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Assessment of prestige and price of professional publications[1]

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Abstract

A bibliometric and citation analysis of seventeen major journals in mineralogy, petrology, and geochemistry led to relative rankings within those categories based primarily on their impact factors in the "Journal Citation Reports" of the *Science Citation Index*. A further study of the sources of financial support over the period 1980–1986 for the research reported in individual articles by persons listing U.S. addresses indicated that grants and contracts awarded by the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE), in that order, accounted for the vast majority of support. In journals containing more than 20% articles with U.S. authors, the level of grant support ranged from 34% to more than 85% (86% in *Journal of Petrology* and 89% in *Geochimica et Cosmochimica Acta*). Journals with the higher bibliometric ratings showed the higher levels of grant support. An opposite trend was noted for papers written by authors who gave federal agencies, museums, or laboratories as addresses: as a percentage of total papers from U.S. authors, theirs were somewhat more likely to go to journals with lower ratings. The number of grants per federally supported paper increased with journal reputation; the mean value for those papers with support was 1.25 grants, reaching 1.56 for the *Journal of Petrology*. Circulation data indicate that the dominant journals are published by professional societies (the Society of Economic Geologists, the Mineralogical Society of America, and the Geochemical and Meteoritical Societies).

An adjunct investigation of the institutional subscription prices indicates that professional societies are selling their journals' wares at one-third to one-twentieth the price of commercial for-profit publishers. Certain of the latter have reached costs to libraries in excess of $10 per article; the decline of the U.S. dollar in currency markets is by no means the only cause of that inordinate price.

Introduction

About half of the members of the Mineralogical Society of America (MSA) are professors, one-fifth are graduate students, and the remainder are split evenly as employees of industry and governmental agencies. So it is obvious that scientific research is the professional preoccupation of most of us. And because research is often expensive, the amounts and sources of its funding are likely to be indicators of the relative value it is accorded by those who engage in its pursuit. In the 1987 presidential address to MSA, entitled "Mammon and Prestige in Mineralogy and Petrology," I investigated the distribution of federal funding for research among U.S. Earth science departments, a subject I will consider in the second part of this written version of the address.[2] In this, the first part, I will discuss the tribunal in which the prestige of research is ostensibly judged, namely the archival literature.

For many decades the motto "Publish or Perish" has been the vexation of growing numbers of academic professionals, and at least in part because publication productivity has become the primary criterion for career advancement, the scientific literature is bloated with papers and an ever-increasing number of journals. Thus the relative quality of kindred periodicals—old or new, reviewed or not refereed, provincial or international, society nonprofit or commercial for-profit—is a matter of concern to the members of any identifiable subgroup of scientists. For the members of MSA, a study of selected journals in mineralogy, petrology, geochemistry, and related subjects seemed a reasonable way to begin objectively assessing prestige in these disciplines.

But what are some possible measures of the relative reputations of such journals? (1) Bibliometric rankings are reported annually in the "Journal Citation Reports" ("JCR") volume of the *Science Citation Index* (*SCI*); these include impact factor, immediacy index, half-life, number and source of citations, etc. (2) Circulation data related to the numbers of institutional subscribers and of

[1] Adapted from the Presidential Address at the annual meeting of the Mineralogical Society of America, October 27, 1987, in Phoenix, Arizona.

[2] The second part will appear later in 1988 in *American Mineralogist*.

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individual members of professional societies are useful, though difficult to obtain. And (3) there often is information in the "Acknowledgments" section of an article about the source or sources of financial support for the research reported therein that provides a link to another measure of prestige, i.e., funding obtained by the author(s) on a competitive basis.

Although alternate methods of research publication, such as microfiche and camera-ready copy, have been and are still being field-tested, typeset professional journals continue to be the medium of choice for scientific communication. In small and relatively circumscribed disciplines like ours, such journals tend to be expensive. At the moment, inflation is modest, but federal and state budget cutting, weakening dollars in currency markets, the ever-present profit motive, languishing mineral and fossil-fuel industries, and increased competition for research funding (particularly in Earth sciences) all conspire to closely focus attention on the rapidly rising prices of journals. Thus, as an adjunct to the investigation of prestige among professional publications, I have assembled comparative data on their prices. The purpose is to assist science libraries, professional societies, commercial publishers, and individual subscribers and authors in dealing with what is widely recognized—at least in North America—to be a crisis in library funding.

Journals assessed

Because English is the language of ~88% of the half-million articles and ~96% of the 7.5 million citations listed in the 1986 *Science Citation Index* (*SCI*; Garfield, 1987), I have chosen a limited number of primarily English-language journals to represent the research disciplines in which MSA members are involved, namely, mineralogy (including crystallography), petrology, and geochemistry. By definition, these are not mutually exclusive—the overlap is considerable. In Table 1, I have somewhat arbitrarily assigned journals to one category or another. For instance, *Contributions to Mineralogy and Petrology* and *Mineralogy and Petrology,* in spite of their titles, are assigned to petrology, whereas in one of the comparative studies the *American Mineralogist* is listed under both mineralogy and petrology in order to give a familiar point of cross-reference between the related categories.

Some journals were investigated less extensively than others. In particular, the sources of financial support for U.S. authors publishing in *Economic Geology* were not enumerated. And only the two-thirds of those papers in the *American Journal of Science* that I decided were "petrologic" in emphasis were evaluated in this manner. *Reviews in Mineralogy* has only recently been indexed by *SCI* (its first-reported impact factor is 3.52, based on 362 citations in 1986), so it lacks a sufficient database for meaningful comparison with other publications. The *Journal of Metamorphic Geology* has only been published since 1983 so its comparison with other journals in petrology is somewhat less than equitable.

Clay Minerals (British) and *Clays and Clay Minerals* (U.S.) were taken as representative of an important subdiscipline of mineralogy and crystallography, and *Mineralium Deposita* and *Economic Geology* represent ore mineralogy and petrology, the former a commercial journal with an associated professional society, the latter a journal of a society whose membership is about 5000.

In geochemistry, *Geochimica et Cosmochimica Acta* is the giant. It is one of two journals offered to the membership of both the Geochemical Society and the Meteoritical Society, but it is published for profit by Pergamon Journals. The other periodicals chosen for inclusion are *Chemical Geology* and *Geochemical Journal. Geochemistry International* is an English translation of the Russian monthly *Geokhimiya*; it has very limited circulation (80 in 1987) and high price ($625 in 1988).

I did not attempt to survey the crystallographic literature because a detailed bibliometric and citation analysis was recently completed by Hawkins (1980). Careful examination of the *American Mineralogist* and *Zeitschrift für Kristallographie* showed that 156 and 80 papers (respectively) describing crystal-structure determinations of minerals and directly related synthetic compounds appeared in the period 1980–1986. Judging from their indexes, the five European journals of mineralogy (*Mineralogical Magazine, Bulletin de Minéralogie, Schweizerische Mineralogische und Petrographische Mitteilungen, Rendiconti della Società Italiana di Mineralogia e Petrologia,* and *Fortschritte der Mineralogie*) published about 65 mineralogically related structure papers.

Financial support data were collected for the years 1980–1986, with these exceptions: (1) the *Journal of Metamorphic Geology* (1983–1986), (2) *Mineralium Deposita* (1980–1985), and (3) *Clays and Clay Minerals* (1980–1983, 1985, 1986). Bibliometric data from "JCR" were available for all years for (2) and (3).

Tools of assessment

Science Citation Index

The Institute of Scientific Information (ISI) of Philadelphia, Pennsylvania, was organized by Eugene Garfield. It has made outsized contributions to the *rate* and thus the quality of communication in science through its weekly *Current Contents* and annual (since 1964) *Science Citation Index* (*SCI*). In 1986 alone, 4316 journals containing 480 642 "source items" (articles, excluding abstracts of papers presented at meetings) and 7 464 192 "citations" (references) were processed by ISI and catalogued in many useful ways. Of particular relevance in our evaluation of selected journals are the *SCI* "Journal Citation Reports" ("JCR") that answer these basic questions: "How often has a journal been cited? What journals have cited it? How frequently . . . ? What journals has it cited? How often? What are the chronological patterns of citation (older or newer material)? What is the degree of self-citation?" ("JCR," 1985, vol. 19, p. 7A).

I have collected data on the journals in Table 1 for the

TABLE 1. List of journals and their publishers, grouped by category

Abbreviation	Journal title*	Publisher(s)
	Mineralogy	
Am Min	*American Mineralogist*	Mineralogical Society of America
RiM	(*Reviews in Mineralogy*)	(Mineralogical Society of America)
Bull Min	*Bulletin de Minéralogie*	Société Française de Minéralogie et de Cristallographie
Can Min	*Canadian Mineralogist*	Mineralogical Association of Canada
Min Mag	*Mineralogical Magazine*	Mineralogical Society of Great Britain and Ireland
P C M	*Physics and Chemistry of Minerals*	Springer-Verlag
	Petrology	
A J S	*American Journal of Science*	Kline Geology Laboratory, Yale University
C M P	*Contributions to Mineralogy and Petrology*	Springer-Verlag
J Met Geol	*Journal of Metamorphic Geology*	Blackwell Scientific Publications
J Pet	*Journal of Petrology*	Oxford University Press
Lithos	*Lithos*	Universitetsforlaget (through 1983); Elsevier Science Publishers
Min & Pet TMPM	*Mineralogy and Petrology* [formerly *Tschermaks Mineralogische und Petrographische Mitteilungen*]	Österreichischen Mineralogischen Gesellschaft; Springer-Verlag
	Geochemistry	
G C A	*Geochimica et Cosmochimica Acta*	Geochemical Society and Meteoritical Society; Pergamon Press
Ch G	*Chemical Geology*	Elsevier Science Publishers
G'chem J	*Geochemical Journal*	Geochemical Society of Japan
—	(*Geochemistry International*)	(Scripta Technica—John Wiley & Sons)
	Other	
Cl Min	*Clay Minerals*	Clay Minerals Group of the Mineralogical Society of Great Britain and Ireland; Blackwell Scientific Publications
Cl Cl Min	*Clays and Clay Minerals*	Clay Minerals Society
Min Dep	*Mineralium Deposita*	Springer-Verlag; Society for Geology Applied to Mineral Deposits
Ec Geol	(*Economic Geology*)	(Society of Economic Geologists)

* Journals in parentheses were investigated bibliometrically on a limited scale.

years 1980–1986 from the "JCR" volumes numbered 14, 14, 14, 15, 15, 18, and 19, respectively, in the seven *SCI* annual series. Each of these volumes contains an updated reference list of recent and the more important older studies involving citation analysis applied to a variety of disciplines (see especially Garfield, 1972). Each also gives definitions and caveats regarding the various bibliometric parameters chosen for use in this study. They are impact factor, immediacy index, citing half-life, and self-citation rate.

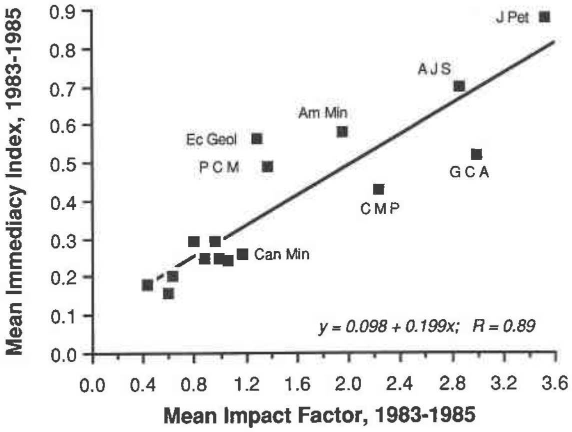

Fig. 1. Plot of immediacy index vs. impact factor, both averaged over the three-year period 1983–1985. Data are from App. Table 1 as summarized in the second and fourth columns of Table 2. Abbreviations represent names of the more prestigious journals (see Table 1).

