentation, a bi-monthly journal. A new service announced for 1972 is Bibliography and Index of Micropaleontology.

USE OF FOREIGN LITERATURE BY AMERICAN EARTH SCIENTISTS

The rise of cover-to-cover translation journals in itself is a tacit admission that the modern American scientist is a linguistic illiterate -- at least insofar as Russian is concerned. This is more or less true of most native English-speaking scientists. From a poll of 30 geologists in three Scottish Universities, for example, Craig (1969(estimated that only 3 percent of papers read were in languages other than English. A British government commission in the late 1950's (Todd, 1957) arrived at the conclusion that less than 2 percent of U. K. scientists read Russian, and similar figures were indicated for the United States.

After Sputnik, a rise in linguistic competence occurred to the extent that about 5 percent of the 215,000 scientists reporting to the National Register in 1962 indicated some reading knowledge of Russian, compared with 48 percent of the registrants who cited German and 39 percent who cited French ability (Gingold, 1964). For 1970, earth scientists who filled questionnaires included 4 percent listing some reading competence in Russian, while 35-36 percent listed French, German, and Spanish. On the basis of informal polls and inquiries, I estimate that 2 percent of earth scientists in the United States is a realistic upper limit for the proportion of those who have reading ability in Russian and use it to any extent. This situation is a rather extreme example of the inward orientation, which is characteristic of countries that have reached a scientific "critical mass", that is, they can conduct at least passable scientific-technical training and research in a major field without consulting foreign works. Languages encompassed in this group are English, Russian, French, German, and in the near future, probably Japanese.

One measure of inward orientation in leading scientific countries was provided in a study of citations in major geology journals (Emery and Martin, 1961) (Table 7). Leading the provinciality parade in this selection are the Russians with 85 percent Russian works cited, followed by Americans, with 70 percent national citations. However, the best and most authoritative Russian papers often demonstrate a far better command of Western literature than their American and Western counterparts do with

PERCENTAGE DISTRIBUTION OF REFERENCES

COUNTRY	RUSS.	AMER.	GERMAN	FRENCH	BRIT.	JAP.	MISC.
USSR	85	3.7	3.5	.4	1.2	.4	3.4
USA	.4	70	3.6	2.1	7.1	.2	16.2
GERMANY	.0	4.7	65	4.7	3.2	.8	21.5
FRANCE	1.4	10	8.2	64.3	6.3	.2	9.5
UK	1.4	25	5.2	2.3	47	.2	18.7
JAPAN	3.0	19	11	3.0	4.7	42	17.4

TABLE 7. Citation of references by country of origin, for leading earth science journals of major scientific countries. (Emery and Martin, 1961) Periodicals utilized and number of citations are:

USSR: Izvestiya Akad. Nauk. SSSR (Ser. Geol.) (1554)

USA: Bull. Geological Soc. America (2470)

GERMANY: Geologische Rundschau (404)

BRITAIN: Quarterly Jour., Geol. Soc. London (661)

FRANCE: Bulletin Societe geologique de France (1646)

JAPAN: Japanese Jour. Geol. and Geography (574)

All refer to the complete volumes for 1959.

regard to foreign literature.

Citations in journal articles undoubtedly exaggerate the extent to which foreign works have actually been studied or even seen, for many scientists cite references from review papers and other secondary sources. Sometimes mistakes in citations of works from relatively obscure sources provide tracers to follow the citation route embarrassingly far. One widely travelled example is the study of Baltic Sea sediments by the late Finnish oceanographer, Stina Gripenberg (1934). At least a dozen papers, both Russian and English, show their lineal descent from an earlier citation which misspelled the author's name as "Grippenberg".

Another case involves the distinguished Russian author, "K. Poznaniyu", who studied early diagenesis in recent sediments. This mythical author turns out to be the title of a book, "<u>K poznaniyu diageneza</u>" (Toward understanding diagenesis), edited by Academician N. M. Strakhov in 1959.

The weak language competence of American scientists and the grossly disproportionate focus of present language training on Spanish, German, and French, rather than Russian, has already been noted (for example, Hawkes, 1966). However, even existing linguistic skill levels are now threatened by a decline in language interest in universities since 1965, at least among some highly-rated departments. For example, Yale, M.I.T., Northwestern, University of Washington, State University of New York, Stoneybrook campus, University of California at San Diego (Scripps), and the Calif. Inst. Technology have eliminated departmental as well as university-wide language requirements for the PhD in earth sciences. Harvard, on the other hand, still retains two foreign languages as its departmental requirement for the PhD, pursuant to recent faculty-student votes. (F. McCoy, oral communication, 1972). Though most schools have not yet abandoned language requirements, a model for the stepwise transition to linguistic purity (that is, monolinguality) has already emerged:

1) Elimination of university-wide language requirements, but retention of foreign language(s) as a departmental requirement.

2) Elimination of foreign language as a requirement for the bachelor or master's degree, but retention of departmental requirements for the PhD. Reduction of PhD requirements from two foreign languages to one,

sometimes with the stated intent to promote greater proficiency in the remaining language.

3) Substitution of computer language, special courses or skills for the remaining language as an option.

4) Final elimination of general foreign language requirements, with or without encouragement toward voluntary acquisition of language skills and (or) mention of possible requirements "if appropriate for the particular field of study".

Whether or not the no-language trend should be construed as evidence for the encroachment of barbarism from the top, continuation of the trend cannot fail to add impetus to the already strong drift toward scientific provincialism. This is because the "name" schools train a disproportionately large number of the leaders in earth science departments in American universities. As one can observe in the case of Russian, language-incompetent faculty have little basis and incentive to encourage foreign literature acquisitions by their libraries or to introduce students to works in languages other than English, thus perpetuating the cycle of ignorance. Equally important, high school students may lose their major current incentive to study languages: language requirements for entrance to good colleges or need for languages to complete future degree programs.

So far, only relative numbers of publications have been discussed, not their quality or potential importance to western scientists. Questions to Anglo-American earth scientists about foreign, especially Russian, literature often elicit such viewpoints as "I can't even keep up with English, let alone foreign literature". It may appear better to keep up with only a small segment of informational media than expose oneself to the frustration of desultorily or arbitrarily sampling a tiny fraction of a larger mass. A substantial group views Russian literature as either not pertinent to their interests, or of too low quality to justify efforts in retrieval. The high cost/content ratio of book translations by some firms has further given many scientists a prejudice against translations generally. The hands-off attitude is frequently justified by the belief or statement that if foreign work is important someone will sooner or later find it and present it in review. Additional comments are offered in a Geotimes survey of 45 college departments (Anonymous, 1965).

It seems undeniable that much Soviet literature is grossly overspecialized and has clearly not been exposed to those critical processes of selection and editing that could weed out duplication, verbosity, and trivia and demand documentation and effective presentation. This is particularly true of the monograph literature. The weak critical interaction between many Soviet publishing organs and the scientific public is exemplified by the virtual absence of reader conveniences, such as indexes in books and the fact that book runs are calculated to fit the immediate audience only. Thereafter, good books generally go out of print and are unavailable for purchase. However, a critical examination of our own system offers little justification for complacent dismissal of Soviet or other foreign literature.

As British physicist Ziman (1968) points out, "An American graduate school gives a professional polish to the language and techniques of research . . . the American scholar, however clever or stupid he may be, is not ignorant of his subject . . . on the other hand, many American PhDs, in spite of the rigor of their formal training, do not acquire a critical attitude towards their own and other people's work". Further, Ziman cites the "cult of progress" in the United States, which tends to exaggerate the natural swing of scientific interest by "undiscriminating acceptance and too rapid incorporation into the canon of graduate school curriculum" of "half-baked and speculative notions", even though these may have been arrived at by the latest and most elegant methods.

These factors and publication pressure may tend to make harried American researchers give unduly short shrift to foreign publications, especially those which lack stylistic or methodological elegance, familiar frames of reference, or proper homage to hot topics or fashionable concepts and authors[1]. To paraphrase a comment by my colleague, J. W. Clarke, in

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1/ There is nothing new about this: "The effect which lectures produce on a hearer depends on his habits; for we demand the language we are accustomed to, and that which is different from this seems unintelligible and foreign . . . . Thus some people do not listen to a speaker unless he speaks mathematically; others unless he gives examples, while others expect him to cite a poet as authority" (Aristotle, Metaphysica, Book A, in W. D. Ross (Ed.) Works of Aristotle, Oxford Press (1926), p. 994).

Russian publications there may be more than meets the eye, whereas in American ones there may be less. Likewise, the argument that the English language literature is big enough without worrying about foreign publications, leads to the untenable conclusion that the worst English paper is more meaningful than the best Russian or French one.[1]

With their massive efforts along broad fronts of science, able Soviet scientists and groups must inevitably produce significant information and advances that pertain directly to our problems and interests. As one example of an area of strength, the Soviets' political and scientific organization lends itself well to extensive compilations of information on broad topics, requiring the long-term services of dozens or even hundred of individual scientists and specialities. Thus, the Russians have superseded the Germans of the first part of the 20th century as the foremost geologic map and atlas-makers of the world (for example, Tectonic map of Eurasia, Morskoi Atlas, Atlas Antarktiki). However, our relatively superficial exposure to Russian work, rare personal meetings with Russians, and poor language competence has permitted little of the critically selective but intensive probing of the literature, the correspondence and reprint exchange, or personal contact that are becoming increasingly important functions in the Western information system.

For critical literature search and utilization -- that is, finding out not which publications are ostensibly pertinent on the basis of fine-sounding titles or appropriate subject matter, but those that are really meaningful -- I suggest we shall have to acquire a "critical mass" of linguistically competent scientists. Everyone need not be competent in Russian, French, German, or Japanese, but a certain percentage of scientists, say even as few as 10 percent, must both know enough language and use it actively, so that their combined efforts will uncover and draw to the attention of scientists in each field the really important foreign

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1/ A friendly, but poignantly exasperated plaint about American provincialism was registered by a French geologist (Routhier, 1968): "You ignore us: it is not only disagreeable, it leads us to suspect you of inclinations toward intellectual and technical imperialism, even of contempt, which of course you do not have . . . . ."

scientists and their work. We have the linguistic competence in German and French (and Spanish), though probably not the habit of attention to the literature, needed to uncover most of the significant results in the traditional languages. We are far (and receding) from the critical mass for Russian. Tolpin (1964) has pointed out that skill in "skimming the cream" from Russian materials can be acquired in eight to 16 lessons, carefully structured. It is a little humiliating to have to talk about such meager competence as a big step forward for American scientists, but that is where we stand.

Better linguistic competence in Russian on the part of Americans would not reduce the need for or value of translations, but would complement them. With more and better readers of Russian we would be able to select critical work for translations more readily, have a larger audience for translations, and, not insignificantly, exert a mutually beneficial influence on science in the Soviet Union. I could relate several examples of how carefully some Russian workers watch International Geology Review -- especially reviews of their books there. I have even seen some retranslations (back to Russian from English translation) of summaries of Russian work cited and abstracted in Referativny Zhurnal. This was evidently done deliberately to acquaint Russian scientists with the work Americans had selected as being important.

CONCLUSIONS

1. World earth-science literature is dominated numerically by Russian-language papers, with probably more than 50 percent of total abstracted publications, followed by English-language citations at about 30 percent, and French and German at about 8 and 6 percent, respectively. The rapidly growing Japanese literature at about 2 percent is not far ahead of several other linguistic blocks, such as Italian, Polish, and Portuguese. Communist Chinese publications ceased as a result of the Cultural Revolution and have not resumed significantly. In terms of country or origin, the Soviet Union leads the United States in number of abstracted publications by at least a 4 to 1 margin.

2. With due consideration to factors of pertinence and quality, foreign literature, especially Russian, is grossly underutilized in the United States. The most significant efforts toward better communication have come in 16 cover-to-cover journal translations, largely by the American Geophysical Union, and American Geological Institute. However, less than 0.5 percent of Soviet books are translated or known in the United States, even though books dominate Soviet literature. Of about 24,000 earth-science respondents to the National Scientific Register (1970), about 4 percent listed some competence in Russian, compared with about 35 percent for French, Spanish, and German. However, only a part of these respondents are believed to use their stated skills actively.

3. A marked trend toward even poorer foreign language utilization and greater provincialism in the United States is suggested by the following:

a) Responding to short-term "relevance" arguments, many universities, especially highly rated ones, have lessened or entirely eliminated language requirements for higher earth science degrees. If the trend continues, decline of language teaching in high school will probably take place as an indirect result.

b) Many libraries are curtailing archival functions. Foreign literature is often the first to go.

c) Scientists experience a feeling of hopelessness at the increasingly unmanageable size of the world literature and tend to restrict their informational radius in response.

d) Journal translations (and perhaps also book translations) have reached a plateau below their peak, and appear unlikely to increase, though world literature expansion continues unabated.

e) The National Science Foundation is dropping nearly all translation subsidies, except for the soft-currency program.

f) The U. S. Geological Survey is ceasing its abstracting activities, including <u>Abstracts of North American Geology</u>, <u>Abs. of Geology exclusive of North America</u>, and <u>Geophysical Abstracts</u>. Though the <u>Bibliography and Index of Geology</u> (with partial annotations) is expanding, there will be no broad or comprehensive English language abstracting service whatever for the earth sciences after 1971.