Impact factor. Impact factor is basically a ratio between citations and citable source items published. For example, if the hypothetical *Journal of Minpet* (*JM*) contained 28 articles in 1984 and 32 in 1985, and *JM* was referenced in all journals (including itself) 70 times in 1984 and 50 times in 1985, the impact factor reported in 1986 would be (70 + 50)/(28 + 32) = 120/60 = 2.000. The 70 citations in 1984 include references to *any* articles in *any* issue of *JM* from its beginning through 1984; likewise 1985. Geologic journals usually have impact factors of 4.00 or less.

"The impact factor is useful in evaluating the significance of absolute citation frequencies," tending "to discount the advantage of large journals over small ones," and of frequently issued and older journals over less frequently issued and new ones. The impact factor permits "some qualification of quantitative data"; it is "algorithmic and objective, but nonetheless useful" ("JCR," 1986, 20, 10B).

I have found numerous errors in the "JCR" reporting of the number of citable source items for a given year. But a large omission (5 to 20 or more source items) in year N is sometimes compensated in the year $N + 1$ by an excess, indicating that one issue of a journal was received after ISI's annual deadline for processing new documents. Usually, however, corrections to numbers of source items appear without comment in the volume for year $N + 2$; that volume always lists (for the purpose of calculating the impact factor for the year $N + 2$) the most updated numbers of source items for years N and $N + 1$. Based on careful checking of the numbers of source items, it is my judgment that most impact factors are correct within 5%. However, to ameliorate potential problems with any particular value, I have used *mean* impact factors for the years 1983–1985 when comparing journals to one another, but I have reported them individually in

TABLE 2. Summary of data from App. Table 1, with addition of "Grants per funded paper"

Journal	Mean values, 1983–1985: No. of citations	Impact factor	No. of source items	Immediacy index	1986 half-life*	Data from literature survey of papers, 1980–1986: No. of papers	No. of authors	Authors per paper	% U.S. authors	% Papers with U.S. author(s)
Am Min	4224	1.954	132	0.58	>10	978	2164	2.21	59	69
Bull Min	379	0.797	70	0.29	4.8	531	1256	2.37	4	7
Can Min	722	1.174	64	0.26	7.7	457	1064	2.33	22	25
Min Mag	1008	0.628	82	0.20	9.8	636	1225	1.93	11	12
P C M	481	1.374	56	0.49	4.6	352	848	2.41	24	30
Avg. for group								2.22		
A J S	3830	2.862	39	0.70	>10	224	451	2.01	78	81
C M P	4425	2.225	122	0.43	7.3	930	2084	2.24	35	40
J Met Geol‡	74	0.955	25	0.25	n.a.	95	187	1.97	12	13
J Pet	1687	3.508	31	0.88	8.9	211	434	2.06	31	39
Lithos	475	0.988	24	0.25	7.2	181	356	1.97	13	15
Min & Pet§	153	0.426	26	0.18	6.1	176	367	2.09	5	8
Avg. for group								2.13		
G C A	8332	2.994	225	0.52	7.6	1501	3791	2.53	60	66
Ch G	1041	1.063	115	0.24	6.7	762	1811	2.38	21	24
G'chem J	293	0.723	35	0.16	6.7	234	595	2.54	13	14
Avg. for group								2.48		
Cl Min	393	0.878	51	0.25	6.0	339	814	2.40	4	6
Cl Cl Min	1055	0.945	67	0.29	8.4	496	980	1.98	46	44
Min Dep	291	0.591	41	0.16	8.1	268	549	2.05	5	7
Ec Geol	n.d.	1.287	n.d.	0.56	9.3	n.d.	n.d.	n.d.	n.d.	n.d.
Total						8371	18976			
Avg.									34	38

Note: n.d. = not determined; n.a. = not available.
* Data compiled in part from App. Table 1 and in part from *SCI* "JCR" volumes.
† Number of grants per federally supported paper.
‡ *Journal of Metamorphic Geology* published only since 1983.
§ Formerly, *Tschermaks Mineralogische und Petrographische Mitteilungen.*

Appendix Table 1 exactly as recorded in "JCR" (1980–1986).

Immediacy index. This is "a measure of how quickly the 'average article' in a particular journal is cited" ("JCR," 1985, 19, 12A). For example, the immediacy index of *JM* for 1984 is calculated by dividing the number of all journals' 1984 citations of articles in the 1984 *JM* by the total number of articles in *JM* in 1984. Articles published earlier in the year are more likely to be cited, and of course those journals issued biweekly or monthly are likely to have higher immediacy indexes than bimonthly or quarterly publications. A plot of three-year-mean values versus mean-impact-factor values for the same years (Fig. 1) shows a high positive correlation. I have chosen to rely on the latter rather than the former when comparing journals.

Citing half-life. Citing half-life is "the number of journal publication years from the current year going back which account for 50% of the total citations given by the citing journal[s] in the current year" ("JCR," 1985, 19, 12A). See Table 2 for 1986 values; all those half-life values exceeding ten years are reported simply as >10.

Self-citation rate. Self-citation occurs when an article in a journal cites another (previously or simultaneously published) article in the same journal. Self-citing rates are calculated by dividing the number of self-citations by the total number of references made; 20% is an average value for most periodicals. I did not take this into account in assessing the "prestige" of mineralogy, petrology, and geochemistry journals. See the citation study of Earth science journals by Garfield (1983).

Sources of financial support

For the 17 journals in Table 1 (those not in parentheses), the "Acknowledgments" section was checked in every article that had at least one author who gave an address in the United States. The purpose was to determine the source, or lack thereof, of financial support for the research reported in each paper. In order to limit the bookkeeping, only federally funded sources were counted for most journals. The Petroleum Research Fund (PRF) of the American Chemical Society was specifically included for studies of *Geochimica et Cosmochimica Acta* and *Clays and Clay Minerals.*

The relevant data in Appendix Table 1 are listed under the headings "Number of papers supported by . . . NSF, DOE, NASA, NATO, Fed'l (=Federal), Unsupported" and, in the last column, of parts l and p, "PRF." For example, if the authors of an article listed five National Science Foundation (NSF) grants and two National Aero-

TABLE 2—*Continued*

Data from literature survey of papers, 1980–1986						
% Papers supported by					% Unsupported papers	Grants per funded paper†
NSF	DOE	NASA	NATO	Fed'l		
51	3	6	1	19	20	1.27
31	0	0	3	12	54	n.d.
37	2	2	2	27	30	1.05
28	4	3	1	32	32	0.66
59	7	4	5	13	13	1.36
58	5	3	0	14	19	1.52
61	3	8	0	6	22	1.42
83	8	0	8	0	0	1.50
73	5	1	1	8	12	1.56
28	3	3	3	8	56	1.25
33	0	0	11	27	29	0.33
39	10	21	7	9	14	n.d.
29	10	2	0	26	33	n.d.
38	3	5	0	13	42	n.d.
13	3	0	7	3	74	n.d.
26	6	2	4	16	46	n.d.
0	4	11	11	19	56	0.88
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

nautics and Space Administration (NASA) grants (e.g., Steele et al., 1981), "1" would be entered in the NSF and "1" in the NASA column for 1981, indicating simply that each of those groups supported that work. If one or more of the authors gave a federal agency (U.S. Geological Survey, U.S. Bureau of Mines, Smithsonian Institution, Brookhaven National Laboratory (N.L.), Oak Ridge N.L., Los Alamos N.L., etc) as an address, a "1" would be entered in the "Fed'l" column. On rare occasion, as many as three federal sources of funding might be acknowledged in a single article.

Strictly speaking, the North Atlantic Treaty Organization (NATO) is not a U.S. federal agency. Furthermore, its support of scientific research is usually limited to travel and per diem expenses in connection with international collaboration; thus, it does not rank with NSF, DOE (Department of Energy), or NASA in terms of the amount of money contributed to a research effort. But because acknowledgments of NATO grants were recorded in the initial study, they are reported in Appendix Table 1 and Table 2 with the others.

In order to normalize the data (see App. Table 1), I calculated the percent of unsupported papers straightforwardly, i.e., "No. of unsupported" divided by the total number of papers with U.S. authors. Data in the column "Percentage of papers supported by . . . NSF," for example, were calculated by dividing the number of papers referencing NSF by the total number of papers referencing (NSF + DOE + NASA + NATO + "Fed'l"), and then, in order to normalize that number to account for the fact that more than one funding or federal agency might have supported a single article, this quotient was multiplied by the percent of supported papers [= (100 − "% unsupported")].

Although details are not recorded in Appendix Table 1, those 11 periodicals that have an entry in the column labeled "Grants per funded paper" in Table 2 were more thoroughly examined than the above. In addition to papers whose authors gave federal agencies, laboratories, or museums as addresses, every individual grant acknowledged in papers by U.S. authors in these journals was counted. For example, the article by Steele et al. (1981) received seven entries but, had one of the authors given the Smithsonian Institution as an address, the article would have had eight entries. By this means it was possible to determine the number of federal research grants per federally supported paper. The hypothesis is that the more prestigious journals report the more prestigious research which in turn is more heavily supported—not only by larger amounts of money but also by multiple grants—than research of "less importance."

"Unsupported" research papers

Nearly every professional paper is written by someone whose salary is paid by someone else and who is provided with a place in which to work. Thus the concept of "unsupported research" is mythical in the absolute sense. But in the context of this study, characterizing an article as "unsupported" indicates that no acknowledgment was specifically given to NSF, DOE, NASA, or NATO, nor was an author's address an agency of the federal government or a national laboratory. In the case of *Geochimica et Cosmochimica Acta,* two categories of "support" were added (see Fig. 2c): "PRF" (Petroleum Research Fund) and "Other Fed'l," which includes National Institutes of Health, the Environmental Protection Agency, National Oceanographic and Atmospheric Administration, Army and Navy research offices, the Bureau of Land Management, and others not in the "Fed'l" group defined for all other journals.

To get an idea of to what extent "unsupported" research papers by U.S. authors are actually unsupported, I examined the acknowledgments of 139 such articles in the *American Mineralogist* (1980–1986) and found that 60% had absolutely no references to financial support. These included a paper by Linus Pauling (1980), one by Grove et al. (1983), and a very unusual one by Peacor et al. (1982), plus 11 discussions, replies, and nomenclature notes, 13 crystal structures and descriptions of new minerals, and a study of the effects of locomotive steam on road ballast. The other 40% could be apportioned about equally among (1) authors with industrial addresses, (2) those at the Geophysical Laboratory, (3) those who ac-

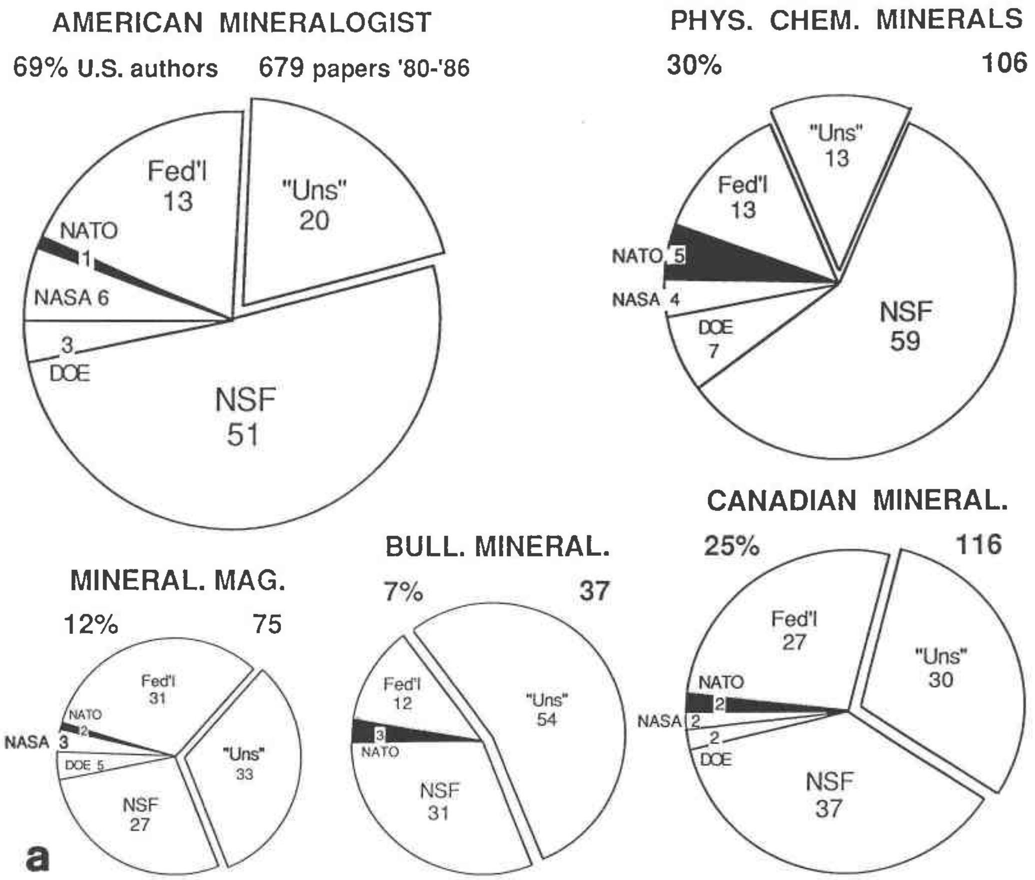

Fig. 2. Pie charts showing distributions of percentages of financial support (or lack thereof) acknowledged by authors giving addresses in the United States in the 17 journals of Table 1 for the years 1980–1986. (**a**) Journals with a primary mineralogical emphasis; (**b**) journals with a petrologic emphasis [note that the *American Mineralogist* is repeated here for purposes of comparison with (a); only papers of petrologic interest were examined in the *American Journal of Science*]; (**c**) journals with geochemical or other emphases. The areas of the pie charts are proportional to the mean impact factors of the journals for 1983–1985; numbers are percentages from Table 2.

knowledged small external grants (Sigma Xi, Geological Society of America, etc.), and (4) others with (probably small) internal grants from university research foundations.

Assessment of prestige

Journals were grouped for comparison as in Table 1 using data from Appendix Table 1, summaries of which are reiterated in Table 2. As a convenient reference point between the overlapping disciplines of mineralogy and petrology, the *American Mineralogist* was considered in both categories. *Mineralium Deposita* and the clay mineral journals are combined with geochemical ones only for convenience. More than 3150 papers with nearly 6450 U.S. authors (38% and 34% of the respective total numbers of papers and authors) were examined in this study.

Impact factor and support of research

Figure 2 contains pie charts for the 17 journals. Areas are proportional to the mean impact factor of the journal for the years 1983–1985, and the slices of the pie are labeled according to supporting agencies (or lack thereof), as discussed above.

Ranking of journals. There are few surprises in these compilations. The way I have categorized the journals, the *American Mineralogist* appears to be the leading "mineralogical" journal (Fig. 2a), but *Contributions to Mineralogy and Petrology* has had a consistently higher impact factor (Fig. 2b) for at least ten years. The *Journal of Petrology* is outstanding (Fig. 2b), and on the basis of its impact factor, it has been ranked first in the "JCR" "geology" category since it was introduced in 1979. The second-ranked *American Journal of Science* has also been second in the "JCR" list of "geology" journals, but note that only papers with a petrologic emphasis were evaluated for the sources of support of research, whereas the impact factors were based on its entire contents. *Geochimica et Cosmochimica Acta* (Fig. 2c) is the leading geochemical journal by a wide margin.

Funded research. The agencies supporting the research reported in this selection of 17 journals are dominated by NSF, NASA, and DOE, in that order. In fact, of all

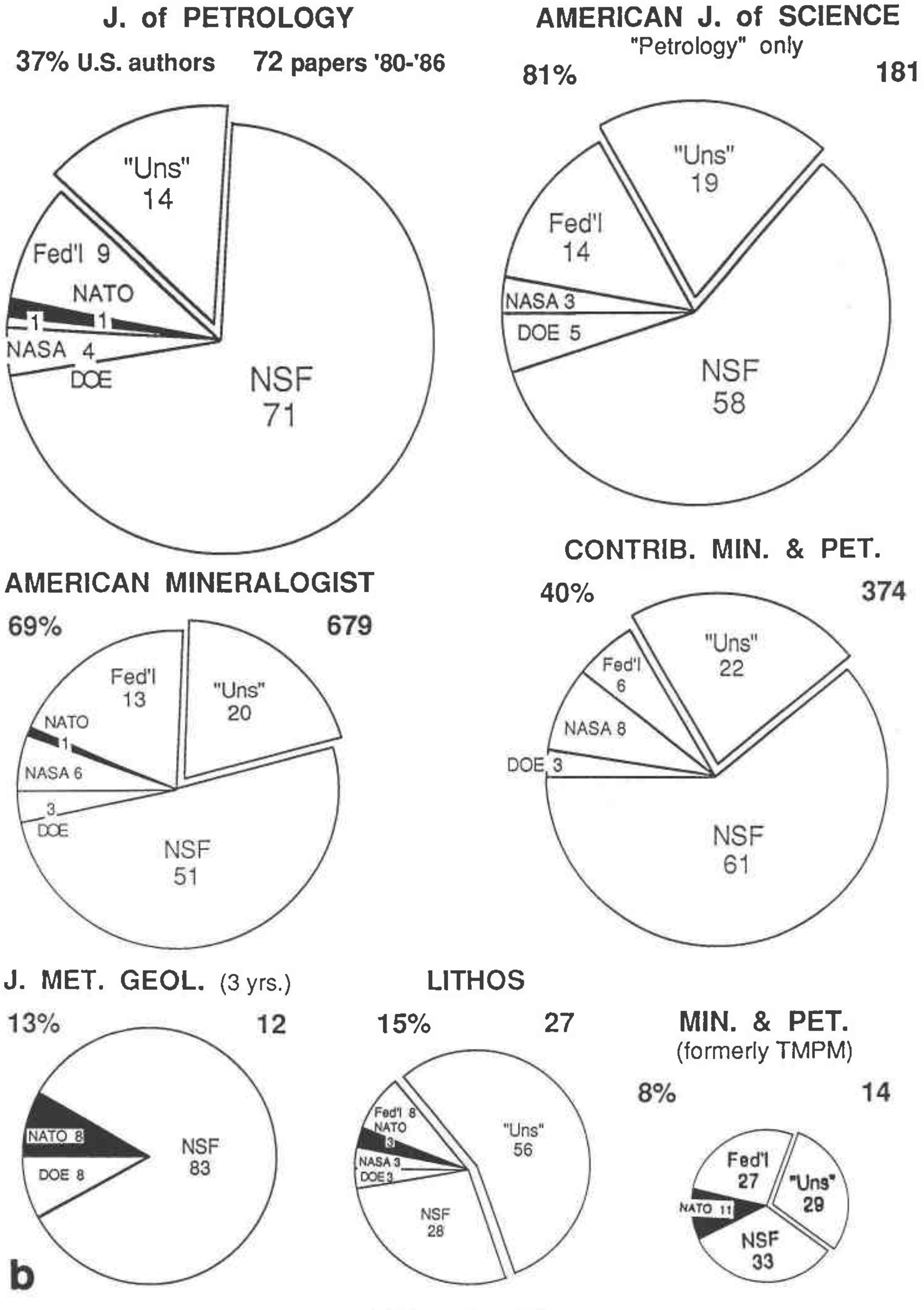

Fig. 2—*Continued.*

papers by U.S. authors that are supported by the big three granting agencies, more than three-quarters are funded by NSF, and most of these by the Earth Science Division, followed distantly by Ocean Sciences and the Materials Research Division.

Figure 3 summarizes data from Figure 2 (and App. Table 1 and Table 2). In Figure 3a is shown the relationship between the percentage of papers by U.S. authors supported by the three primary granting agencies (for 1980–1986) as a function of the mean impact factors of the journals. Clearly, the better journals are attracting the greater percentage of funded research papers. Figure 3b contains a portion of the same curve, although only data from journals with >20% of its papers by U.S. authors are plotted. For comparison, the percentage of papers by authors employed by government agencies ("% Fed'l" in Table 2) shows a general decrease with increasing quality of the journal. The regression line shown is statistically the same as that obtained using the full data set.