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Schneider, J. H., 1971. Selective dissemination and indexing of scientific information. Science, v. 173, p. 300-308.

Strakhov, N. M. (Ed.), 1959. K. poznanivu diageneza, Izdatel'stvo Akad. Nauk, SSSR, Moscow, 295 p.

Todd, Alexander, 1957. Annual report of the Advisory Council on Scientific Policy, (also 1956-7, Chairman, Prof. Alexander Todd; Cmd 278, Official Publ. United Kingdom. Cited in Announcement of Pergamon Institute, Oxford, England, 1957.)

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Tybulewicz, A., 1969. Languages used in physics papers. Physics Bulletin, v. 20, p. 19-20.

Yaalon, D. H., 1966. Publications as a measure of a nation's research effort. Geotimes, v. 11, p. 20-21.

Zakharov, E. E., and B. V. Krustal'nyi, 1969. Razvitiye v SSSR nauchno-tekhnicheskom informatsiye po geologii (Development of scientific-technological information on geology in the USSR). Izvestiya Akad. Nauk, SSSR, Ser. Geol., no. 4, p. 218-33.

Ziman, J., 1968, Public knowledge. Cambridge Univ. Press, 154 p.

APPENDIX I

Commercially available monographs translated from Russian, and in a few cases, other Slavic languages. The list does not claim to be exhaustive. Addresses of publishers are listed in Appendix III, where not otherwise given. G.S. refers to sponsorship of Geochemical Society. AGI refers likewise to the American Geological Institute. IPST refers to Israel Program for Scientific Translation.

Alekseev, F. A. (Ed) Soviet advances in nuclear geophysics, 189 p., $27.00, Plenum.

Al'pin, L. M., N. M. Berdichevskii, G. A. Vedrintsev, and A. M. Zagarmistr, 1966. Dipole methods for measuring earth conductivity. 302 p. $27.50, Plenum.

Altovskii, M. E., Z. I. Kuznetsova and V. M. Shvets, 1961. Origin of oil and oil deposits. 107 p., $17.50, Plenum.

Andreev, D. F., A. I. Bogomolov, A. F. Dobrianskii, and A. A. Kartsev, 1968. Transformations of petroleum in nature. 466 p., $18.00, Pergamon.

Andrianova, Z. S., and M. G. Neigauz, 1967. Seismic love waves. 91 p., $15.00, Plenum.

Antsyferov, M. S., 1966. Seismo-acoustic methods in mining. 134 p., $17.50, Plenum.

Ashgirei, G. D., 1968. Strukturgeologie (Structural geology: transl. into German), 572 p., 68 marks, Teubner.

Baidyuk, B. V., 1967. Mechanical properties of rocks at high temperatures and pressures. 75 p., $15.00, Plenum.

Bardin, I. P. (Ed.), 1961. Metallurgy of the USSR (1917-1957). NSF-IPST, 207 p., $10.00.

Barsukov, O. A., et al., 1964. Radioactive investigations of oil and gas wells. 270 p., $12.50, Pergamon.

Battey, M. H., and S. I. Tomkeieff, (Editors), 1964. Aspects of theoretical mineralogy in the USSR, 503 p., $10.00, Pergamon.

Beloussov, V. V., 1962. Basic problems in geotectonics. 820 p., $16.00, AGI-McGraw-Hill.

Bessanova, E. N., O. D. Gotsadze, V. I. Keilis-Borok, I. V. Kirillova, S. D. Kogan, T. I. Kikhtikova, L. N. Malinovskaya, G. I. Pavlova, and A. A. Sorskii, 1960. Investigation of the mechanism of earthquakes. 201 p., $12.50, Plenum.

Beus, A. A., 1962. Beryllium. 161 p., $5.00, G.S. Freeman.

Beus, A. A., 1966. Geochemistry of beryllium. 401 p., $15.00, G.S. Freeman.

Borisenko, L. F., 1963. Scandium: its geochemistry, mineralogy. 82 p., $17.50, Plenum.

Buyalov, N. I., et al., 1964. Quantitative evaluation of predicted reserves of oil and gas. 69 p., $12.50, Plenum.

Cherdyntsev, V. V., 1961. Abundance of chemical elements. 304 p., $10.00, Univ. Chicago Press.

Chikishev, A. G., (Ed.), 1965, Plant indicators of soils, rocks and subsurface waters. 210 p., $27.50, Plenum.

Cimerman, Vj. and Z. Tomasegovic, 1969. Atlas of photogrammetric instruments. 216 p., $32.50, Elsevier (translated from Serbo-Croatian).

Cook, E. F., (Ed.), 1966. Tufflavas and ignimbrites. 224 p., $7.00, Elsevier.

Fedorov, Ye.P., 1963. Nutation and forced motion of the Earth's pole from the data of latitude observations. 152 p., 50/s, Pergamon.

Fomin, L. M., 1964. The dynamic method in oceanography. 223 p., $13.50, Elsevier.

Gamburtsev, G. A., 1964. Grundlagen der seismischen Erkundung (Fundamentals of seismic prospecting: transl. into German). 430 p., 68 marks, Teubner.

Gedroils, K. K., 1955. (Orig. Russ. date). Chemical analysis of soils. 608 p., $16.00, IPST.

Ginzburg, A. I., 1963. New data on rare element mineralogy. 140 p., $17.50.

Ginzburg, I. I., 1960. Principals of geochemical prospecting. 311 p., 70 shillings, G.S. Pergamon.

Glazov, N. V., and A.N. Glazov, 1959. New instruments and methods of engineering geology. 91 p., $10.00, Plenum.

Glinka, K. D., 1931 (Orig. Russ. date). Treatise on soil science. 680 p., $18.00, IPST.

Golubev, V. S., and A. A. Garibiants, 1971. Heterogeneous processes of geochemical migration. 145 p., $22.50, Plenum.

Gorshkov, G. S., 1970. Volcanism and the upper mantle. 385 p., $35.00, Plenum.

Grigor'ev, D. P., 1961 (Orig. Russ. date). Ontogeny of minerals, 256 p., IPST.

Gulyaeva, L. A. (Ed.), 1962 (Orig. Russ. date). The geochemistry of petroleum deposits. 224 p., $6.00, NSF - IPST.

Gumenskii, B. M., and N. S. Komarov, 1961. Soil drilling by vibration. 80 p., $12.50, Plenum.

Hecker, R. E., 1965. Introduction to paleoecology. 176 p., $7.50, AGI - Elsevier.

Ivakin, B. N., 1960. The microstructure and macrostructure of elastic waves in one-dimensional continuous nonhomogeneous media. 113 p., $12.50, Plenum.

Ivanov, M. V., 1968. Microbiological processes in the formation of sulfur deposits. 288 p., $3.00, NTIS.

Kartsev, A. A., Z. A. Tabasaranskii, M. I. Subbota and G. A. Mogilevskii, 1959. Geochemical methods of prospecting and exploration for petroleum and natural gas. 349 p., $12.50, Univ. California Press, Berkley and Los Angeles.

Khitarov, N. I. (Ed.), 1969. Problems of geochemistry. 754 p., NSF-IPST-NTIS.

Klenova, M. V., 1961. Geology of the Barents Sea. 338 p., Library, Administrative Service Office, U. S. Navy Hydrographic Office, Washington, D.C.

Komarnitskii, N. I., 1968. Zones and planes of weakness in rocks and slope stability. 108 p., $15.00, Plenum.

Korzhinskii, D. S., 1970. Theory of metasomatic zoning. 162 p., $8.00, Oxford University Press.

Korzhinskii, D. S., 1959. Physiocochemical basis of the analysis of the paragenesis of minerals. 142 p., $15.00, G.S., Plenum.

Kostov, I., 1968. Mineralogy (transl. from Bulgarian). 587 p., L10/10s, Oliver and Boyd.

Krinov, E. L., 1966. Giant meteorites. 397 p., $16.50, Pergamon Press.

Kriss, A. E., 1963. Marine microbiology. 536 p., $20.75, Wiley-Interscience.

Kuznetsov, S. I. (Ed.), 1962. Geologic activity of microorganisms. 112 p., $20.00, Plenum.

Kuznetsov, S. I., M. V. Ivanov, and N. N. Lyalikova, 1963. Introduction to geological microbiology. 272 p., $10.50, McGraw-Hill.

Kudymov, B. Y., 1962. Spectral well logging. 85 p., $7.50, Elsevier.

Lebedev, L. M., 1967. Metacolloids in endogenic deposits. 298 p., $19.50, Plenum.

Lukashev, K. I., 1970. Lithology and geochemistry of the weathering crust. 368 p., $6.00, NSF-IPST-NTIS.

Lyustikh, E. N., 1960. Isostacy and isostatic hypotheses. 119 p., $12.50, Plenum.

Marfunin, A. M., 1966. The feldspars. 316 p., NSF-IPST.

Manskaya, S.M. and Drozdova, T. V., 1968. Geochemistry of organic substances. 345 p., $18.00, G.S. Pergamon Press.

Medvedev, S. V., 1963. Problems of engineering seismology. 112 p., $27.50, Plenum.

Nalivkin, D. V., 1960. The geology of the USSR, a short outline. 170 p., $15.00, Pergamon (with 1:7,500,000 map).

Nikolaev, B. A., 1962. Pile driving by clectroosmosis. 62 p., $12.50, Plenum.

Ogilvy, N. A. and D. I. Fedorovich, 1966. Groundwater seepage rates. 33 p., $7.50, Plenum.

Ostrovskii, A. P., 1962. Deep-hole drilling with explosives. 133 p., $20.00, Plenum.

Ovcharenko, F. D., 1967. Colloid chemistry of palygorskite. 120 p., IPST.

Ovcharenko, F. D., S. P. Nichiporenko, N. N. Kruglitskii, and V. Yu. Tretinnik, 1967. Investigation of the physicochemical mechanics of clay-mineral dispersions. 146 p., IPST.

Parkomenko, E. I., 1967. Electrical properties of rocks. 314 p., $19.50, Plenum.

Parkomenko, E. I., 1971. Electrification phenomena in rocks. 260 p., $25.00, Plenum.

Perel'man, A. T., 1967. Geochemistry of epigenesis. 266 p., $19.50, Plenum.

Perfiliev, B. V., D. R. Gabe, A. M. Gal'perina, V. A. Rabinovich, A. A. Sapotnitskii, E. E. Sherman, and E. P. Troshonov, 1965. Applied capillary microscopy, The role of microorganisms in the formation of iron-manganese deposits. 122 p., $22.50, Plenum.

Pokorny, V., 1963. Principles of zoological micropaleontology, v. 1, $17.50, (trans. from Czech.), Pergamon.

Pokorny, V., 1965. Principles of zoological micropaleontology, v. 2, $15.00, (trans. from Czech.), Pergamon.

Polubarinova-Kochina, P. Ya, 1962. Theory of ground water movement. 613 p., $10.00, Princeton University Press.

Radchenko, O. A., 1968. Geochemical regularities in the distribution of the oil-bearing regions of the world. 312 p., $6.00, NSF-IPST-NTIS.

Rast, N. (Ed.), 1962. Applied Geophysics, USSR. 429 p., Pergamon.

Romanova, M. A., 1964. Air survey of sand deposits by spectral luminance. 158 p., $22.50, Plenum.

Rodionov, D. A., 1965. Distribution functions of the elements and mineral contents of igneous rocks. 80 p., $17.50, Plenum.

Povarennykh, A. S., 1969. Crystal chemical classification of minerals. 611 p., $40.00, Plenum.

Saranchina, G. M., 1963. Die Fedorov-Methode (The Fedorov method: transl. German). 135 p., 35 marks, Teubner.

Savinskii, I. D., 1965. Probability tables for locating elliptical underground masses with a rectangular grid. 110 p., $15.00, Plenum.

Sindeeva, N. D., 1964. Mineralogy and types of deposits of selenium and tellurium. 363 p., $11.00, G.S. Wiley-Interscience (original price; now available from Geochemical Society, $3.00 Attention E. Ingerson, Dept. Geol. Sciences, University of Texas, Austin, Texas).

Sokolova, E. I., 1964 (date of original Russian). Physiochemical investigations of sedimentary iron and manganese ores and associated rocks. 220 p., $5.50, NSF-IPST.

Sokolova, G. A. and Kavavaiko, G. I., 1968. Physiology and Geochemical Activity of Thiobacilli. 283 p., NSF-IPST.

Songina, O. A., 1970. Rare metals. NSF-IPST.

Solomin, G. A., 1965. Methods of determining Eh and pH in sedimentary rocks. 56 p., $10.00, Plenum.

Suslov, S. P., 1961. Physical geography of Asiatic Russia. 594 p., $16.00, Freeman.

Strakhov, N. M., 1948 (original Russ. date). Principles of historical geology. 704 p. in two volumes plus map folder, $30.00, IPST.

Strakhov, N. M., 1969-71. Principles of Lithogenesis. Three volumes, $75.00, Oliver-Boyd, Plenum.

Soviet Antarctic Expedition, v.1, 1964. 398 p.; v. 2, 1964, 328 p.; v. 3, 1965, 389 p.; $17.50 each, Elsevier.