"Unsupported" research. The percentages of papers by

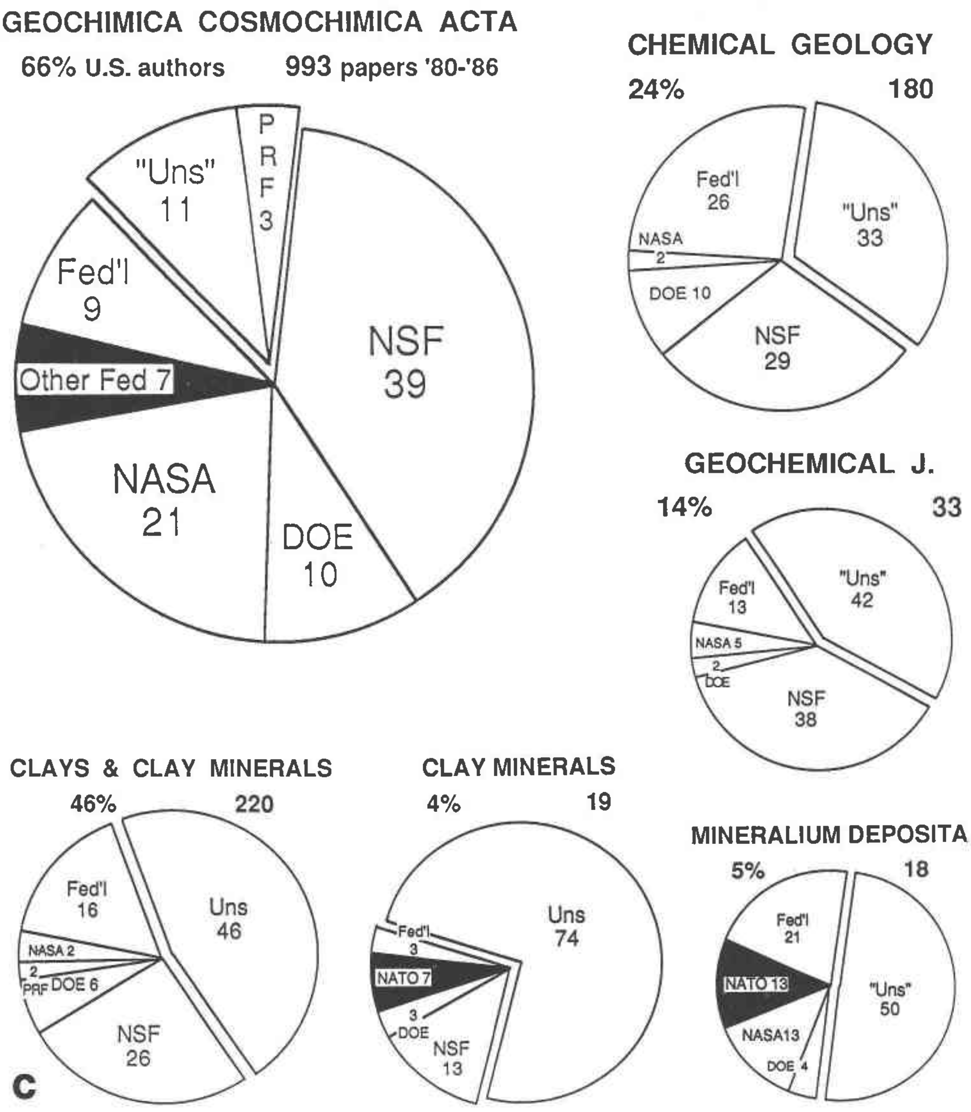

Fig. 2—*Continued.*

U.S. authors that contain no reference to a federal laboratory, museum, or granting agency, or to PRF or NATO, are plotted as a function of mean impact factor in Figure 3c. The "better" journals (vertical labels) average ~16% "unsupported" papers, those with impact factor <1.0 range between 30 and 75% "unsupported" papers.

Multiple grants. Although dollar amounts of grants were never mentioned in journal articles, many U.S. authors acknowledged multiple grants from one or more federal agencies, including those implicit in their addresses. Such data were gathered from only 11 of the 17 journals. They are presented in Figure 4 as a plot of average number of grants per federally funded paper, where "federally funded paper" includes not only those containing acknowledged grants but also those whose authors list addresses at government agencies. Papers by federal employees are not funded by NSF, and generally not by NASA or DOE, although there are occasional exceptions for NASA and many more so for DOE, which heavily supports research at some of the national laboratories. Not surprisingly, the curve in Figure 4 has the same form as that in 3a: grants beget more grants. (I will discuss the issue of multiple grants in the second part of my written version of the 1987 presidential address.)

Circulation

The circulation of a particular journal is generally not a reliable measure of the esteem in which it is held by the scientific community. A commercial, for-profit journal is not likely to be subscribed to by individual scientists unless the journal is also sponsored, edited, or otherwise controlled by a not-for-profit professional society

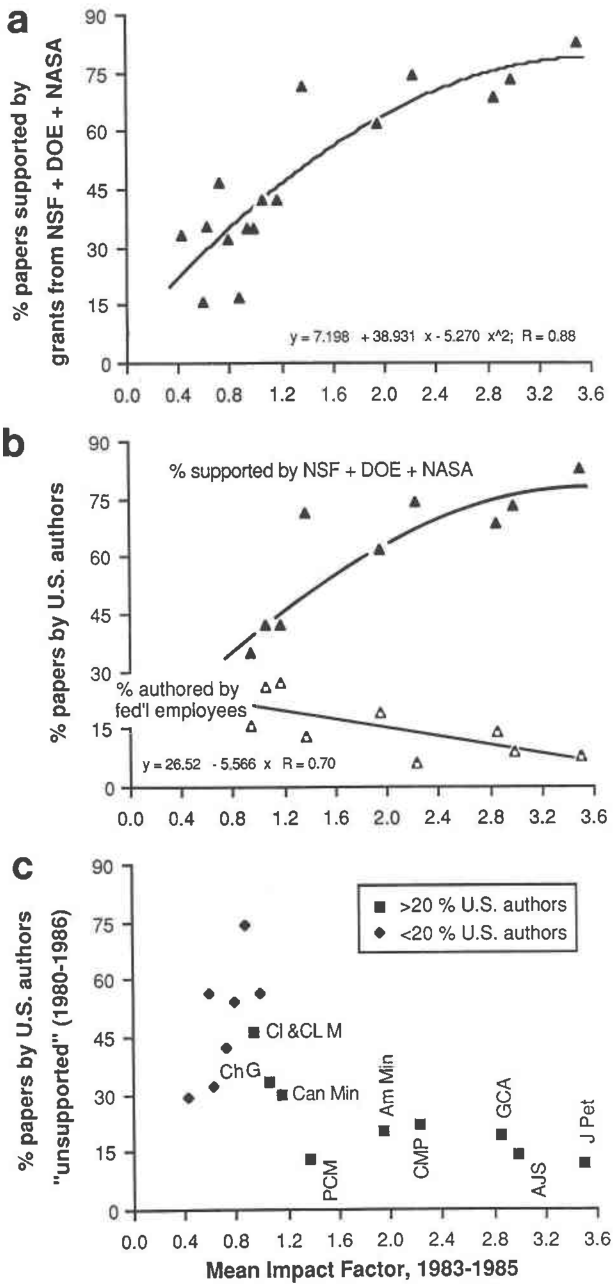

Fig. 3. Mean impact factors of journals for the years 1983–1985 plotted against (**a**) total percentages of papers by U.S. authors that were supported by NSF, NASA, and DOE in the years 1980–1986; (**b**) same as (a) (solid triangles) with percentages of papers of authors employed by governmental agencies (open triangles) shown for comparison [only journals with >20% papers with U.S. authors are plotted]; (**c**) percentages of "unsupported" papers—see text for discussion. Data from Table 2.

and made available to its membership at a price considerably below institutional subscription rates (*Geochimica et Cosmochimica Acta* is a notable example). Most societies publish and market their own journals privately, and lacking the profit motive, they often are constrained

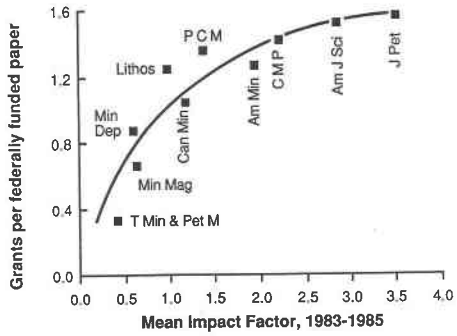

Fig. 4. Average number of federal grants per paper, as acknowledged by U.S. authors in papers considered to be "supported" (see text), plotted against mean impact factor (1983–1985) for 11 journals.

to subsidize the publication costs with volunteer editorial labor (commercial publishers do the same) and voluntary or even mandatory page charges and/or charges to the authors for reprints. So price is not unrelated to circulation, but as discussed below, price is likely to become a major issue in the effectiveness or even the survival of some of the historically "better" journals.

I think that very few scientists have any idea of the relative circulation of the periodicals to which they submit their research papers. And until recently, few of them have given any thought to how much that journal is costing their library. My conversations on this subject with certain "more esteemed" members of the community of mineralogists and petrologists have been revealing: most simply are interested in fast publication (preferably with a minimum of hassle from reviewers), with no page charges and free reprints. Some obtain a degree of personal and professional fulfillment by publishing in journals outside their traditional areas of endeavor, but most are concerned with communicating as rapidly as possible within their "invisible colleges" (for the sociology of this phenomenon, see Crane, 1972). As indicated above in the study of impact factor and financial support of research, few scientists of repute are likely to sacrifice much in the way of perceived prestige of the journal they choose in order to obtain quick, "cheap" publication, but almost none have given any thought to circulation or price—they would assume that the best institutions subscribe to *every* journal regardless of price. This may not be a valid assumption in the future.

Figure 5 is a plot of circulation data collected almost entirely through personal communication with journal editors, secretaries of societies, and employees of various status within commercial publishing establishments (except Elsevier Scientific Publishers, who declined to release figures). In the bar graph to the left are plotted the numbers of individual subscribers. Prices listed there are the 1988 dues paid to professional societies, or (in the case of *American Journal of Science*) to a nonprofit publisher, or in the case of *Physics and Chemistry of Minerals* and *Journal of Metamorphic Petrology* to MSA as a spe-

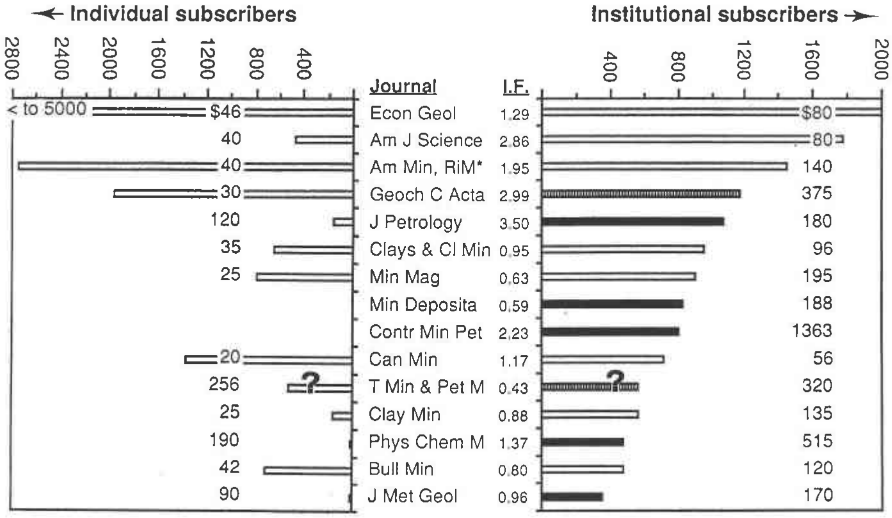

Fig. 5. Circulation data for 14 journals (Table 3), divided between individual subscribers (left) and institutional subscribers (right). Abbreviations of titles may be interpreted from journal listings in Table 1. Data and 1988 prices (1987 for *Bulletin de Minéralogie*) are from Table 3; mean impact factors for 1983–1985 are from Table 2. *The institutional subscription rate for *American Mineralogist* includes *Reviews in Mineralogy* (*RiM*). Question marks on *Mineralogy and Petrology* (*T Min & Pet M*) data indicate uncertainty as to the distribution of total circulation of 710 volumes between individual and institutional subscribers.

cial reduced price from the publishers (see Table 3). Note that significant numbers of individuals choose to subscribe only to journals of professional societies whose prices are low. Exceptions are the *American Journal of Science* and the *Journal of Petrology,* whose reputations are outstanding and whose prices to individuals for personal use are moderate.

In the graph on the right are plotted the numbers of institutional subscribers who pay the 1988 rates recorded on the bars. Open bars represent journals of professional societies (average price of eight: $113), shaded bars represent journals of societies that are published and marketed by commercial scientific presses (average price of two: $347), and black bars represent commercial for-prof-

TABLE 3. Subscription prices to members, circulation data, normalized institutional prices, and normalized institutional prices divided by impact factor

Journal	1988 member price	1986 total circulation	No. of subscribers: Individuals	No. of subscribers: Institutions	Mean normalized institutional price*	Mean normalized institutional price* divided by mean impact factor†
Am Min	40	4100	2750	1350	0.72	0.37
Bull Min	42	1200	720	480	1.82	2.28
Can Min	20	2102	1379	723	0.60	0.51
Min Mag	25	1695	795	900	1.92	3.05
P C M	190	504	22	482	4.06	2.95
A J S	40	2250	480	1770	2.48	0.87
C M P		808	2	806	6.54	2.94
J Met Geol‡	90	364	9	355	4.80	5.03
J Pet	120	1227	152	1075	2.83	0.81
Lithos		n.a.	n.a.		4.47	4.52
Min & Pet§	256	710	150?		4.45	10.43
G C A	30	3150	1975	1175	1.38	0.46
Ch G		n.a.	n.a.		4.92	4.62
G'chem J	64	n.a.	n.a.		2.38	3.29
Cl Min	25	1090	530	560	2.17	2.47
Cl Cl Min	35	1600	650	950	1.14	1.20
Min Dep		836		836	2.94	4.97
Ec Geol	46	7000	5000	2000	0.32	0.25

Note: Numbers are only approximate; all prices are in U.S. dollars. See Figure 8 for explanation; n.a. = not available.
* Mean of 1985 and 1986; normalized prices are the institutional price per source item.
† Mean of 1983, 1984, 1985 impact factors.
‡ *Journal of Metamorphic Geology* published only since 1983.
§ Formerly, *Tschermaks Mineralogische und Petrographische Mitteilungen.*

TABLE 4. Institutional prices in current and inflation-adjusted (1980) dollars, 1980–1988

Journal	1980	1981	1982	1983	1984	1985	1986	1987	1988
Am Min	55 (55)	55 (50)	55 (47)	80 (66)	105 (84)	110 (85)	115 (85)	130 (93)	140 (96)
Bull Min	n.a.	n.a.	97 (83)	99 (82)	99 (79)	105 (81)	108 (80)	120 (86)	120 (82)
Can Min	35 (35)	35 (32)	35 (30)	35 (29)	29 (23)	41 (32)	46 (34)	54 (38)	56 (38)
Min Mag	75 (75)	100 (91)	160 (138)	160 (133)	165 (132)	170 (131)	170 (126)	170 (121)	195 (134)
P C M	94 (94)	155 (141)	163 (140)	155 (128)	176 (141)	223 (172)	234 (173)	403 (287)	515 (353)
A J S	50 (50)	70 (64)	70 (60)	80 (66)	80 (64)	80 (62)	80 (59)	80 (57)	80 (55)
C M P	707 (707)	774 (706)	813 (699)	526 (436)	556 (444)	787 (605)	826 (612)	1125 (802)	1363 (934)
J Met Geol‡	n.p.	n.p.	n.p.	98 (81)	98 (78)	98 (75)	140 (104)	140 (100)	170 (117)
J Pet	55 (55)	65 (59)	79 (68)	87 (72)	90 (72)	120 (92)	135 (100)	160 (114)	180 (123)
Lithos	47 (47)	54 (49)	55 (47)	59 (49)	70 (56)	70 (54)	129 (96)	143 (102)	157 (108)
Min & Pet§	105 (105)	226 (206)	125 (107)	176 (146)	87 (69)	91 (70)	95 (70)	262 (187)	320 (219)
G C A	275 (275)	240 (219)	240 (206)	240 (199)	290 (232)	290 (223)	340 (252)	375 (267)	375 (257)
Ch G	324 (324)	225 (205)	240 (206)	344 (285)	551 (440)	694 (534)	850 (630)	888 (633)	1000 (685)
G'chem J	61 (61)	62 (57)	55 (47)	58 (48)	71 (57)	71 (55)	95 (70)	116 (83)	166 (114)
Cl Min	95 (95)	95 (87)	100 (86)	100 (83)	110 (88)	110 (85)	110 (82)	110 (78)	135 (93)
Cl Cl Min	84 (84)	84 (77)	96 (83)	96 (80)	96 (77)	96 (74)	96 (71)	110 (78)	96 (66)
Min Dep	97 (97)	110 (100)	81 (70)	101 (84)	104 (83)	113 (87)	118 (87)	155 (110)	188 (129)
Ec Geol	25 (25)	30 (27)	30 (26)	39 (32)	39 (31)	46 (35)	55 (41)	80 (57)	80 (55)

Note: For each year, the first value is the actual price in U.S. dollars; the second value is the price in inflation-adjusted (1980) dollars. n.a. = not available; n.p. = not published.

‡ *Journal of Metamorphic Geology* published only since 1983.

§ Formerly, *Tschermaks Mineralogische und Petrographische Mitteilungen.*

it journals [average price of the five shown: $483; if the two Elsevier publications are added (Tables 1 and 4), the average price is $481]. The highest priced journal is *Contributions to Mineralogy and Petrology,* which at $1363 for 1988 costs only $235 less than the total price of all *ten* journals published by professional societies.

"Twigging" is practiced among commercial publishers looking for new markets and additional ways to serve the scientific community; it involves introducing new journals that represent ever-more-specialized subdisciplines. In December 1987, three new "twigs" (all from Elsevier, who publishes nearly 600 journals) crossed my desk. The only recent one in the list in Table 1 is Blackwell's *Journal of Metamorphic Geology,* whose appearance in 1983, just before the dramatic upturn of European currencies relative to the U.S. dollar (Fig. 6), may account for its very low circulation of 364 copies. To be sure, Bowker (1987) recently stated that "we [Blackwell Scientific Publications, Ltd.] are very conscious of the need to avoid 'twigging' of journals, and indeed we are moving cautiously in the opposite direction by encouraging mergers of existing titles." Unfortunately, merging is likely to occur only among journals published by a single company and probably only when profitability is threatened or additional profitability is promised. The two mineralogy-petrology journals with highest prices per article (normalized prices, Table 5) have similar titles and meet the first criterion for potential merger—but probably not the second. An interesting and highly commendable development is underway among three mineralogical societies in continental Europe to combine their separate journals into one.

In the assessment of prestige, circulation is obviously of minor importance. However, in an author's choice of a journal, it may well be of some relevance now that it is known for at least these few publications. Although in the past, many authors have had little concern for anything other than their own interests in the choice of a journal, the price of journals to libraries has recently emerged as a significant factor to be taken into consideration.

Assessment of prices

"Libraries stunned by journal price increases." "Major reduction in periodical subscriptions." The former was the title of a recent news article in *Science* (Holden, 1987); the latter was the heading of a memo from the Director of Libraries to department heads of a major western university. Together they represent the major preoccupation of science librarians and library committees of academic faculties for the past few years. The problem has been exacerbated by a declining dollar in foreign currency markets.

The U.S. dollar

In 1980 the U.S. dollar was at its lowest value in at least a decade relative to European currencies and nearly its lowest relative to the Japanese yen. Figure 6 shows the trends since then, normalized to 1980 = 1.00. With high dollar values in 1984 and early 1985, European journals in particular seemed reasonably priced, and indeed Figure 7 shows that most reached their lowest dollar prices at that time. But at the time of writing (late December 1987), German and Dutch currencies (the coin of Springer-Verlag and Elsevier, respectively) have risen 12–15% above 1980 levels, and the Japanese yen (affecting only *Geochemical Journal* in our list) has gained 80%!

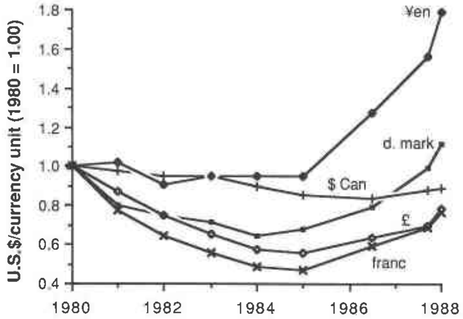

Fig. 6. The change in value of the Japanese yen, Canadian dollar, West German deutsche mark, British pound (£), and French franc, normalized to the value of the U.S. dollar in 1980. The relative value of the Dutch florin almost exactly mimics that of the German mark. Data from *Statistical Abstracts* (1987) and the *Washington Post*, September 15, 1987, and December 23, 1987.

The price of journals

In order to meaningfully compare the prices of journals, it is necessary to somehow normalize the database. To consider price per page would be misleading, because formats vary widely. For example, word density in *Mineralogy and Petrology* is ~500 per page, but in *Contributions to Mineralogy and Petrology*, it is >1000. So in Figure 7 I have chosen to plot the price per source item (as defined by the *Science Citation Index*) for the years 1980–1988. [Barschall (1987) used price per character for physics journals!] Prices of journals for 1988 were obtained by personal communication from societies and publishers (Table 4), but exact numbers of articles are still unknown for 1987 and 1988, and averages for the three previous years were used to calculate the data points for both years. Actual prices per source item may be 10 or 15% lower than those in Table 5 or Figure 7, if the numbers of source items are underestimated; but they may also be as much higher if (as it appears in late December 1987) foreign currencies continue to rise relative to the U.S. dollar. Indeed, the price of *Chemical Geology* rose from $891 to $1000 in the past three months.

It is obvious from a cursory glance at Figure 7 that the journals published by professional societies (*Geochimica et Cosmochimica Acta, American Mineralogist, Mineralogical Magazine*; lower right) have much lower prices per source item to libraries than commercial journals. These were chosen to be representative—the *Canadian Mineralogist, Economic Geology,* and *Clays and Clay Minerals* are priced similarly to *American Mineralogist*, and *Bulletin de Minéralogie, American Journal of Science* and *Geochemical Journal* have prices like *Mineralogical Magazine* and *Geochimica et Cosmochimica Acta* (see Table 5). There tends to be little fluctuation in the prices, especially in inflation-adjusted dollars.

Our sample of commercial for-profit journals (all foreign) certainly reflects fluctuations in exchange rates (compare Figs. 6 and 7). But prices to libraries started relatively high and some have risen precipitously in recent years. For example, even if *Contributions to Mineralogy and Petrology* has 150 citable articles in 1988, and *Mineralogy and Petrology* has 25, the prices per source item will be about $9 and $13, respectively (higher, if the U.S. dollar continues its decline). If *Lithos* (whose price took a big jump when its publication was assumed by a commercial press) has 24 and *Chemical Geology* 160 articles, their prices will be about $6 per source item. These prices range from up to 20 times as expensive as *Economic Geology* to as low as 3 times as expensive as the European mineralogical society journals, judging by their "North American" prices.