Teodorovich, G. I., 1961. Authigenic minerals in sedimentary rocks. 120 p., $22.50, Plenum.

Titkov, N. I., A. S. Korzhuev, V. G. Smolyaninov, V. A. Nikishin, and A. Ya. Neretina, 1961. Electrochemical induration of weak rocks. 52 p., $12.50, Plenum.

Tkhostov, B. A., 1963. Initial rock pressures in oil and gas deposits. 118 p., 50/s, Pergamon.

Tyutyunov, I. A., 1964. An introduction to the theory of the formation of frozen rocks. 94 p., $7.50, Pergamon.

Trudy, VNIGRI, New Ser. No. 5, 1965. Contributions to geochemistry. No. 2-3, 276 p., $6.00, NSF-IPST-NTIS.

Varentsov, I. M., 1964. Sedimentary manganese ores. 124 p., $9.00, Elsevier.

Vinogradov, A. P., 1959. The geochemistry of rare and dispersed chemical elements in soils. 209 p., $9.50, G.S. Plenum.

Vinogradov, A. P., 1953. The elementary chemical composition of marine organisms. 647 p. revised and supplemented by V. W. Odum, $17.00 (out of print), Sears Foundation for Marine Research, Yale Univ., New Haven.

Vinogradov, A. P., Chemistry of the earth's crust: 1966. v. 1, 464 p.; v. 2, 1967, 705 p.; NSF-IPST.

Vinogradov, A. P., and D. I. Ryabchikov, 1962 (editors). Detection and analysis of rare elements. 744 p., $7.50, NSF-IPST-NTIS.

Vistelius, A. B., 1966. Structural diagrams. 178 p., Pergamon.

Vistelius, A. B., 1967. Studies in mathematical geology. 294 p., $37.50, Plenum.

Vlasov, K. A., Kuz'menko, M.Z., and Eskova, E. M., 1966. The Lovozero alkali massif. 628 p., $30.25, G.S., Oliver and Boyd, Edinburgh.

Vlasov, K. A. (editor). Geochemistry and mineralogy of rare elements and Geochemistry of rare elements, 1966. 945 p.; v. 3, Genetic types of rare element deposits , 916 p. NSF-IPST.

Viktorov, S. V., 1960. The use of the geobotanical method in geological and hydrogeological investigations. 219 p., $3.50, Transl. Series, U.S. Atomic Energy Comm., NTIS.

Yermakov, N. P., 1965. Research on the nature of mineral-forming fluids. 743 p., $25.00, Pergamon.

Zavaritskii, A. N., and V. S. Sobolev, 1964. The physiocochemical principles of igneous petrology. 414 p., NSF-IPST.

Zenkevich, L. A., 1963. Biology of the seas of the USSR. 955 p., $25.00, Wiley-Interscience.

Zenkovich, V. P., 1967. Processes of coastal development. 738 p., $30.24, Oliver and Boyd, Edinburgh and London.

Zhigach, K. F., 1963. Industrial and exploratory geophysical prospecting. 136 p., $17.50, Plenum.

Zulfugarly, D. I., 1964. Verbreitung der Spurenelements in Kaustobiolithen, Organismen, Sedimentgesteinen und Schichtwässern (Distribution of trace elements in organisms, organic matter, sedimentary rocks and formation waters; transl. from Russian to German). 297 p., VEB Deutscher Verlag für Grundstoffindustrie, Leipzig.

Zverev, S. M., 1967. Problems in deep seismic sounding. 166 p., $22.50, Plenum.

Zyvagin, B. B., 1967. Electron-diffraction analysis of clay mineral structures. 264 p., $19.50, Plenum.

APPENDIX II

Selected monographs translated from non-Slavic languages

Agassiz, L., 1967. Studies on glaciers; Discourse of Neuchatel (transl. from French, by A. V. Carozzi). 213 p., $27.50, Hafner.

Agricola, Georgius, 1950. De re metallica (transl. from Latin of 1556 by Herbert and Linn Hoover, 1912; reprint). 638 p., $10.00, Dover.

Agricola, Georgius, 1955. De Natura fossilium (transl. from Latin of 1546). 240 p., $8.50.

Aubouin, Jean, 1965. Geosynclines. 325 p., $20.00, American Elsevier, N.Y.

Braitsch, O., 1971. Salt deposits, their origin and composition (transl. from German). Springer Verlag, Berlin, N.Y.

Brinkmann, Roland, 1960. Geologic evolution of Europe (transl. from German by John Sanders). 167 p., $8.50; 2nd revised ed., 161 p., 1969, $8.75, Hafner.

Bourrit, M. T., 1776. A relation of a journey to the glaciers in the Dutchy of Savoy (transl. from French of 1773 by C. & F. Davy). 266 p., G. Robinson in Paternoster Row, London.

Birot, Pierre, 1966. General physical geography (transl. from French). 360 p., $8.50, Wiley-Interscience.

Cagniard, C., 1962. Reflection and refraction of seismic waves (transl. from French). 276 p., McGraw Hill, N.Y.

Cayeux, L., 1970. Sedimentary rocks of France. Carbonate rocks.(transl. from French by A. Carozzi). 506 p., $37.50, Hafner.

Cayeux L., 1971. Past and present causes in geology (transl. from French of 1941 by A. Carozzi). 161 p., $13.95, Hafner.

Cloos, H., 1953. Conversation with the Earth (transl. from German by Ernst Cloos and K. Dietz). 413 p., Knopf, N.Y.

Correns, C. W., 1969. Introduction of mineralogy (transl. from German). $14.50, Springer Verlag, Berlin, N.Y.

Coulomb, J. and G. Jobert, 1963. The physical constitution of the Earth (transl. from French). 320 p., $10.00.

de Jong, W. F., 1959. General crystallography (transl. from Dutch). 672 p., $10.00, Freeman.

Dietrich, Gunter, 1963. General oceanography (transl. from German). 588 p., $21.00, Wiley-Interscience.

Furon, Raymond, 1963. Geology of Africa (transl. from French). 377 p., $9.95, Hafner.

Goguel, Jean, 1962. Tectonics (transl. from French). 384 p., $11.00, Freeman.

Gignoux, Maurice, 1955. Stratigraphic geology. 682 p., $11.00, Freeman.

Machatschek, F., Geomorphology (transl. from German). v. 1, 216 p., $11.75, Elsevier.

Millot, Georges, 1970. Geology of clays (transl. from French). 450 p., $16.80, Springer Verlag N.Y. - Masson et Cie, Paris.

Miyake, Yasuo, 1965. Elements of geochemistry (transl. from Japanese). 475 p., Maruzen Co. Ltd., Tokyo.

Müller, German, 1967. Methods in sedimentary petrology (transl. from German). 283 p., $12.50, Hafner.

Niggli, Paul, 1954. Rocks and mineral deposits (transl. from German). 559 p., $13.00, Freeman.

Palissy, Bernard, 1957. Discours admirable de la nature des eaux et fontaines tant naturelles qu'artificielles (Discourse on the nature of the waters of natural and artificial springs, Eng. transl. from original of 1580). Univ. Illinois Press, Urbana, Ill.

Perrault, P., 1967. On the origin of springs (transl. from French). 209 p., $15.00, Hafner.

Raguin, Eugene, 1965. The geology of granite (transl. from French). 314 p., $11.00, Wiley Interscience.

Rendu, M. le Chanoine, 1874. Theory of the glaciers of Savoy (transl. from French of 1841 with augmentation by P. G. Tait and John Ruskin). 216 p., MacMillan, London.

Ramdohr, Paul, 1969. Ore minerals and their intergrowths (transl. from German). $54.00, Pergamon.

Rittman, A., 1962. Volcanoes and their activity (transl. from German). 320 p., Wiley-Interscience.

Raspe, R. E., 1970. Natural history of terrestrial spheres (transl. from Specimen Historiae Naturalis Globi Terraquei by A. V. Carozzi and A. Iverson). 400 p., $15.00, Hafner.

Sederholm, J. J., 1968. Selected works on granites and migmatites. 608 p., $50.00, Wiley and Sons, N.Y.

Steno, Nicolaus, 1916 (reprint, 1918). Prodromus of Dissertation concerning a solid body enclosed by process of nature within a solid (transl. from Latin of 1669). 141 p., $14.95, Hafner.

Takeuchi, H., S. Uyeda, H. Kanamori, 1967. Debate about the Earth (transl. from Japanese). 248 p., Freeman Cooper, Stockton St., San Francisco, Calif. 94133.

Termier, H., and Termier, G., 1963. Erosion and sedimentation (transl. from French). 433 p., Van Nostrand, London.

Volney, C. F., 1968. View of the soil and climate of the United States of America (1804). 446 p., $20.00, Hafner.

Wedepohl, K. H., 1971. Geochemistry (transl. from German). 231 p., $6.55, Holt, Reinhart and Winston, N.Y.

Wegener, Alfred, 1924. The origin of continents and oceans (transl. from German). E. P. Dutton, & Co., N.Y.; new transl. from 4th (1929) German ed., 1967. $2.50, Dover.

Wendt, H., 1968. Before the deluge (transl. from German). 419 p., $6.95, Doubleday, N.Y.

Werner, A. G., Short classification and description of the various rocks (transl. from Latin of 1786). 194 p., $13.95, Hafner.

Winkler, H. G. F., 1967. Petrogenesis of metamorphic rocks (transl. from German). 237 p., $5.80, Springer Verlag, Berlin, N.Y.

Zittel, K. A. von, 1962. History of geology and paleontology (from Engl. transl. of 1901). 562 p., $8.40, Hafner.

APPENDIX III

Technical Sources

American Elsevier Publ. Co., Inc., 52 Vanderbilt Ave., N.Y., N.Y. 10017.

American Geological Institute, Translations Office, 2201 M St., N.W., Washington, D.C.

American Geophysical Union, Suite 435, 2100 Pennsylvania Ave., N.W., Washington, D.C. 20037.

Associated Technical Services, Inc., Drawer 271, East Orange, N.J. (catalogs of article translations).

Bibliographie des Services de la Terre. Bureau de Recherche Geologique de Miniere (BRGM), Subscript. Dept., B.P. 6009, 45 - Orleans -02, France.

Bibliography and Index of Geology (Subscription $150/year). Geological Society of America, Colorado Bldg., P.O. Box 1719, Boulder, Colorado 80302.

Bibliography and Index of Micropaleontology. Variable price schedule. American Museum of Natural History, Central Park W. at 79th St., N.Y., N.Y. 10024.

Bulletin Signaletique. Centre de Documentation, Centre National de Recherche Scientifique (CNRS), 15 Quai Anatole-France, 75 - Paris, France.

Clarke, J. W., Publisher, McLean, Virginia.

Consultants Bureau, Inc. (see Plenum Publishing Corp.).

Dover Publishing Co., 180 Varick St., N.Y., N.Y. 10014.

European Translations Centre (ETC), Doelenstraat 101, Delft, Holland.

Four Continents Book Corp., 156 Fifth Ave., N.Y., N.Y. 10010 (books and subscriptions to Russian journals).

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A LIBRARY NETWORK FOR THE GEOSCIENCES

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Abstract - The AGI Committee on Geoscience Information has provided the initial philosophy, leadership, and action toward an information system. The plan is commendably broad in scope and acknowledges the numerous disparate elements necessary to its formation. However, the library network is inadequately explored or justified as an element of the total system. The analytical study of geoscience library resources and services is only one of numerous efforts which will be necessary before a library network can be created. Additional areas must be systematically established or investigated: 1) Documentation and substantiation of the need for the network; 2) Specifications on clientele and library membership; 3) Organizational structure most appropriate and realizable; 4) Relationship of the network to other major library resources and libraries; 5) Codification of users' needs for services of the network; 6) Levels of responsiveness the network and its members must attain; 7) Identification, ranking, and scheduling of primary tasks; 8) Telecommunication requirements. Using this and additional data, a detailed plan for discussion should be drawn.

The geoscience information system does not appear to be aware of the necessities of libraries in the establishment of bibliographic, thesauri and vocabulary controls. This must be changed, or corrective and duplicate efforts may result.

A LIBRARY NETWORK FOR THE GEOSCIENCES

The concept paper[1] prepared by the AGI Committee on Geoscience Information which we are discussing cannot easily be faulted. It is a rational market list of basic information elements and shows a progress in geoscience not yet even considered in most other disciplines. Even so, there is a pronounced breeziness in the handling of the immensely complex information problems. This will have to be translated into more certain and realistic statements before acceptance or commitment will be forthcoming. I do not oppose such a document, in fact, within the past two years I was involved in writing one not unlike it. I am sure that the Committee on Geoscience Information was faced with the same basic question: How can one transmit to the geoscience community at large, an adequate amount of information on the problem and its possible solution without having it thrown in the wastebasket? The solution employed is probably the best one, although I feel it is too brief for those who are going to look at it seriously.

But to be more specific. The epigrammatic references to a Library Network (p. 10 & 15) amount to 24 typed lines. The content of those 24 lines is not great. This points up a major problem to be faced by a discipline-oriented library network: Visibility within the discipline, and an adequate hearing on the role of libraries in an information system. This lack of awareness of libraries' interrelationships, needs and payoffs with the other elements in the geoscience plan (bibliographic control, data bases, thesauri, translations and vocabularies) must be corrected.