There is a well-established practice known as "discrim-

TABLE 5. Normalized institutional prices in current and inflation-adjusted (1980) dollars, 1980–1988

Journal	1980	1981	1982	1983	1984	1985	1986	1987	1988
Am Min	0.36 (0.36)	0.45 (0.41)	0.40 (0.34)	0.66 (0.55)	0.82 (0.66)	0.75 (0.58)	0.68 (0.50)	0.88 (0.63)	0.95 (0.65)
Bull Min	n.a.	n.a.	1.13 (0.97)	1.57 (1.30)	1.50 (1.20)	1.44 (1.11)	2.20 (1.63)	1.79 (1.28)	1.79 (1.22)
Can Min	0.54 (0.54)	0.47 (0.43)	0.70 (0.60)	0.74 (0.62)	0.39 (0.31)	0.58 (0.45)	0.61 (0.45)	0.73 (0.51)	0.76 (0.51)
Min Mag	0.87 (0.87)	1.33 (1.21)	1.34 (1.16)	1.76 (1.46)	1.96 (1.57)	2.18 (1.68)	1.65 (1.22)	1.98 (1.41)	2.27 (1.56)
P C M	2.19 (2.19)	3.30 (3.00)	3.98 (3.41)	2.92 (2.42)	3.20 (2.56)	3.78 (2.92)	4.33 (3.20)	7.33 (5.22)	9.36 (6.42)
A J S	0.62 (0.62)	1.27 (1.16)	1.25 (1.07)	2.05 (1.69)	1.86 (1.49)	2.29 (1.77)	2.67 (1.97)	2.05 (1.46)	2.05 (1.41)
C M P	4.04 (4.04)	5.73 (5.23)	7.07 (6.08)	4.87 (4.04)	3.83 (3.06)	7.42 (5.71)	5.66 (4.19)	8.27 (5.90)	10.02 (6.87)
J Met Geol‡	n.p.	n.p.	n.p.	4.90 (4.05)	3.92 (3.12)	3.77 (2.88)	5.83 (4.33)	5.60 (4.00)	6.80 (4.68)
J Pet	2.20 (2.20)	3.82 (3.47)	3.95 (3.40)	3.78 (3.13)	2.73 (2.18)	3.24 (2.49)	2.41 (1.79)	4.10 (2.92)	4.62 (3.15)
Lithos	1.47 (1.47)	2.08 (1.88)	1.96 (1.68)	2.19 (1.81)	2.92 (2.33)	3.33 (2.57)	5.61 (4.17)	6.22 (4.43)	6.83 (4.70)
Min & Pet§	5.25 (5.25)	8.07 (7.36)	4.31 (3.69)	5.50 (4.56)	3.48 (2.76)	4.14 (3.18)	4.75 (3.50)	11.91 (8.50)	14.55 (9.95)
G C A	1.49 (1.49)	1.19 (1.08)	1.10 (0.94)	1.17 (0.97)	1.24 (1.00)	1.37 (1.06)	1.38 (1.02)	1.59 (1.13)	1.59 (1.09)
Ch G	4.21 (4.21)	2.85 (2.59)	3.48 (2.99)	4.00 (3.31)	4.02 (3.21)	4.45 (3.42)	5.38 (3.99)	6.04 (4.31)	6.80 (4.66)
G'chem J	1.69 (1.69)	2.07 (1.90)	1.90 (1.62)	1.87 (1.55)	1.87 (1.50)	1.97 (1.53)	2.79 (2.06)	3.22 (2.31)	4.61 (3.17)
Cl Min	2.38 (2.38)	2.57 (2.35)	2.22 (1.91)	2.33 (1.93)	1.62 (1.29)	2.62 (2.02)	1.72 (1.28)	1.90 (1.34)	2.33 (1.60)
Cl Cl Min	1.29 (1.29)	1.33 (1.22)	1.48 (1.28)	1.45 (1.21)	1.43 (1.15)	1.23 (0.95)	1.04 (0.77)	1.53 (1.08)	1.33 (0.92)
Min Dep	2.55 (2.55)	2.89 (2.63)	2.53 (2.19)	2.40 (2.00)	2.67 (2.13)	2.76 (2.12)	3.11 (2.29)	3.88 (2.75)	4.70 (3.23)
Ec Geol	n.d.	n.d.	n.d.	n.d.	n.d.	0.27 (0.23)	0.36 (0.27)	n.d.	n.d.

Note: For each year, the first value is the actual price in U.S. dollars; the second value is the price in inflation-adjusted (1980) dollars. n.a. = not available; n.p. = not published; n.d. = not determined.

‡ *Journal of Metamorphic Geology* published only since 1983.

§ Formerly, *Tschermaks Mineralogische und Petrographische Mitteilungen.*

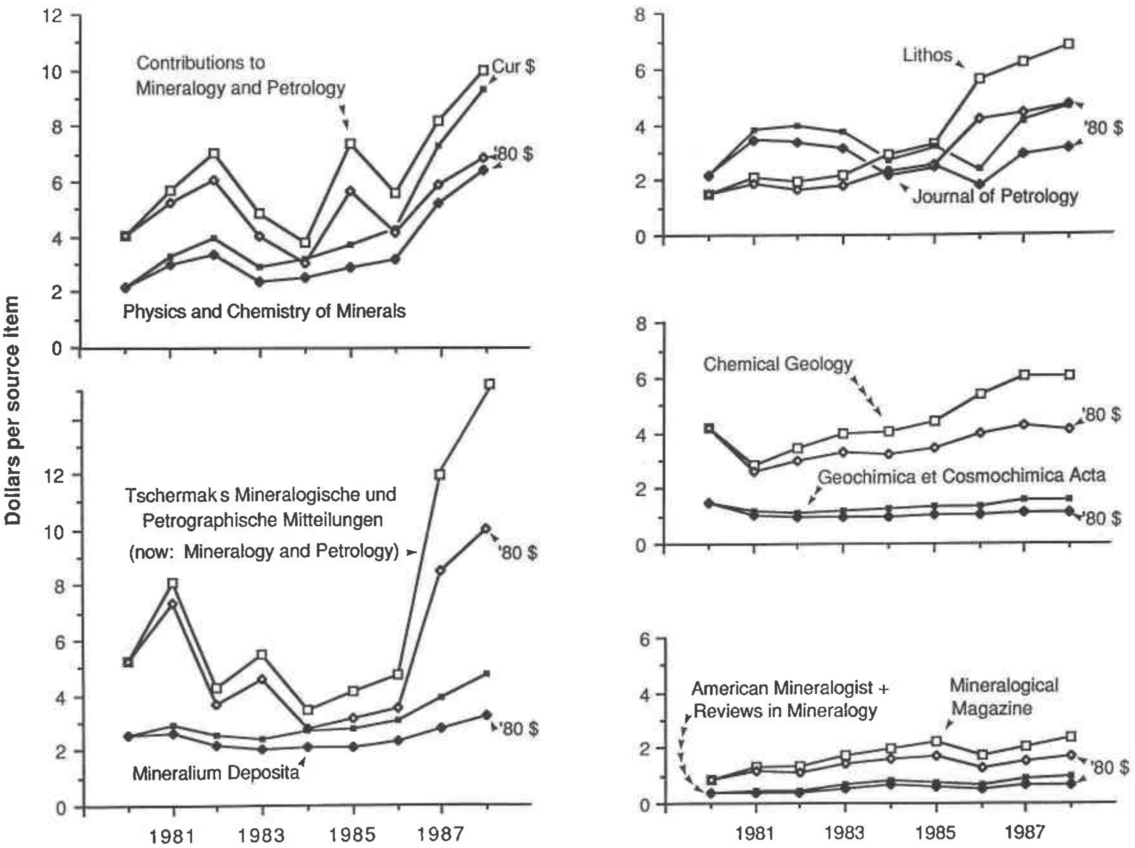

Fig. 7. Plots of change in price per source item for selected journals for the period 1980–1988. Squares represent prices in current U.S. dollars, diamonds those in 1980 dollars (adjusted for inflation using the gross national product price deflators from National Science Board, 1986, and more recent sources). Data from Table 5; the numbers of source items for 1987 and 1988 were estimated to be the same as the average of the previous three years (see App. Table 1).

inatory pricing" in which certain British and German publishers charge substantially higher prices to North American subscribers than to Europeans. (Seventeen commercial presses in England averaged a 68% surcharge in a recent year.) Some U.S. publishers do the same in reverse—Pergamon's European price is 20% higher than its domestic price (Holden, 1987). These facts may be the cause of little astonishment, but it was disquieting to me to realize that between 1984 and 1987, the surcharge by the nonprofit Mineralogical Society of Great Britain and Ireland amounted to 42% (about $50 per year) for *Mineralogical Magazine,* and the rate is presumably as great for its other publications (*Clay Minerals* and *Mineralogical Abstracts*); there may be 450–500 subscriptions to each of the three in the U.S. and Canada. On the other hand, the U.S. dollar prices of *Physics and Chemistry of Minerals* (Springer-Verlag) were less than 5% higher than the German currency prices between 1980 and 1987. Elsevier sells its journals only in the currency of the country in which it is printed, so apart from the portion of the price that is pure profit, both publisher and purchaser are at the mercy of the foreign exchange currency merchants—win or lose.

Conclusions

It is somewhat arbitrary to consider journals purely in monetary terms, although in times of austerity "cost per source item" is a reasonable point of reference. In the conference rooms of many science libraries, there is talk of "collective bargaining" with the commercial press, and for those in dire financial straits, this approach to the problem is preferable to cancellation of subscriptions to the highest priced (and often good to excellent quality) journals. Unfortunately for some, cancellation may be the only recourse, because "restraint of trade" laws preclude certain types of collective actions. Our library at Virginia Tech is among the swelling multitude of those that are cancelling large numbers of subscriptions: the first cuts were not particularly injurious, but the second were distressing, and the third will be painful. Libraries once considered to be "comprehensive" are being forced into sharing collections.

It would be naive to think that a significant number of cancellations will force journal prices down, because publishers' costs are figures on a "per unit" basis: prices will rise to those still well enough endowed to continue all

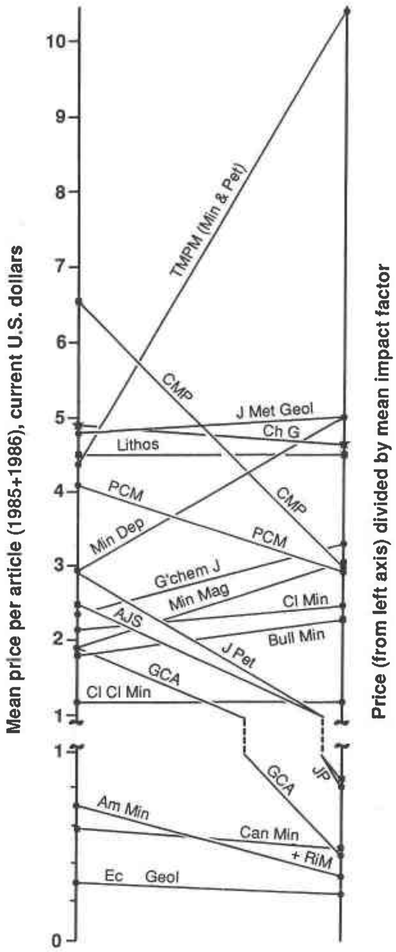

Fig. 8. Prices in current dollars per source item, averaged for 1985 and 1986 (left), compared to the same prices divided by the journal's mean impact factor for 1983–1985 (right). The lower portion of the scale ($0.00–1.00) is expanded by 2.5×. Note that all professional society journals have prices of less than $2.50 per source item. Data are from the last two columns of Table 3; abbreviations may be interpreted from journal listings in Table 1.

their subscriptions. But this cannot go on indefinitely. "There is a widespread belief that many small-circulation journals will go out of business" (Holden, 1987). Market pressures will prevail.