I will not attempt to persuade you of the essentiality of geoscience libraries in transfering information today or in the future except by making these observations:

- Society can ill afford an unbalanced and disparate information system in geoscience, for that matter, probably in any discipline. All major functioning units should proceed roughly at the same pace.
- Society has decreed upon libraries the role of a major information handler; I see few shifts of responsibility in the scientific community.
- The organization of libraries, their distributed locations, and the immense investments in them provide the continuity, the single-agent approach, and the visibility which any information system needs.
- Two information networks or systems at the national level, in medicine and agriculture, have faced these same questions and have placed their national libraries as the nuclei.

To restate my point: Your concept plan does not display adequate awareness or concern for the role of the geoscience libraries. Two complementary actions might help to remedy this deficiency.

The libraries might embark on a program of establishing their generally recognized, but usually unheralded, position within the information system. This could be accomplished in a variety of ways, but one example of an immediate opportunity will suffice. The user-geoscientist with political acumen should be involved with the librarian in afixing the place of libraries in the information system. The very basic Analytical Study on Geoscience Library Resources and Services[2] accomplished by the joint COSI Working Group did not have a user of library services as a member or the Dean of a university. Although the Study might have been slowed by such representation, the library community probably would have been greatly aided by additional understanding and visibility within its user community. The Study should be the first of a series of systematic projects concerning libraries, information transfer, and geoscience; so, the opportunities still exist. Although this process of education by committee may be painful to all parties, it is probably the best method to pull uncommunicating parties together for agreement, understanding and political and technical progress.

On the part of the geoscience information community, a converse arrangement should be instituted, if it does not now exist. Wherever the libraries have the potential as information handlers, interrelationships exist or are apt to be created, get the librarians involved. Most librarians will not force themselves into unwanted councils. My experience has been that they have much to give in technical and operational areas if sought out.

The Analytical Study prepared at the behest of the Committee on Geoscience Information is an excellent single piece of the whole cloth that needs to be stitched together before a library network can be even partially realized. It is evident from the Study that the Working Group understands geoscience libraries well, and their problems. It is also evident from this Study and from knowing geoscience information people that you possess the talent to bring about a strong libraries component.

However, it seems unlikely that the many concerns of the Study will receive more than a polite and cursory acknowledgement from the power and money structures unless a more systematic effort is undertaken. The two national offices recommended in the Study are intended, of course, to provide this systematic effort. I doubt that the scope and funding of either office will begin to match the tasks at hand unless a more forceful point is made in the beginning. This first major effort probably should be accomplished conjunctively by the Geoscience Information Society, the American Geological Institute, the Geological Society of America, the U.S. Geological Survey, and appropriate libraries. One cannot wish a library network into existence, nor even create it by saying, "We acknowledge it as part of our larger information system."

What I find lacking is the hard-nosed consideration by users of information and librarians of the information needs of their different communities stated in terms of how a library network might satisfy them. These should be substantiated by empirical data, statistical justification if it exists, and any other form of proof. Numerous library networks exist from which one can extract supposed, real and planned advantages. Are they analogous to geoscience? If your problems are relatively similar, can your solutions be of a similar nature? Will you force the network to solve problems not easily handled by it?

These and related matters cannot quickly be set on paper; years of effort are necessary for absolute or complete answers. But a few more detailed plans are necessary now. In persuading the geoscience community of the need for a library network, numerous unanswered questions will press for attention and someone must have reasoned and knowledgeable solutions. I propose that the next step is a document which reaches some conclusions and which will provide the point of departure on action and discussion. Basic considerations I would include in order to crystalize thinking are these:

- Specify your user clientele as well as the intended membership of the network. Will you serve undergraduates studying geology in an unaccredited college? Will you attempt to scale your services to sized communities and distance, and establish benchmarks for the escalation of services?
- Specify your network objectives and philosophy for attaining them. The sure way to loose support and participation is not to

have a fairly clear picture of where you are going and how you would like to get there.

- Translate these objectives into specific functions and tasks. Try to get a consensus on their relative importance and sequence of implementation. Think imaginatively and realistically as to where you are and what you want the network to do.

- Determine what organizational structure is apt to work best for planning, for control, and for maximum participation of members. Will it involve continuing Federal subsidy? If so, how must the members meet this strong influence?

- How will the libraries network fit into the total geoscience information system? Can you carve out an area and stay within it? Should you? Is the system structure compatible with the objectives and methods of the libraries net?

- State in general terms those technological, social and economic factors that may momentarily be sidelined, but which will demand awareness later. Telecommunications is one of these and should be addressed, at least in terms of a cognizance of its coming influences on library networks.

This document would then be used as a rallying point not only within the libraries involved, but moreso among the user and society communities.

Formal library networks with strong requirements and benefits are coming and I think most librarians feel this trend although known by different names and having varying interpretations. We need not begin by attempting to place a satellite in space for network communications, as has been suggested. Establish your sights realistically and on a time scale which will move you forward. Free your good people for planning since you will need them. And by all means, get the user community involved and convert it to a happy customer so that you can all be benefited.

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INVENTORY OF INFORMATION RESOURCES

A Comparison of the American Geological Institute (AGI) Pilot Project With the National Referral Center (NRC) Inventory

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Abstract - A resource inventory is defined as a collection of all types of information resources, wherever they exist: in government, in industry, and in the academic or professional world. The concept of what constitutes an "information resource" should be broad enough to include any organization, institution , group, or individual with specialized knowledge in a given field and a willingness to share this knowledge with others.

The NRC inventory is described. It contains over 8000 information resources of which 1141 have indicated they provide information in the Geosciences or related subject areas. Approximately 775 of these resources are listed in the latest NRC directory. The AGI pilot project registered 496 resources, most of which are in the NRC file.

NRC referral services are available to the Geoscientist without charge. Requests received through the mail are normally answered within five working days. Depending upon the nature of the request, telephone calls may receive immediate attention. NRC directories may be purchased from the Superintendent of Documents, U.S. Government Printing Office.

Also described are the methods utilized by NRC in updating its resource inventory, i.e., cyclical reviews, feedback program, and resource approval of directory entries.

An informal working agreement is proposed to eliminate further duplication of effort between AGI and NRC.

INVENTORY OF INFORMATION RESOURCES

A Comparison of the American Geological Institute (AGI) Pilot Project With the National Referral Center (NRC) Inventory.

From those preceding me you have heard discussed several activities of the proposed geoscience information system that bear directly on the needs of the geoscientist. If you know of all these activities, and have access to them, and if they contain all the information you want and you can retrieve precisely the data you need -- you're in luck and you don't have to listen to me.

But what happens when they don't satisfy your needs? Where do you start looking? Among the literally hundreds or possibly thousands of places that may have information you seek, how do you locate the one, three of six sources that will satisfy your needs? That's where a resource inventory comes in handy and that's where the organization I represent can be of help. For to define a resource inventory one must describe the National Referral Center.

What is the National Referral Center? I like to describe it as the "information desk" of the scientific and technical community. Operating in the Science and Technology Division, Library of Congress, the Center provides a single place to which anyone may turn for advice on where and how to obtain information on specific topics in science and technology. Functioning as an intermediary, it directs those who have a question concerning a particular subject to organizations or individuals with specialized knowledge of that subject.

The Center is concerned with all fields of science and technology: the physical, biological, social, and engineering sciences, and the many technical areas relating to them. Similarly, it is concerned with all kinds of information resources, wherever they exist: in government, in industry, and in the academic and professional world.

The concept of "information resources" that the Center has adopted is an extremely broad one. It extends to any organization, institution, group, or individual with specialized knowledge in a given field, provided -- and this is important -- provided it has a willingness to share this knowledge with others. Through a continuing survey, the Center has built up and is maintaining a central inventory of detailed data on such resources in terms of their areas of interest and the services they provide. Included in this inventory are professional societies, university research bureaus and institutes, Federal and state agencies and units within them, industrial laboratories, museum specimen collections, testing stations, and individual experts, as well as more traditional sources of information, such as technical libraries, information and document centers, and abstracting and indexing services. The Center has developed two basic criteria for registering information resources:

- It should have some unique or specialized information or knowledge -- if only on a regional basis.
- It should be willing to share this information with others -- within certain restrictions, if necessary.

Now let us see how these criteria would be applied to certain broad categories of resources:

1. Government organizations

Any government agency -- local, state, or Federal -- that has at least the capability of answering questions is considered an information resource unless the agency specifically declines to cooperate. As an exception, public libraries are not registered unless they have significant collections in science and technology or perform unique services.

2. Colleges, Universities, and other schools

Any component part of an educational organization, such as a research institute, may be registered as a resource if it will at least provice substantive answers to questions submitted by persons other than organizational staff members. Libraries of educational institutions will be registered if they have collections in science and technology and if services are available outside the institution.

3. Societies and Associations

Professional societies and trade associations may be registered if they at least provide substantive answers to questions submitted by persons other than members. Organizations which merely publish proceedings of their annual meetings will not be registered. Some organizations may provide an abstracting and indexing service through their publications and this is a legitimate information resource.

4. Commercial Organizations

Commercial organizations with information services that are primarily product-oriented or are only for customers or staff members are not considered to be information resources nor are consulting firms that only provide consulting services.

If an organization has a library, information center, or collections of materials and will allow on-site use or provide interlibrary loan service, it may be registered as an information resource. Also acceptable are companies that distribute technical reports in response to inquiries.

5. Foundations and Nonprofit Organizations

Foundation and nonprofit organizations must at least provide substantive answers to questions. Here again, if an organization has a library, information center, or collections of materials and will allow on-site use or provide interlibrary loan service, it may be registered.

6. Individuals

The registration of organizations rather than individuals is preferred. An exception can be made when an individual provides a highly unique service or possesses special qualifications. An individual having a collection relating to science and technology that is either rare or significant may be registered as an information resource provided he will permit access to it or answer substantive questions about its contents.

Organizations or individuals may be registered regardless of whether their services are free, for a fee, or audience restricted.

Some of the Center's operations involve computer processing, utilizing the Library's IBM 360/40. Input to the system is via the Science and Technology Division's two IBM Magnetic Tape Selectric Typewriters (MTST). The COSATI (Committee on Scientific and Technical Information) subject category list is utilized for classification purposes and the Project Lex Thesaurus -- modified to suit our purposes -- is used as a basic document from which we select indexing terms. The NRC Retrieval Program is designed to search not only the NRC Resource Inventory but also the NRC Request Action Record file, taking advantage of previous searches. The Program will retrieve on twelve different data elements. In a subject search, up to 400 terms may be specified. One such search utilizing 200 subject terms resulted in a listing of 1,100 resources that indicated they provided information in the geosciences and related subject areas. Further analysis indicated that approximately 775 of these are listed in NRC's latest directory on the Physical Sciences and Engineering which was released last June.

SERVICES

In its efforts to bring together those who ask and those who know, the Center handles inquiries covering the widest possible spectrum of science and technology. Illustrative of the kinds of questions received are the following:

- WHO can provide information on the production of manganese sulphate from pyrolusite and sulfur dioxide?
- WHAT organization can furnish information on the general geology of Cook Inlet, Alaska and Tillamook Bay, Oregon?
- WHERE can I find bibliographies on the geology of the Soviet Union?

In answer to such inquiries, the National Referral Center provides names, addresses, telephone numbers and brief descriptions of appropriate information resources. In each case the response is individually tailored to the inquirer's special interest. It is always the Center's aim to establish the most direct contact possible between the person seeking the information and the places or people who can provide it. Whenever possible an individual is listed as a contact point for each resource. Referral Service is available without charge to any organization or individual working in any scientific field.

To evaluate the effectiveness of its services, the Center initiated, in July 1963, a comprehensive "feedback" program, asking the requester, after an appropriate interval, how he fared in his search for information. The chief question, of course, is whether he obtained the data or material he sought. The inquirer is also asked how many of the resources cited by the Center were previously unknown to him and which resources were the most useful. The final question concerns the requester's general evaluation of the services he received from the Center, and on this last question 82 percent of those responding have indicated full satisfaction. Many feedback responses include name, address, and telephone changes which aid in updating the resource file.

PUBLICATIONS

In addition to its referral service, the Center compiles a series of directories under the general title A Directory of Information Resources in the United States. The directories contain descriptions of organizations active in various areas of science and technology. Each directory has a subject or organizational focus, which may be quite broad (e.g., Biological Sciences, Federal Government) or more restricted (e.g., Water, General Toxicology). Because the activities and informational capabilities of many organizations encompass more than one subject area, directories overlap in their coverage.

A constantly updated master file of entries written for publication is being built up, from which entries for any given directory are selected by computer and processed for photocomposition. Each entry is drafted by an editor, keyed on the MTST, and converted to tape. Thus, a given entry is input only once. Mailable entries are printed by computer, and are sent to the respective resources for validation. After return, any needed changes are keyed on the MTST -- but only as corrections to existing data fields, not the whole entry. To produce a directory, pertinent entries are selected, sorted, and given a sequential number, all by computer. At this point, the indexes, which are keyed to the sequential number, are generated by computer. The main directory and the Index are put through the Linotron interface program to add the necessary typographic coding, and the two tapes are sent to the Government Printing

Office (GPO).

This system has been designed to produce more timely and cost effective NRC directories. Still under consideration are a number of by-products now made possible (or easier) by having the text machine-searchable, including geographic indexes, more sophisticated subject indexes, KWIC indexes to the names of journals published by the resources, acronym indexes, etc. -- all of them designed to make this series of directories even more useful to its future purchasers.

AGI's PILOT PROJECT

So much for the National Referral Center. Now let's take a look at AGI's pilot project. This project may be described as an initial effort to inventory the geoscience information resources in the United States. Owing to the shortage of both funds and time AGI decided that the identification and collection of resources would be conducted utilizing major reference directories. Announcements were also placed in major earth science publications and newsletters. This initial effort resulted in a listing of 613 candidate resources. Further review and analysis resulted in 496 resources actually being registered. As developed, the system centers around a card index file containing the subject categories and term descriptors for each resource. Cards are keyed to the master file containing detailed information on each resource.

AGI vs NRC

A close examination of the AGI files was made last June. When compared with the NRC file the following similarities were noted:

(1) Ninety percent of the resources in the AGI file are registered with NRC. The remaining ten percent are either in the process of being added to NRC's file, are defunct, or no longer qualify as an information resource. This high percentage of overlap can be explained by AGI's use of three NRC directories as primary source documents.

(2) The forms used by both AGI and NRC in registering resources show a remarkable similarity, both in the number and type of data elements being listed.

(3) NRC now provides a fast and efficient referral service manned by full-time, highly-trained referral specialists. AGI's system, although not operational, does propose a similar service.

(4) AGI's file would have to be updated and expanded before any attempt is made to publish a directory of geoscience information resources. Because of the growing data base, already on tape, of entries written in suitable form for publication, a directory based on the 1,100 geoscience resources presently listed in NRC's inventory could be a reality by late 1972.

(5) The continued development of AGI's resource inventory will draw heavily on the professional and clerical staff of AGI, especially if it's going to include the identification of new resources; their solicitation and resolicitations; analysis of registration forms; cyclical updatings; processing of referral requests; and the editing and updating of resources prior to any publication efforts. NRC can draw not only on a large body of existing computer software backed by the expertise of the Library's Information Systems Office and Computer Service Center, but can also take advantage of the vast collections of the Library in the identification of new and potential resources and consultations with subject specialists in other divisions of the Library (e.g., Science Policy Research Division, Congressional Research Service; Environmental Policy Division, Congressional Research Service; and the Geography and Map Division, Reference Department).

Over the years NRC has engaged in numerous cooperative relationships with other organizations helping to improve communications and otherwise aiding in the transfer of information throughout the scientific community. While all of the ventures are too numberous to list, a sampling follows:

(1) American Society for Microbiology - to register microbiology information resources.

(2) California State Library - To register information resources in California.

(3) SEQUIP (Study of Environmental Quality Information Programs in the Federal Government) Committee, Executive Office of the President - To provide the Committee with a list of Government and Government-sponsored environmental information resources.

I might add that NRC has frequently provided consultation to national and international interests on information-gathering techniques and on the development and implementation of referral services. Canada, Israel and Japan have sent representatives to discuss in detail the establishment of national referral centers.

What I would like to propose today is a cooperative arrangement between the National Referral Center and the American Geological Institute. NRC would welcome the assistance of AGI, its member societies, and all geoscientists in a combined effort to enlarge and maintain a comprehensive current resource inventory. As to our service, it is available now, free, to any geoscientist who wants to use it. If the cooperative bolstering of our inventory should encourage more of you to use the service- - fine, you are all welcome!

Many years and a good deal of money (roughly three million dollars) have been expended in the development and operation of NRC. Its staff is composed of a number of specialists, each of whom has considerable expertise in the procedures and techniques involved in compiling a resource inventory. In this light, it would seem rather foolish for any organization, government or otherwise, not to avail itself of such expertise. And yet, as I see it, that is in effect what the AGI and its contractor have done.

On the plus side, I think AGI deserves credit for recognizing the value of the resource inventory concept. I'm not here to coerce AGI into an unwanted relationship with the National Referral Center. What I am recommending is that the AGI Committee on Geoscience Information reevaluate its program, study its strengths and weaknesses, make further comparisons with NRC if need be, and then and only then decide on how to proceed with the development of its resource inventory.

As I said, we are ready to cooperate, because we think it will benefit us as well as the geoscience information community. If, however, the Committee reaffirms its previous decision -- so be it -- as a geologist and former "mud logger" in the California oil and gas fields I will do everything in my power to assure its success.

TOWARD THE DEVELOPMENT OF A GEOSCIENCES INFORMATION SYSTEM - RESEARCH IN PROGRESS

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Abstract - It is estimated that about 20,000 earth sciences related research projects are underway in the United States.

The Smithsonian Science Information Exchange attempts to provide to the geologic community a means of locating and evaluating this geologic research for which no published results yet exist. The Exchange solicits and inputs summaries of research projects sponsored by state and local governments, private foundations, universities, and industry, as well as the research funded by all Federal agencies. Response has been good in all of these areas with the exception of industry where proprietary interests sometimes inhibit cooperation.

The information received is stored in an IBM 360-40 computer where it is available for retrieval by both subject and administrative criteria. The subject index is conceptual in nature and organized into hierarchies. It is designed for both administrative personnel planning and evaluating programs, and individual scientists interested in research related to their own.

It is suggested that the proposed Geosciences Information System be decentralized with centralized services. In the area of Research in Progress, duplication of the activities of the Exchange would be inefficient. A much smaller effort could be expended to supplement the existing geological data base at the Exchange with the savings applied to those areas for which information systems presently do not exist. It is thus proposed that the Geosciences Information System consist of independent components which are coordinated to add their type of information to each inquiry received by the central system.

INPUT

It is estimated that about 20,000 earth sciences related research projects are underway in the United States. On a world wide basis, a rough estimate, about 75,000 earth science research projects is an indication of the size of a system necessary to handle the bulk of this type of information, if it were all available.

The Smithsonian Sciences Information Exchange, Inc., a non-profit corporation located in Washington D.C., maintains a national collection of scientific research information. This collection covers the entire area of current research, including both basic and applied aspects, with research summaries in medicine, life sciences, physical sciences, social sciences, and engineering. Over 100,000 current research reports are input per year. Of these about 15,000 are in the area of earth sciences, broadly defined, with about 4,000 in geology. The geological projects come from a variety of Federal sources such as the U.S. Geological Survey, the U.S. Bureau of Mines, the Department of Defense, the Office of Water Resources Research, the National Science Foundation, the Environmental Science Services Administration, the Bureau of Reclamation, the Office of Coal Research, the Environmental Protection Agency, the Department of Transportation, the Atomic Energy Commission, the National Aeronautics and Space Administration, and numerous others. Non-Federal projects are received from state governments, state geological surveys, universities, private foundations, foreign governments, and private individuals. The above list indicates the scope of the input operation. Reports of Earth Sciences projects are received annually from over 1000 separate sources including industry, although proprietary interests sometimes inhibit cooperation in this area.

A good deal of effort is necessary to build and maintain an adequate level of input. It is necessary that individual earth scientists submit summaries of their current research activities on a continuing basis at a time in which the demands of paper work are already excessive. Federal input to the Exchange is on a routine basis, but non-Federal input is voluntary and depends upon the good will of non-Federal organizations and of the investigators themselves.

THE BASIC DOCUMENT

The Notice of Research Project is the standard input document used at the Exchange. It provides the following basic items of information, all contained on a one-page form preferably completed by the principal investigator involved in the project:

1. Who is supporting the research.
2. Who is performing the research (principal and associate investigators).
3. Where the research is being performed (location and institution).
4. What is being done (title plus 200 word summary of the research).
5. When the research is to be carried on (fiscal year or years).
6. The amount of money to be spent on the research.

THE INDEXES

Upon receipt at the Exchange, the completed Notice of Research Project is registered, given a retrieval number, and input into the computer system. All of the information contained including the summary is indexed and coded into the data cell of an IBM-360-40 computer for future retrieval using twelve Bunker-Ramo 2206B/17 video display terminals.

The subject indexes are conceptual in nature and organized into hierarchies. Provision is made for surveys of broad areas and for pinpointing specific topics. As the system must deal with interrelated current research concepts, as well as specialized scientific nomenclature, the indexing is done by a staff of scientists selected for broad training in their fields. A series of independent indexes, each of which brings together all work in a given area, is used. The main indexes in the Earth Sciences Branch are as follows:

Astronomy	Mineralogy
Economic Geology	Oceanography
Engineering Geology	Paleontology
Geochemistry	Petrology

Geography	Project Location Index
Geologic Techniques and Instruments	Sedimentology
Geomorphology	Stratigraphy - Historical Geology
Geophysics	Structural Geology
Glaciology	Upper Atmosphere Physics
Meteorology	Water Resources

These main indexes are subdivided into hierarchies. The lower divisions represent current research interests as shown by the summaries received and evaluated by the Exchange Scientists. Each index is grouped logically into second, third, fourth, and fifth level topics and can be altered when necessary. New indexes are added and modified and others made obsolete whenever new material or new concepts appear. Each project is indexed by as many sciences branches as may have an interest in it and all of the branch indexes in the Exchange may be used in conjunction with each other for retrieval. An average of about a dozen index points are needed to cover the research descriptions available, however, as many as 40 may be used and are sometimes necessary.

The subject indexes are independent, but they may be used together for retrieval. For example, the index point for marine seismological studies is located in the Oceanography Index while the index point for the Gulf of Mexico is in the Project Location Index. A computer match of these two points will yield a printout of seismological studies in the Gulf of Mexico. The computer system provides for two, three, and four way matches of this type. Projects may also be selected utilizing searches which yield all projects indexed to one or more specific index points. All projects indexed to marine seismological studies can be retrieved or all projects taking place in the Gulf of Mexico. Projects may be selected or matched on any of the five hierarchical levels.

Project administrative information is also coded and indexed into the computer data cell for retrieval either alone or in conjunction with subject topics. One example of administrative retrieval is an investigator search in which all the current registered research conducted by a given individual is retrieved. Other administrative information retrieval includes searches for all registered research conducted by a given institution or in a given state or country. All registered geologic research at a given university is an example of retrieval resulting from a match between administrative and subject information.

OUTPUT

The information system is designed to serve administrative personnel in planning and evaluating research programs which will provide maximum return on the research dollar as well as working scientists interested in locating research related to their own.

The output of the system is tailored to meet the needs of the requester and is available in a variety of formats ranging from computer printed copies of the Notice of Research Projects to standard computer tabulations and listings of research titles ordered by investigator, location, or funding organization and selected by subject or administrative criteria. Specialized catalogs such as Marine Research - Fiscal Year 1968 or the Water Resources Research series are available under special contract. These catalogs are compilations of research in specific areas and contain subject and administrative indexes which are adapted by computer programs from regular Exchange indexes.

The Exchange also cooperated with the University of Tulsa Information Services Department, the American Association of Petroleum Geologists, and the Society of Exploration Geophysicists in the production of the Earth Sciences Research Catalog - Volume I.

DEVELOPMENT OF A GEOSCIENCES INFORMATION SYSTEM

It is suggested that the proposed Geosciences Information System be decentralized with centralized services. A network of independent components which are coordinated to add their specific type of information to each inquiry would appear to be the most efficient structure from an economic standpoint and from the standpoint of accessibility. In this manner advantage could be taken of existing data collections and specialized information systems. Publications, well logs, sample logs, maps, etc., would not need to be duplicated and new retrieval systems constructed. It should be required, however, that each component of the system have the ability to retrieve its material on a subject basis with a response time of one to two weeks.

In the area of research in progress money spent on duplication of the 15,000 research summaries held by the Exchange and the creation of a computer system to store and search this mass of data could better be applied to those areas for which information systems utilizing subject searches presently do not exist. A much smaller effort would be needed to supplement the existing data base at the Exchange particularly in the non-Federal area.

A request arriving at any component of the network could automatically be referred to as many of the other components as applicable with a stated response time. The resulting information would be collected and forwarded to the requester.

Costly duplication of information and efforts could thus be avoided and the specialized information centers would have continued incentive to improve their data collections, their services, and their internal retrieval systems.

DATA STANDARDIZATION IN GEOLOGY

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Abstract - To be effective in solving geological problems, the growing mass of numerical earth science data, (largely geophysical and geochemical), must be correlated with geological 'ground truth' data. Lack of a standardized system for recording these largely qualitative geological data not only inhibits this correlation but denies earth scientists the use of statistics and systematic ordering and recall of data as a basis for geological interpretation.

The essential steps in standardizing geological data are 1. to establish content - the minimal factual observations that are necessary for objective description of each geological entity, (rock exposure, mineral deposit, stratigraphic holotype etc.); 2. to establish notation - the descriptive terms and units for recording the descriptions, which must be free from subjective input by the observer, and 3. to establish a method of recording data that will be compatible with computer usage. Such standards must provide flexibility to enable geologists to record additional data to meet specific requirements.