But the literature of science is not simply a matter of economics. If it were, we would cancel a few highly priced journals and continue subscribing to the many reasonably priced ones. Journal quality is a paramount consideration, and factoring quality into price is an interesting exercise. Figure 8 is a crude effort to do just that. On the left ordinate axis is plotted the mean price per article for 18 journals, based on the average institutional subscription and numbers of source items for 1985 and 1986. [Note from the data for 1988 (Table 5) that many of these prices will have more than doubled and one has nearly tripled since then!] It is interesting that only commercial journals have prices in excess of $2.50 per article.

On the right ordinate of Figure 8 are points calculated by dividing the average prices per source item (Table 5) by the mean impact factor assigned to the journal by *SCI* "JCR" for the years 1983–1985 (Table 2). The line joining the data points for a particular journal will have a positive slope if the impact factor (I.F.) is >1.000 and a negative slope if I.F. <1.000. Note, however, that a low-priced journal (*American Mineralogist*; I.F. = 1.954, not including *Reviews in Mineralogy*) with an impact factor nearly the same as a high-priced journal (*Contributions to Mineralogy and Petrology*; I.F. = 2.225) has a much lower negative slope than its counterpart.

How best to use such a compilation—if at all—is open to debate. A library committee might decide that lines with high positive slopes, representing as they do both a high price and a low impact factor, would implicate those journals for cancellation. Alternatively, it might choose a reference point on the right axis of (say) 4.00 or 3.00, above which similar judgments would be rendered. Whether individual authors submitting a paper for publication should take these data into consideration or not is complicated by their personal needs for prestige (see the *Oxford English Dictionary* for a definition!), fast publication, free reprints, and/or assured circulation to members of their "invisible colleges."

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APPENDIX TABLE 1. Bibliometric and financial support data for the journals listed in Table 1

Appendix Table 1a. Citation and support analysis for *AMERICAN MINERALOGIST*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	152	299	105	190	3211	1.104	154	0.357		56	1	7	0	21	20	53	1	7	0	20	19
1981	122	264	87	175	3363	1.194	125	0.208		50	0	10	1	14	18	53	0	11	1	15	21
1982	138	290	92	187	3619	1.480	130	0.515		45	6	4	0	20	27	42	6	4	0	19	29
1983	121	275	86	184	4179	2.110	123	0.610		63	0	1	1	14	11	70	0	1	1	15	13
1984	128	296	92	197	4300	1.779	128	0.617		46	8	8	0	26	16	43	8	8	0	24	17
1985	147	334	98	201	4192	1.972	146	0.514	>10	56	3	7	2	17	23	50	3	6	2	15	23
1986	170	406	119	141	4479	1.569	169	0.609	>10	61	7	6	1	31	21	47	5	5	1	24	18
Total:	978	2164	679	1275	27343		975			377	25	43	5	143	136	51	3	6	1	19	20
Percent:			69	59						64 --	of	total	supp'd								
Mean	1983- 1985:				4224	1.954	132	0.580													
Mean	1984- 1986:				4324	1.773	148	0.580													

Appendix Table 1b. Citation and support analysis for *BULLETIN de MINÉRALOGIE*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	86	191	6	7	112	0.570	85	0.306		2	0	0	0	0	3	50	0	0	0	0	50
1981	108	216	13	16	197	0.873	108	0.139		5	0	0	0	1	6	45	0	0	0	9	46
1982	86	232	3	3	39	0.477	87	0.493		1	0	0	0	0	2	33	0	0	0	0	67
1983	63	167	7	14	307	0.585	64	0.346		2	0	0	0	1	4	29	0	0	0	14	57
1984	66	158	4	6	442	0.901	73	0.329		0	0	0	1	1	2	0	0	0	25	25	50
1985	73	178	1	2	389	0.905	73	0.192	3.9	0	0	0	0	0	1	0	0	0	0	0	100
1986	49	114	3	5	398	0.555	54	0.167	4.8	0	0	0	0	1	2	0	0	0	0	33	67
Total:	531	1256	37	53	1884		544			10	0	0	1	4	20	31	0	0	3	12	54
Percent:			7	4						67 --	of	total	supp'd								
Mean	1983- 1985:				379	0.797	70	0.289													
Mean	1984- 1986:				410	0.787	67	0.229													

Note: Citations in year *N* to papers of all years < *N*, impact factors, numbers of source items, immediacy indexes, and half-lives of the journal (1985 and 1986 only) are from the *SCI* "Journal Citation Reports." Other data were collected specifically for this study—see text for details and explanations of headings. The bottom number in the first NSF column is the percent of total federally supported papers that were supported by the National Science Foundation. For some journals, an asterisk (*) next to the number of source items for a given year indicates that the *SCI* "JCR" values were in error and that corrections were made based on actual counts. The 1984 volume of *Clays and Clay Minerals* was not available (n.a.) in my library.

App. Table 1 continues on succeeding pages.

Appendix Table 1c. Citation and support analysis for *CANADIAN MINERALOGIST*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	65	148	14	26	--	--	65	--		4	0	0	1	7	4	24	0	0	6	42	29
1981	74	165	17	29	--	--	74	--		5	1	0	0	7	7	23	5	0	0	32	41
1982	50	108	16	26	--	--	50	--		13	0	1	0	3	1	72	0	6	0	17	6
1983	47	109	10	17	691	2.119	46	0.326		4	0	0	1	3	2	40	0	0	10	30	20
1984	74	175	18	34	780	0.811	74	0.270		5	0	1	0	4	7	31	0	6	0	24	39
1985	71	187	25	63	696	0.592	71	0.169	6.7	11	0	0	0	7	7	44	0	0	0	28	28
1986	76	172	16	36	822	0.841	76*	0.389	7.7	5	1	1	0	4	7	26	5	5	0	20	44
Total:	457	1064	116	231	2989		456			47	2	3	2	35	35	37	2	2	2	27	30
Percent:			25	22						53 --	of	total	supp'd								
Mean	1983- 1985:				722	1.174	64	0.255													
Mean	1984- 1986:				766	0.748	74	0.276													

Appendix Table 1d. Citation and support analysis for *MINERALOGICAL MAGAZINE*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	86	166	11	16	703	0.541	87	0.138		1	0	0	0	1	7	18	0	0	0	18	64
1981	75	198	11	18	660	0.475	73	0.110		6	2	0	0	1	3	48	16	0	0	8	27
1982	119	155	11	20	841	0.635	118	0.220		2	0	0	0	7	3	16	0	0	0	57	27
1983	91	177	8	14	1063	0.764	89	0.270		2	0	0	1	4	2	21	0	0	11	43	25
1984	84	155	10	22	1030	0.662	83	0.143		2	0	2	0	7	1	16	0	16	0	57	10
1985	78	154	10	20	930	0.459	75	0.200	>10	4	1	0	0	1	4	40	10	0	0	10	40
1986	103	220	14	28	1060	0.717	101	0.149	9.8	5	0	0	0	4	4	40	0	0	0	32	29
Total	636	1225	75	138	6287		626			22	3	2	1	25	24	28	4	3	1	32	32
Percent:			12	11						42 --	of	total	supp'd								
Mean	1983- 1985:				1008	0.628	82	0.204													
Mean	1984- 1986:				1007	0.613	86	0.164													

Appendix Table 1e. Citation and support analysis for *PHYSICS and CHEMISTRY of MINERALS*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	43	95	9	19	211	1.083	41	0.293		5	2	1	0	5	1	34	14	7	0	34	11
1981	47	118	13	25	299	1.233	47	0.195		8	1	1	2	3	2	45	6	6	11	17	15
1982	41	107	8	16	334	1.080	42	0.357		6	0	0	0	0	2	75	0	0	0	0	25
1983	53	131	12	24	411	1.281	53	0.434		9	0	1	2	0	1	69	0	8	15	0	8
1984	55	129	24	34	484	1.221	55	0.509		19	1	2	0	3	3	67	4	7	0	11	13
1985	59	142	17	43	548	1.620	59	0.514	3.8	12	2	0	0	2	4	57	10	0	0	10	24
1986	54	126	23	43	546	1.342	50	0.420	4.6	16	3	0	2	3	1	64	12	0	8	12	4
Total:	352	848	106	204	2833		347			75	9	5	6	16	14	59	7	4	5	13	13
Percent:			30	24						68 --	of	total	supp'd								
Mean	1983- 1985:				481	1.374	56	0.486													
Mean	1984- 1986:				526	1.394	55	0.481													

Appendix Table 1f. Citation and support analysis for *AMERICAN JOURNAL of SCIENCE*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of citations	Impact factor	Source items	Immediacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsupported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsupported
1980	53	111	45	95	3251	2.729	81	0.765		25	3	3	0	10	10	47	6	6	0	19	22
1981	28	51	25	46	3145	1.948	55	0.873		17	1	0	0	5	4	62	4	0	0	18	16
1982	38	61	28	47	3647	2.566	56	0.571		19	0	1	0	7	6	55	0	3	0	20	21
1983	44	89	37	67	3751	2.730	39	0.897		30	3	1	1	3	4	70	7	2	2	7	11
1984	16	32	14	25	3990	3.063	43	0.326		8	1	1	0	3	4	44	5	5	0	16	29
1985	29	68	22	50	3749	2.793	35	0.886	>10	17	2	0	0	2	3	70	8	0	0	8	14
1986	16	39	10	23	3735	1.859	30	0.767	>10	6	0	1	0	0	4	51	0	9	0	0	40
Caution:	"Petr ology"		papers	only!																	
Total:	224	451	181	353	25268		339			122	10	7	1	30	35	58	5	3	0	14	19
Percent:			81	78						72 --	of	total	supp'd								
Mean	1983- 1985:				3796	2.786	46	0.598													
Mean	1984- 1986:				3830	2.862	39	0.703													

Appendix Table 1g. Citation and support analysis for *CONTRIBUTIONS to MINERALOGY and PETROLOGY*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of citations	Impact factor	Source items	Immediacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsupported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsupported
1980	175	355	65	124	3047	2.076	172	0.230		36	2	7	1	3	24	46	3	9	1	4	37
1981	135	285	50	93	3320	2.151	135	0.131		33	0	3	0	5	11	63	0	6	0	10	22
1982	115	260	45	87	3549	1.928	115	0.274		35	3	2	0	1	6	74	6	4	0	2	13
1983	108	252	47	93	4178	2.396	107	0.346		28	2	5	0	4	11	55	4	10	0	8	23
1984	145	341	59	128	4577	2.293	154	0.479		43	3	2	0	2	12	69	5	3	0	3	20
1985	106	246	40	75	4520	1.985	106	0.453	7.0	28	2	2	0	2	10	62	4	4	0	4	25
1986	146	345	68	134	5153	2.608	147	0.558	7.3	53	1	11	0	10	7	63	1	13	0	12	10
Total:	930	2084	374	734	28344		936			256	13	32	1	27	81	61	3	8	0	6	22
Percent:			40	35						78 --	of	total	supp'd								
Mean	1983- 1985:				4425	2.225	122	0.426													
Mean	1984- 1986:				4750	2.295	136	0.497													