Some projects employing teams of observers have introduced data gathering standards successfully and have even converted geologists to their use. National and international committees are trying to bring about adoption of standards with the hope of facilitating exchange of data and eventually, the establishment of archival data sources. General acceptance of standardization, however, will depend upon explicit demonstration of its practical advantages.

Introduction

As a descriptive science dependent mainly on qualitative observations, geology has amassed a staggering volume of literature, (Craig 1969), notable more for its discussion, conclusions and concepts than for its factual content. Even its maps are the product of subjective interpretation and subject to significant change with time and changing ideas. In fact, it lacks a consistent data base.

In recent decades by contrast, geology has been increasingly challenged by geophysical and geochemical observations that are disciplined, quantitative and reproducible. Indeed, for such essential, pragmatic purposes as mineral and petroleum exploration, companies place greater reliance on geophysics and geochemistry than they do upon geology, at least in terms of money expended.

Nevertheless, geology is the main integrating and interpretative discipline among the Earth Sciences, which has developed the unifying concepts that interpret and explain the composition, distribution and structures of the rocks comprising the Earth's Crust and the mineral and energy resources that they contain.

Geology is primarily dependent upon comparisons and recognition of similarities as the basis for constructing a system of classifying such entities as rock formations, mineral deposits, fossils, stratigraphic sections, rock types, biostratigraphic zones and many others. Minerals by contrast are one of the few geological entities that can be defined in quantitative terms, (of atomic structure and elemental composition).

Because rocks as exposed in outcrop or section comprise a continuum whose characteristics vary from point to point, it has not been feasible to record the great volume of facts needed to define the rock at each outcrop. Instead it has become the practice to integrate salient observations on the spot and to record a conclusion in the form of a rock or formation name rather than the facts on which its choice was based. Because there is wide variance in the training of geologists which is reflected in the classification they use, and in their experience which may affect the parameters on which they base their integrations, other geologists can rarely interpret such records unequivocally as they could a record of facts. This practice of recording integrated facts in the form of subjective conclusions is true for most other geological entities and is a major obstacle to more effective use of geology as a problem-solving science.

Reasons for Standardization of Geological Data

The primary reason for standardizing geological data is to provide a reliable and consistent basis for solution of problems and for the evolution and testing of geological thought. Acceptance of such standardization, for example, would permit comparison of local phenomena with those in the World's classic type localities which have been exhaustively studied and explained, and thus greatly increase the power of geologists to solve local problems.

Availability of standardized objective geological data would materially improve the usefulness of numerical, geophysical and geochemical data by improving their interpretation in terms of 'ground truth'. Thus unified, the Earth Sciences would be much more effective in exploration for mineral resources than they are when considered individually as at present.

Applications of mathematics and particularly of statistics to geology that have become possible with the development of modern computers, offer the advantages of logical and systematic ordering, classification, comparison and interrelation of geological facts; identification of trends, clusters and correlations that require geological explanation; a means of testing geological concepts, models and hypotheses; and a quantitative basis for the solution of such problems as the prediction of probability of occurrence of specified types of mineral deposits in a given region. Such use of mathematics can be effective only where standard and comparable geological data are available; statistics cannot be applied to subjective conclusions that are the usual records of geological investigations.

The need for international geological correlation for purposes of ensuring a continuing supply of energy and fuels for the increasing World population, of providing a basis for policies to develop and preserve the environment and to increase man's understanding of the earth's crust, has been recognized by a proposed joint I.U.G.S.-UNESCO International Geological Correlation Program (See Unesco Document No. SC/MD/16, Jan. 1970). An essential basis for this program is the provision of comparable geological data, as recognized by assignment of one of its four divisions to this task.

The enormous memories of modern computers and their ability to order, search and process the facts they contain, offer the opportunity to geologists, for the first time, to base their science on recorded facts instead of recorded conclusions. In order to take advantage of this opportunity, geologists must set their house in order by establishing agreed standards for their scientific data. Three aspects of standardization are suggested in this review:

1. Standardization of observations, including the establishment of standard geological 'bench marks' such as Hedberg's 'stratotypes'.

2. Standardization of the means for recording and transmitting geological data; notation, units and terminology.

3. Standardization of input for computer storage, and of processing programs.

Standardization of Required Observations and Measurements

Unquestionably the most important requirement in standardizing geological data is to ensure that equivalent data are recorded for all examples of each geological entity so that, independent of a preferred classification, hypothesis or genetic concept, there shall be a record of comparable facts. It is a measure of geology's progress as a disciplined science, that there are so few geological phenomena for which an agreed checklist of necessary observations and measurements exists. A notable exception is the list of requirements for establishment of new mineral names, as approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association (Donnay & Fleischer (1970)).

The sheer complexity and volume of desirable observations must be balanced against the time and effort needed to record them, and assessed in terms of frequency of use and relative importance to specific projects and as permanent records. The number of observations needed can be greatly reduced by limiting the size of the entity to be described. It is, for example, convenient to devise separate checklists of observations for sedimentary, igneous, volcanic and metamorphic rocks but in doing this a subjective decision is first needed as to which type of rock is involved.

A further factor is that differing classifications and concepts require different observations and the average geologist is unwilling to make observations that are not required for the classification or concept that he favours.

Attempts to establish checklists of geological observations on mineral deposits illustrate these problems very well. They vary from comprehensive lists such as that of the British Columbia Department of Mines and Petroleum Resources (See Robinson (1970) pp. 381-385) and that proposed by the Canadian National Advisory Committee (Brisbin & Ediger (1967)), to lists that comprise only geographic location, commodities, name, degree of development, estimated tonnage and grade but no geological data that will permit their classification or comparison with other deposits. The latter reflect either a cynical attitude toward the value of geological data or inability of geologists to agree on any observations except those that are not geological. It is possible that statistical evaluation of the importance of each geological observation to the phenomenon, (e.g. mineral deposit), being described may aid selection of a checklist.

Clearly it is important to review and list all geological entities for which standard observations are desirable (rock exposures, mineral deposits, stratigraphic sections (including wells and drill holes), rock formations etc. For each such entity, possibly relevant observations and measurements should be listed and a selection made of those that are best suited as a basis for objective classification. Once such a list is compiled, it could be submitted for approval by the International Union of Geological Sciences and then become the international standard. Because geology is a dynamic science, any such list should be reviewed and modified periodically. Once established, the observations it requires should be considered to be the minimum to be recorded: additional observations would probably be required to fulfil the needs of individual observers.

Establishment of Regional 'Holotypes'

In order to facilitate correlation internationally, it is desirable to establish well-studied and correlated standards that are accessible in various regions throughout the World. Perhaps the most important of these are stratotypes (standard stratigraphic sections) as proposed by Hedberg for the International Geological Correlation Program. Fossil holotypes or models are already in wide use as international standards. Dr. Subba Rao has proposed establishment of a petrological museum to house standard rock types, a suggestion that could be extended to include preparation of standard suites of specimens representing all commonly-used rock names. It is even possible that certain well-studied mineral deposits could be selected that exhibit essential characteristics of such well-known types of deposits as porphyry copper, stratabound massive sulphide, supergene enriched copper deposits etc. All such regional geological holotypes should be fully described, with emphasis on features common to each type. Results should be published by I.U.G.S.

Standardization of Means of Recording and Transmitting Geological Data

Once the standard observations and measurements have been made, it is essential that they be recorded in forms that are universally and unequivocally understood. Ideally, the forms used should be wholly objective expressing statements of fact that require no subjective interpretation by either the writer or the reader. This utopian objective will be difficult to achieve but it is important that it be stated.

Traditionally, geological information is expressed graphically in maps, sections and figures, illustrating and amplifying written reports. Harrison (1963) has underscored the fact that geological maps are the products of research and express scientific interpretation and conclusions. Even a geologist's notebook and the air photographs or other working sheets on which the day to day graphic record of his mapping is recorded, contain conclusions expressed in formation and petrological names, postulated structures etc., rather than the actual observations on which these are based. It is no secret that maps of equivalent areas by different geologists may be significantly different, reflecting differences in their training, experience and scientific interests. There are, therefore, real limitations on the usefulness of such maps for a comparison of geological facts. This has necessitated their re-interpretation by a single geologist in order to achieve a consistent basis for such procedures as statistical evaluation of mineral potential. The re-interpretation, unfortunately, involves reduction of the information each map contains in terms of a new legend that represents the highest level of information that is common to them all. Inevitably, there is loss of useful information that is not common to all the maps. For such purposes of course, a regional map compiled with the assistance of authors of all the more detailed maps is the best compromise. As a consistent data base such a regional map is still not as good as maps and profiles which portray observed facts would be, combined with computer records of numerical and other data that cannot be adequately presented graphically.

Geological terminology has evolved by haphazard accretion of terms and, with minor exceptions, lacks a systematic basis. Generally, these terms have been coined as a type of shorthand to convey a mixture of several characteristics and often have genetic implications. Few subsequent users of such terms can match exactly the phenomena for which they were originally coined and thus by usage, considerable discrepancies in meaning develop. Even such simple and widely-used terms as common rock names defy attempts to give them unique and systematic definitions. There is no question that such terms have become accepted and necessary to written geological reports. As a means of recording geological data however, they are imprecise and involve subjective input and interpretation. A further difficulty in existing terminology is the difficulty of translating from one language to another.

The units used in recording numerical data are readily convertible by computer but there are minor advantages to international use of the metric system. There are also advantages to standardization in usage of 'relative' units such as parts per million. In matters such as chemical composition, it is desirable to bring about a concensus as to whether they should be expressed as percentages of oxides or elements. Finally, agreement is required on a standard method of recording limits of accuracy.

For purposes of recording and transmitting qualitative geological data (as distinct from geological information), it may be necessary to devise a system that is free from the uncertainties of existing nomenclature. This might involve recording the essential observations (on a rock for example), rather than recording the conclusion as to its name. Studies by Hubaux and Hugi (1969) and by Wynne-Edwards (1970) have listed observations on rocks that should be recorded. Germeraad & Muller (1970) among others have presented a system for recording characteristics of spores and pollen.

Probably the most comprehensive system for recording observations instead of names is that of 'semantic analysis' developed by Laffitte and Dixon (Laffitte 1968,1969), Dixon (1969,1970)). Their system is designed for application to any type of geological phenomena. For each such type, a series of "classification attributes" are chosen which taken together provide essential data for classifying or naming the object described. Their method involves a sequence of questions each answerable by an affirmative or negative response. These responses when recorded as a sequence of binary digits or 'bits' (1 or 0), can be compared, integrated and processed by computer and interfaced with any system of classification in any language.

Standardization of Input for Computer Storage, Processing and Retrieval

Modern trends in computer input and storage are toward maximum flexibility and reduction of the need for coding and fixed formats. This becomes easier as computers increase in size and computer programs become more sophisticated. The real boon of such modern input and storage systems is the readiness with which they can be modified to suit many different purposes but still make use of the same basic programs.

Earlier computer input systems, particularly those employing coded and fixed formats, had the advantages of 1. acting as checklists to ensure that all required data are recorded and 2. ensuring that the data were recorded consistently in accordance with the definitions of an agreed code. Because these features of older systems favoured systematic standardized records, it was hoped that use of computers would bring about some standardization of geological data. It is hoped that these real advantages will not be lost as a result of the increased flexibility of input to modern computers.

All users of computers will be aware of the truth embodied in the phrase "garbage in: garbage out". For storage and retrieval of geological data, the use of terms incapable of precise and unique definition, or of terms reflecting or implying subjective conclusions, is the equivalent of garbage. There is, of course, a place for these terms as a record of professional opinion and in fact they can be used as samples of information providing it is recognized that they are samples of opinion, not samples of fact.

The best use by geologists of the enlarged memories of modern computers would appear to be the recording of the reproducible observations needed for systematic geological classification - the "classification attributes" of Laffitte and Dixon. These basic observations can be interfaced with any designated classification in any language.

I am indebted to my colleague, Dr. J.O. Wheeler, for the observation that because geology is dominantly a continuum, analogue records may be more appropriate and revealing for field geology than digital records. This is particularly true in areas of high relief where good exposures permit tracing of recognizable features such as marker horizons, intrusive contacts, faults and other structures, and particularly of recognized stratigraphic sections. In such records it may be much easier to recognize gradual changes of facies and metamorphic grade than it would be from digital records. In areas of poor exposure however, use of analogue records introduces a large element of subjective interpretation. For purposes of computer processing and retrieval, digital records have overwhelming advantages as evidenced by the fact that records of geophysical measurements, earlier recorded in analogue form are usually converted to a series of closely spaced digital records. The advantages of digital form for storage of geological data are that processing and retrieval are greatly facilitated. If these 'point source' data are plotted by computer, the geologist interpreting them can readily weigh alternative possibilities and add the observations that will result in maps exhibiting continuity of formations or other phenomena.

The Establishment of Standards

Standards for local areas or specific projects can usually be hammered out between the few scientists involved to satisfy known requirements. Standards for international correlation on the other hand must satisfy a wide variety of projects and be understood by the World's geologists in many languages. It is in this broad context that national and international organizations are active.

Probably the greatest advances have been made by the large multinational oil companies which can specify their requirements and assign competent staffs to satisfy them. In the public domaine, national and international organizations are active as time from other commitments permits and with very limited funds. In Canada, for example, the National Advisory Committee on Research in the Geological Sciences (NACRGS) has sub-committees active in defining data to be observed on mineral deposits, field exposures (outcrops), and in the realm of geochemistry. Furthermore, on the advice of NACRGS, the Canadian Centre for Geoscience Data has been established by the Geological Survey of Canada, one of whose responsibilities is to serve as a stimulant to, and focus for storage of geological data.

The International Union of Geological Sciences through its Commissions on Stratigraphy and Petrology has working groups assigned to systemization of World geological data and to definition of terminology. Its Committee on Documentation is working on modern geological lexicons in up to 8 languages. Its Cogeodata Committee is working on means of recording data on mineral deposits, geochemical data, palaeontological data and petrological data. Such well-known organizations as the American Commission on Stratigraphic Nomenclature define and correlate terminology for whole continents. Nationally, geological surveys and institutes identify and define specific rock formations and other entities of all types. There is thus, an imposing array of organizations engaged in bringing order to the geological record but despite their names, few are wholly devoted to the facts of geology.

Use of Standardized Geological Data

It is not the purpose of this paper to describe in detail the uses of standardized geological data nor of the files in which they are found. Two recent papers that do give some insight into such uses are Burk (1971) and Robinson (1970). In addition, the field of data standardization in geology and uses to which such data are put, are listed on a World-wide basis, Hruska & Burk (1971) and in an earlier annotated bibliography by Hruska (1968).

One field that has made successful use of some forms of standardized geological information, including data, are computer-based indexes. The major bibliography of the American Geological Institute is possibly the best known of these. Another more directly devoted to data is the Canadian Index to Geoscience Data which provides indexing by subjects, (such as copper, conodonts, Con-Rycon Mine, Coniacion Stage, Copes Bay Formation etc.), and by geographic area and author.

For such geological entities as mineral deposits, there has been a retreat from early files that contained abundant geological data to modern computerized ones that are, in fact, a specialized index, often limited to the name, location, commodities contained, tonnage and grade, state of development and references. Although these and others like them are referred to as geological files, in fact they contain little or no geological data at all. Well data files in the petroleum industry contain the usual index data together with engineering and geophysical data but their geochemical files may contain considerable geological data used to describe the samples analysed.

This retreat from geological data is also reflected in deliberations of committees and working groups whose recommendations are usually specific as to content and form in which index data (name, location, etc.) are to be recorded but rarely achieve more than broad generalities concerning content and form of geological facts. The few recommendations that have been specific as to content and form of geological data are usually the butts of vigorous, but rarely constructive, criticism.

The greatest use of standardized geological data is in project files, mine records and similar documents pertaining to a limited area or limited field in which small numbers of geologists are concerned. An example is mine geology where records are kept in terms of local geological entities, usually defined by two or three characteristics and often illustrated by 'bench mark' samples of rock, ore and drill core. Examples in field geology include, Operation Pioneer (Haugh, Brisbin & Turek (1967)), the Coast Range Mountain Project (Hutchison & Roddick (1968)), the Grenville mapping project in Quebec (Wynne-Edwards et al. (1970)), and recording of sedimentary strata in Greenland (Alexander-Marrack, Friend & Yeats (1970)) and in Spitzbergen (Piper, Harland & Cutbill (1970)).

Archival geological files required for purposes of wide-scale comparison of geological phenomena (such as mineral deposits), for statistical identification of trends, for long range correlation, for evolution and testing of geological ideas, and for pragmatic purposes such as estimation of regional or national energy and mineral potential have had little support. It is possible that the usefulness of such files will be established in the context of World-wide and national programs designed to apply geology directly to appraisal of mineral and energy potential. Such a process requires the interpretation of geology in terms of the probability of existence of unfound resources. If this becomes an objective of such programs as the I.U.G.S.-Unesco International Geological Correlation Program, computer-based files of standardized geological data, in addition to major files of geophysical and geochemical data, may eventually be funded and supported. In the meantime it is important that advances in standardization of geological data for individual projects be recorded, be compiled and assessed by national and international committees, and be disseminated as widely as possible. If this is done, certain basic elements at least will emerge that have been tested and found generally useful.

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GEOSCIENCE PUBLICATION

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Abstract - Periodicals and books, the geoscience publications having the most impact on the researcher, are experiencing the greatest financial difficulties and the most severe criticism of their efficacy as information-transfer media. The cost of reviewing, editing, and typesetting the JOURNAL OF GEOPHYSICAL RESEARCH is almost \$60 per page; printing and mailing add \$0.0027 per page per copy. However, perhaps only a few of the 40 articles in a typical issue contain information relevant to an individual researcher. An integrated information system that articulates all methods of publication and dissemination of information in order to serve the needs of scientists as fully as possible at a reasonable cost to the users at both ends of the system is required. Papers of a broad interest should continue to be published in the traditional format, whereas others could be abstracted or listed by title only; the mode or presentation would depend on an evaluation by peer review. Availability in microform or hard copy by request or through previously established interest profiles is essential. Indexing would also be critical to provide ready access to the published paper and the information in storage. Publishers who do not adopt a flexible approach that maximizes the sum of the benefits to authors and information consumers are not likely to survive in the competition for author prestige and reader attention.

Publication is a major segment of the information-transfer system, which is the life blood of science. The users of this system are the authors and the readers. Publishers and libraries are part of the system, but their sole function is facilitating the use of the system. The publishers and libraries have a responsibility to remain flexible as changing technology and new techniques in research up-end traditional points of view and alter user requirements.

Almost all the problems related to geoscience publication can be traced to increasing volume. More is being written, and so storing, indexing, and retrieving according to user demands become increasingly more difficult.

Briefly examining the requirements at the input and output ends of the system, we find the author demanding timeliness of publication, the broadest possible audience, a prestige journal, and minimal cost to him. The reader is similarly looking for timely publication at minimal cost, but his greatest problem is obtaining essentially complete coverage of the important literature in his specialty, within the usual constraints of reasonable expenditure of time and money.

In their effort to mate the requirements of authors and readers, publishers and libraries operate within a financial framework that necessarily imposes limitations on both the input and the output functions. The ability to substantially change the financial framework is more limited than the ability to change the systems supported by it. Therefore, it is useful for us to approach the analysis of the system from the financial point of view.

Publication costs and financing

Table 1 gives a breakdown of the expenses associated with the production of the JOURNAL OF GEOPHYSICAL RESEARCH, a publication of the American Geophysical Union that is comprised exclusively of original research articles. Although no journal is likely to be representative of all geoscience journals, the costs for JGR will express at least the order of magnitude of the expenses associated with publishing a journal in the traditional format.

The item Editorial Offices includes the cost of the scientific editing and peer review that each paper undergoes. This step of the publication process is critical to the system, since the revision-rejection procedure improves the product for the reader by raising the standard of the journal which in turn provides greater prestige for the successful author.

How extensive the redactory process should be causes continuing debate between authors and publishers. It is safe to say that if material is to be set in type, there must be at least manuscript marking and proofreading. All primary publications of the American Geophysical Union, including JGR, are also edited for clarity, correctness of grammar, and uniformity of style. Composition costs can be reduced by careful attention to the format of such items as tables and mathematics.

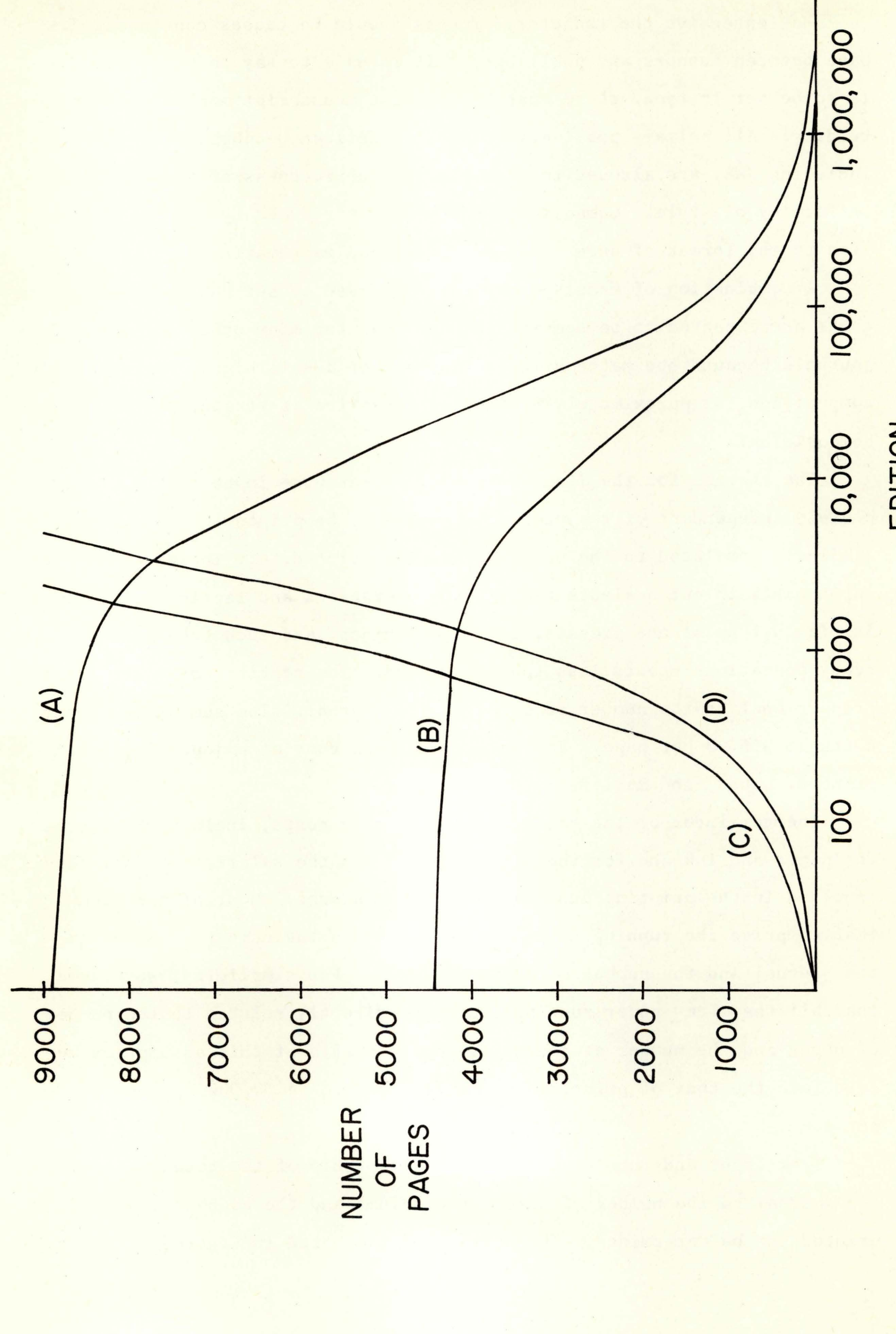
A combination of monotype and linotype used to set JGR and composition costs are expected to be somewhat higher than for many other geoscience journals because the mathematical component of JGR is high. Mathematical composition is approximately 3 times as expensive as straight text composition.

The charges for the items discussed so far (the input costs) are completely independent of the number of copies to be printed. Two other items, similarly unrelated to the number of copies printed, are included with the input costs in our analysis (make-ready operations and reprints). The initial set up of the presses, binding machines, and such (the make-ready operations) costs less than $5 a page. The reprint costs are nearly proportional to the number of pages in the journal. The sum of the input costs is $56.90 per page. For this amount one copy of a journal can be printed, bound, and mailed.

The remainder of the costs, termed running costs, include the charge for paper and ink and for the time on press and the salaries of individuals involved in the printing and circulation procedures. Most of the items that comprise the running costs are dependent on the number of pages in the journal and the number of copies printed. For simplicity, we assume that all the items under running costs are directly related to the number of pages and the number of journals. On the basis of this assumption we calculate the cost of printing and mailing JGR to be $0.0027 per page per copy.

From input and running costs the relationship of the total cost of the journal to the number of pages in a volume and the number of copies printed can be determined. This relation is plotted in Figure 1 for

Figure 1



NUMBER OF PAGES
9000
8000
7000
6000
5000
4000
3000
2000
1000
(A)
(B)
(C)
(D)
100
1000
10,000
100,000
1,000,000
EDITION

several different conditions.

Curves A and B are based on a fixed total cost of $500,000 and $250,000 respectively. For a fixed budget the number of pages that can be printed remains relatively constant within the circulation range of most primary geoscience journals.

Many scientific societies have adopted the policy of assessing the author a per page charge. This source of income allows expansion of material published without serious financial handicaps. Curves C and D are plots of page versus edition using the JGR relationship of input and running costs. For both curves the income from subscriptions is $50 per volume; for curve C the income from publication charges is $50 per page and for curve D, $45 per page. For case C to keep the subscription cost of the journal at around 1¢ per page, a good figure for journals with a page charge, only 1000 fullrate subscriptions must be sold; additional copies could be printed and sold to members at the rate of $12.50 for 5000 pages. For case D 1800 fewer pages can be printed with the same number of subscribers. We see that 35% fewer pages can be printed if the publication charges decrease by about 10%. If input costs are considerably greater than the running costs and if income is not received on a per page basis, the number of pages that can be printed per volume must be controlled rigidly.

Thus far we have considered only periodical publication. Additional costs are incurred in the publication of hard-cover books: the binding and promoting. Binding a 300-page book will cost about $2 per copy. A minimum expenditure for promotion would be $1 per copy. Thus $3 per book must be added to the input and running costs (Table 1). For an edition of 1500 to 2000 each book will cost $5 per 100 pages plus the $3 for binding and promoting. Book publication is clearly an expensive mode of information-transfer and its advantages should be weighed carefully before it is undertaken.

Users Requirements

To achieve publication as rapidly as possible, (a major requirement for the author) the number of contributions must not be able to overload the system either physically or financially. Continuing attention must be given to the process of reviewing and redacting. More timely publication can frequently be obtained by sacrifices in quality or by changes in the format of the final product. The author also requires from the information-transfer system circulation to those interested in his work. To meet this need, the publication must be available through most major libraries and should reach key individuals directly either through subscriptions to the journal or through reprints. The author and his institutional supporters also seek the prestige of appearing in a respected publication. Many factors are coupled to the prestige quotient, including the reputation of the journal gained through its reviewing and publication policies, the quality of its redacting and composition, and the professional appearance of the final product.

The final requirement of the author, to obtain all of the foregoing at minimal or essentially no cost to his research budget, is the one most difficult to meet. However, at present he is, or should be, relatively satisfied with the system, since if necessary he is able to escape the burden of the publication charges, either by declining these charges, which are rarely made mandatory, or be seeking to publish in journals that do not assess them. It can be expected that as the volume of material to be published increases pressures will also build to process information faster, and the cost to the author will rise unless compromises are made.

The primary problem for the reader is to become aware of publications in his field. He will perhaps read some of these, but he must be able to retrieve on demand what he requires to support his research. If he is actively engaged in a project, developments in his field must be available immediately. The present system cannot adequately meet the need for immediate dissemination of information. Many investigators now rely more heavily on personal communications. For the reader the early publication of the abstracts of papers in press and the more rapid handling of material for publication would be desirable.

The reader must be able to cover the important literature in his specialty. He requires immediate indexing of material in press and announcement journals that are specialized enough that he need not spend an inordinate amount of time scanning material that is of little or no value to him. Since abstracts will not always provide enough information he must have access to reprints either through the author or the publisher and after publication access to copies of the material through library collections.

Possible Solutions

Bearing in mind that the financial support for scientific publishing comes directly from research funds, we question whether the present information-transfer system is operating efficiently as possible. It seems evident that the burden of producing an alternative system that lowers the user's expenditure of time and money rests largely with the publishers.

In Table 2 the costs of conventional publication are compared with the costs of other means of distributing information. The cost of peer review now about \$8 per page, must be expected to increase substantially in the future in response to the demand for more selective reviewing. Greater effort to avoid dual publication of material will be required. An attempt to reduce costs at this initial stage of the information-transfer system will not be a service to either the author or the reader.

Redacting, which currently costs about \$10 per page, could range from \$0 per page to \$12 per page. The high end of this scale can be allowed only for a wide readership, in particular a readership not highly versed in the specialty treated. Certainly when hard-cover publication is justified or when review articles of broad general interest are printed, the highest quality redacting is indicated. On the other hand, if a paper is to be read by only a few researchers in a very specialized field, the \$10 treatment may be a regretful squandering of resource.

Hot-lead composition of mathematical material is one of the most expensive typesetting jobs. At present many jobs set by computer methods are also very costly. Intermediate-priced methods of setting would include typewriter composition, some cold type methods (Varityper and IBM Magnetic Tape Selectric System), and hot-lead composition of straight text. No outlay for composition would be required if the author submitted camera ready copy. The composition method used will also influence the savings that can be allowed in the redacting operation. Redacting can considerably lessen composition expenditures by reducing changes in proof and by altering format to avoid the most time-consuming and costly handsetting.

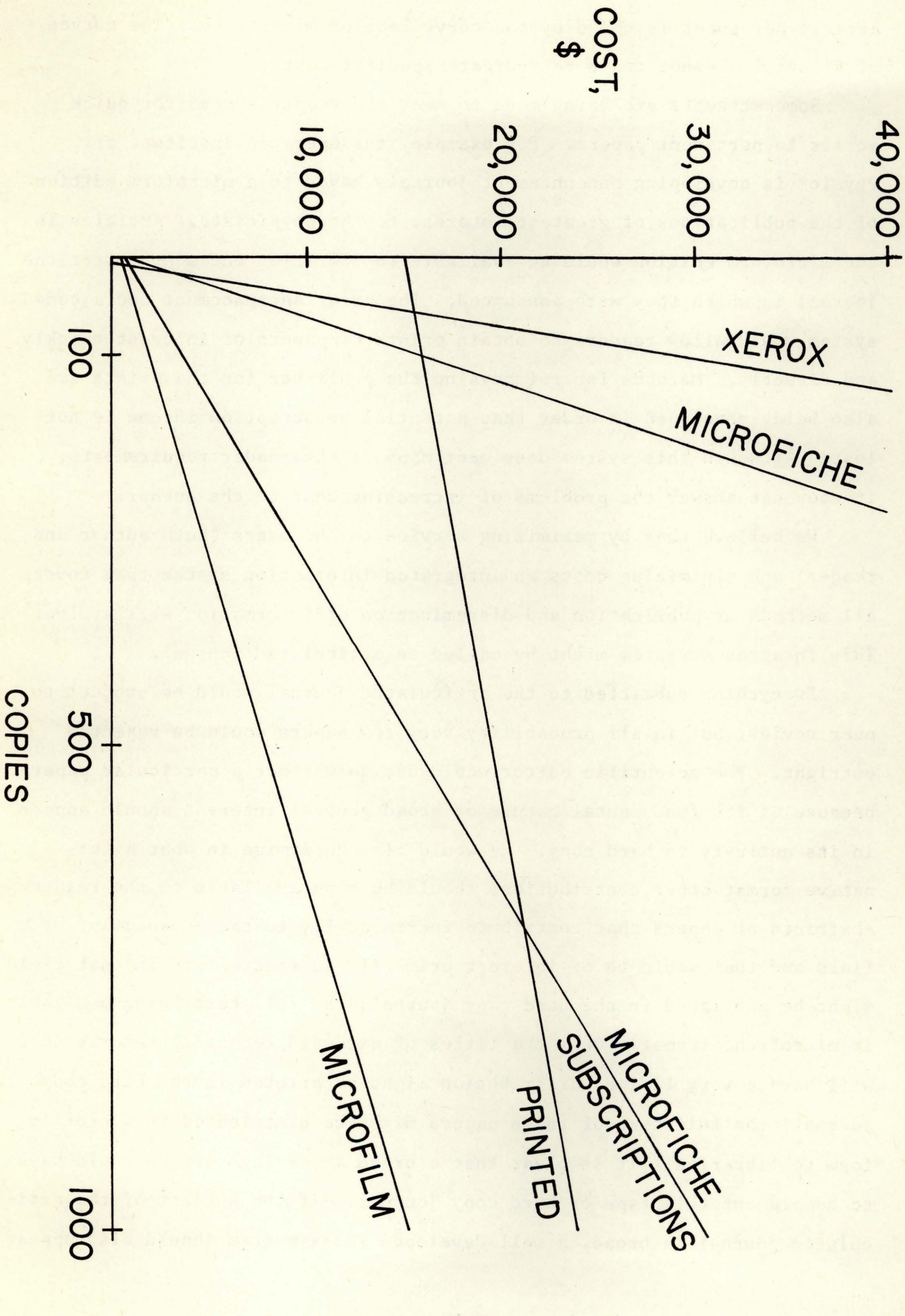
Most computer methods of typesetting are now included in the highest price bracket because of the expense of making alterations in proof and the difficulties of handling mathematical and tabular material. It is likely that a method or reducing the costs of changes in proof will be developed sooner than a method for handling difficult composition.

The $5 per page make-ready operations for conventional printing can be lowered if film is used as the publication medium. These initial costs could be reduced to essentially zero for a Xerox reproduction scheme.

The costs of reprints have not been included in the cost breakdown shown in Table 2 because under the alternative schemes these costs could become part of the distribution costs rather than the input costs. In alternative system reprints might easily comprise the major portion of the distribution of any single article.

On the basis of printing and distribution costs ink on paper is by far the cheapest method to use if broad distribution is contemplated. For reduced distribution microfilm, microfiche, or some form of photo reproduction or etechostatic copying could prove less expensive. In Figure 2 the relative costs for producing and distributing a 3000-page journal by these various methods are shown for an edition of 0 to 1000 copies. The curve labeled microfiche-subscriptions reflects the cost if each sheet contains as many text pages as possible (about 100 pages)

Figure 2


COST, $
40,000
30,000
20,000
10,000
XEROX
MICROFICHE
MICROFICHE SUBSCRIPTIONS
PRINTED
MICROFILM
100
500
1000
COPIES

instead of just the text of one paper (1 to 50 pages). The cost for one article per sheet is shown by the curve labeled microfiche. The curves of Figure 2 are.not meant to indicate specific costs.

Some attempts are being made to meet the reader's need for quick access to pertinent papers. For example, the American Institute of Physics is developing announcement journals keyed to a microform edition of the publications of greatest interest to the physicists. Articles in the microform edition would be available in libraries one month after the journal in which they were announced. The prior announcement and a coded system would allow readers to obtain prints of papers of interest quickly and directly. Methods for reimbursing the publisher for the prints are also being developed in order that potential subscription income is not lost. Although this system does meet many of the reader requirements, it does not answer the problems of increasing cost to the author.

We believe that by maximizing service to the users (both author and reader) and minimizing costs an integrated information system that covers all methods of publication and dissemination of information will evolve. This integrated system might be called an articulated journal.

Everything submitted to the articulated journal would be subject to peer review, but in all probability very few papers would be rejected outright. The scientific editor would decide whether a particular paper because of its fundamental nature or broad general interest should appear in its entirety in hard copy. He would also determine in what alternative format other contributions should be made available to the reader. Abstracts of papers that contribute incrementally to the advancement of a field and that would be of interest primarily to specialists in that field might be published in the hard copy journal, the full text being available in microfiche format. Only the titles of extended technical reports that will have a very limited distribution might be printed in the hard copy journal; the full text of these papers might be distributed in microfilm form to libraries. It is clear that a broad archiving service would have to complement this type of hard copy journal. If the subject of the articulated journal is broad, a well-developed index system should also appear in the hard copy journal and perhaps in tape format as well.

The introduction of such a system may cause some anguish for authors and editors, since at present rejection is a private matter but under the proposed scheme selection of papers would be public. Inevitable prestige might be attached to hard copy publication. This natural prejudice will have to be overcome through careful review procedures and clearly understood criteria for hard copy publication. Authors and readers alike must recognize that the reduction of both input and output costs will save substantial sums for the research community.

Perhaps the most interesting aspect of this proposal as far as the publisher is concerned is that experimentation along these lines can be tried without a commitment to irreversible changes in publishing practices. Furthermore, forward-looking organizations could begin today to adapt the system to their membership's needs and capital. In all probability such information programs will have to be based in the large societies since they have the resources to integrate a sufficient number of disciplines to make the program economically viable. Cooperative ventures among organizations with similar subject orientation could also be attempted. If geologically oriented societies begin to cooperate to produce such an articulated journal, traditional publications may become too great a luxury for the libraries. The traditional publications would have to find some way to participate in system or face extinction. Prospects for developing a system for timely dissemination of information at a reasonable cost are good if publishers and libraries do not insist on using publication methods that are fast becoming obsolete.

Table 1. Expenses of Publishing the JOURNAL OF GEOPHYSICAL RESEARCH

Input Costs		
Editorial offices	$ 7.60/page*	
Redacting	9.30/page	
Composition	31.50/page	
Make-ready operations	4.25/page	
Reprints	4.25/page	
Total	$56.90/page	
Running Costs		
Printing and mailing	19.55/page	(0.0026/copy/page)
Miscellaneous services and supplies	1.10/page	(0.0001/copy/page)
Total	20.55/page	(0.0027/copy/page)
Total of input and running costs	$77.45/page	(0.0102/copy/page)

* There are approximately 900 words to a page in JGR.

Table 2. Comparison of Conventional and Alternative Methods of Publication (Gross Estimates Only)

	Conventional Publication	Alternative Methods		
Input Costs				
Review	$8		$8	
Redacting	$10		$0 $12	
			intermediate	
Composition	$32	none		$32
		minimum	microfilm	microfiche
Make-ready	$5	$0	$0.10	$0.20
Total	$55	$8		$52
		hard copy	microfilm	microfiche
Printing and Distributing	0.26¢	10¢	1.0¢	5¢

Input costs are given in dollars per page of text.

Printing and distributing costs are given in cents per copy page. One copy page for conventional publication or alternative hard copy methods would be equal to one page of text; for microfiche, 100 pages of text; for microfilm, from 1500 to 2000 pages of text.

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