Appendix Table 1h. Citation and support analysis for *JOURNAL of METAMORPHIC GEOLOGY*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of citations	Impact factor	Source items	Immediacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsupported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsupported
1980	0	0	0	0	0	--	0	--		--	--	--	--	--	--	--	--	--	--	--	--
1981	0	0	0	0	0	--	0	--		--	--	--	--	--	--	--	--	--	--	--	--
1982	0	0	0	0	0	--	0	--		--	--	--	--	--	--	--	--	--	--	--	--
1983	20	42	3	4	--	--	20	--		2	0	0	1	0	0	67	0	0	33	0	0
1984	25	46	2	5	--	--	24	--		2	0	0	0	0	0	100	0	0	0	0	0
1985	26	52	2	7	61	1.250	26*	0.333		2	0	0	0	0	0	100	0	0	0	0	0
1986	24	47	5	7	87	0.660	24	0.167		4	1	0	0	0	0	80	20	0	0	0	0
Total:	95	187	12	23	148		94			10	1	0	1	0	0	83	8	0	8	0	0
Percent:			13	12						83 --	of	total	supp'd								
Mean	1983- 1985:				--	--	--	--													
Mean	1984- 1986:				74	0.955	25	0.250													

Appendix Table 1i. Citation and support analysis for *JOURNAL of PETROLOGY*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	25	48	6	7	1448	4.044	23	0.261		4	0	0	0	0	2	67	0	0	0	0	33
1981	17	31	4	6	1348	3.313	17	0.294		4	1	0	0	0	0	80	20	0	0	0	0
1982	20	37	6	7	1503	3.825	20	0.500		4	0	0	0	0	2	67	0	0	0	0	33
1983	23	50	10	17	1591	3.541	23	0.826		7	1	0	0	2	1	63	9	0	0	18	10
1984	33	74	15	26	1725	3.465	33	1.030		12	1	1	0	3	1	66	5	5	0	16	7
1985	37	78	19	29	1746	3.518	37	0.784	9.5	15	0	0	1	2	3	70	0	0	5	9	16
1986	56	116	22	42	1961	4.200	47	0.809	8.9	18	1	0	0	0	1	90	5	0	0	0	5
Total:	211	434	82	134	11322		200			64	4	1	1	7	10	73	5	1	1	8	12
Percent:			39	31						83 --	of	total	supp'd								
Mean	1983- 1985:				1687	3.508	31	0.880													
Mean	1984- 1986:				1811	3.728	39	0.874													

Appendix Table 1j. Citation and support analysis for *LITHOS*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	32	61	3	3	352	1.193	31	0.226		0	0	0	0	0	3	0	0	0	0	0	100
1981	26	46	4	10	395	1.435	26	0.192		2	0	0	0	0	2	50	0	0	0	0	50
1982	28	49	2	3	425	1.298	28	0.286		0	0	0	0	0	2	0	0	0	0	0	100
1983	27	51	7	13	448	0.963	27	0.333		1	1	1	0	3	4	7	7	7	0	21	57
1984	24	55	3	3	492	1.000	24	0.333		2	0	0	0	0	1	67	0	0	0	0	33
1985	21	45	2	5	486	1.000	21	0.095	7.5	0	0	0	0	0	2	0	0	0	0	0	100
1986	23	49	6	10	479	1.467	23	0.783	7.2	5	0	0	1	0	1	69	0	0	14	0	17
Total:	181	356	27	47	3077		180			10	1	1	1	3	15	28	3	3	3	8	56
Percent:			15	13						63 --	of	total	supp'd								
Mean	1983- 1985:				475	0.988	24	0.254													
Mean	1984- 1986:				486	1.156	23	0.404													

Appendix Table 1k. Citation and support analysis for *MINERALOGY and PETROLOGY*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	20	37	1	3	122	0.267	20	0.000		0	0	0	0	0	2	0	0	0	0	0	200
1981	28	57	3	3	105	0.295	28	0.036		1	0	0	0	1	1	33	0	0	0	33	33
1982	29	54	1	1	86	0.313	27	0.190		0	0	0	0	1	0	0	0	0	0	100	0
1983	32	81	4	5	141	0.364	32	0.125		2	0	0	0	1	1	50	0	0	0	25	25
1984	25	61	2	3	161	0.441	25	0.200		2	0	0	0	0	0	100	0	0	0	0	0
1985	22	38	2	3	158	0.474	22	0.227	8.3	0	0	0	2	2	0	0	0	0	50	50	0
1986	20	39	1	2	151	0.638	20	0.250	6.1	1	0	0	0	0	0	100	0	0	0	0	0
Total:	176	367	14	20	924		174			6	0	0	2	5	4	33	0	0	11	27	29
Percent:			8	5						46 --	of	total	supp'd								
Mean	1983- 1985:				153	0.426	26	0.184													
Mean	1984- 1986:				157	0.518	22	0.226													

Appendix Table 1l. Citation and support analysis for *GEOCHIMICA et COSMOCHIMICA ACTA*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported	No. of PRF
1980	184	471	116	281	6103	3.086	186	0.538		47	15	30	5	8	25	35	11	22	4	6	22	4
1981	202	459	135	298	6254	2.610	204	0.490		60	13	39	12	10	20	38	8	25	8	6	15	0
1982	219	520	139	303	7156	3.062	224	0.719		55	19	43	12	19	14	33	12	26	7	12	10	4
1983	206	509	126	293	8533	3.540	214	0.491		66	17	29	9	21	15	41	11	18	6	13	12	1
1984	233	598	159	375	8048	2.881	238	0.475		73	17	32	13	13	24	42	10	18	7	7	15	6
1985	211	544	147	349	8416	2.562	223	0.596	6.8	83	20	25	9	17	21	46	11	14	5	9	14	3
1986	246	690	171	390	9966	3.020	248	0.742	7.6	73	20	43	19	16	16	39	11	23	10	8	9	6
Total:	1501	3791	993	2289	54476		1537			457	121	241	79	104	135	39	10	21	7	9	14	24
Percent:			66	60						46 --	of	total	supp'd									
Mean	1983- 1985:				8332	2.994	225	0.521														
Mean	1984- 1986:				8810	2.821	236	0.604														

Appendix Table 1m. Citation and support analysis for *CHEMICAL GEOLOGY*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	77	187	17	31	637	0.890	77	0.195		6		1		6	5	33	0	5	0	33	29
1981	79	154	21	46	731	0.927	81	0.247		8	1			3	9	38	5	0	0	14	43
1982	69	175	14	33	815	1.089	69	0.420		2	4			6	1	15	31	0	0	46	7
1983	86	212	16	31	988	1.280	63	0.286		5	2			5	5	29	11	0	0	29	31
1984	137	316	37	76	1051	1.144	111	0.275		11	5	1		9	17	23	10	2	0	19	46
1985	156	375	35	82	1085	0.764	172	0.151	6.8	7	1	1		6	7	37	5	5	0	32	20
1986	158	392	40	76	1238	0.827	158*	0.341	6.7	11	4	1		10	15	26	10	2	0	24	38
Total:	762	1811	180	375	6545		731			50	17	4	0	45	59	29	10	2	0	26	33
Percent:			24	21						43 --	of	total	supp'd								
Mean	1983- 1985:				1041	1.063	115	0.237													
Mean	1984- 1986:				1125	0.912	147	0.256													

Appendix Table 1n. Citation and support analysis for *GEOCHEMICAL JOURNAL*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	36	83	7	14	177	0.473	36	0.143		2				3	3	23	0	0	0	34	43
1981	30	67	3	4	203	0.514	29	0.04		3				1	0	75	0	0	0	25	0
1982	29	72	3	6	235	0.723	28	0.111		3	1			1	0	60	20	0	0	20	0
1983	31	80	3	4	295	1.035	30	0.053		1					2	33	0	0	0	0	67
1984	38	83	3	8	296	0.655	39	0.154		2					1	67	0	0	0	0	33
1985	36	108	6	20	287	0.478	36	0.259	6.7	4					2	67	0	0	0	0	33
1986	34	102	8	21	340	0.560	34*	0.217	6.7	0	0	2			6	0	0	25	0	0	75
Total:	234	595	33	77	1833		232			15	1	2	0	5	14	38	3	5	0	13	42
Percent:			14	13						65 --	of	total	supp'd								
Mean	1983- 1985:				293	0.723	35	0.155													
Mean	1984- 1986:				308	0.564	36	0.210													

Appendix Table 1o. Citation and support analysis for *CLAY MINERALS*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	40	90	2	2	322	0.623	40	0.475		1	0	0	0	0	1	50	0	0	0	0	50
1981	37	95	1	1	256	0.411	37	0.189		1	0	0	0	0	0	100	0	0	0	0	0
1982	45	91	1	2	309	0.740	44	0.250		0	0	0	0	0	1	0	0	0	0	0	100
1983	43	119	3	6	304	0.642	43	0.152		0	0	0	0	0	3	0	0	0	0	0	100
1984	68	170	3	4	444	1.126	68	0.364		1	0	0	1	1	2	11	0	0	11	11	67
1985	42	100	2	3	431	0.865	42	0.219	6.9	0	0	0	0	0	2	0	0	0	0	0	100
1986	64	149	7	13	472	1.018	64*	0.278	6.0	1	1	0	1	0	5	10	10	0	10	0	71
Total:	339	814	19	31	2538		338			4	1	0	2	1	14	13	3	0	7	3	74
Percent:			6	4						50 --	of	total	supp'd								
Mean	1983- 1985:				393	0.878	51	0.245													
Mean	1984- 1986:				449	1.003	58	0.287													

Appendix Table 1p. Citation and support analysis for *CLAYS and CLAY MINERALS*

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported	No. of PRF
1980	65	139	26	49	840	1.024	65	0.185		14	2	0	0	2	10	48	7	0	0	7	38	0
1981	63	137	33	66	718	0.734	62	0.242		8	2	0	0	10	14	23	6	0	0	29	42	2
1982	65	145	31	58	835	0.835	65	0.323		8	1	1	0	10	12	25	3	3	0	31	39	2
1983	66	167	31	74	909	0.811	60	0.200		9	6	1	1	10	8	25	16	3	3	27	26	1
1984	67	n a	n a	n a	1179	1.084	67	0.478		n a	n a	n a	n a	n a	n a	--	--	--	--	--	--	n a
1985	78	180	42	88	1076	0.940	73	0.194	8.6	9	3	1	0	3	27	20	7	2	0	7	64	3
1986	92	212	57	118	1289	1.021	77	0.403	8.4	18	0	1	0	6	31	33	0	2	0	11	54	2
Total:	496	980	220	453	6846		469			66	14	4	1	41	102	26	6	2	4	16	46	10
Percent:			44	46						52 --	of	total	supp'd									
Mean	1983- 1985:				1055	0.945	67	0.291														
Mean	1984- 1986:				1181	1.015	72	0.358														

Appendix Table 1q. Citation and support analysis for *MINERALIUM DEPOSITA*.

Year	No. of papers	No. of authors	Papers with U.S. authors	No. of U.S. authors	No. of cita-tions	Impact factor	Source items	Imme-diacy index	Half life (yrs)	No. of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	No. unsup-ported	% of papers supported by ... NSF	DOE	NASA	NATO	Fed'l	% unsup-ported
1980	38	73	2	3	156	0.607	38	0.053		0	0	2	2	2	0	0	0	33	33	33	0
1981	38	77	1	1	178	0.348	37	0.162		0	0	0	0	0	1	0	0	0	0	0	100
1982	32	60	6	9	237	0.547	32	0.063		0	1	0	0	0	5	0	17	0	0	0	83
1983	42	98	3	5	267	0.797	42	0.095		0	0	1	1	1	0	0	0	33	33	33	0
1984	39	78	1	3	321	0.365	40	0.300		0	0	0	0	1	0	0	0	0	0	100	0
1985	41	76	3	5	285	0.610	41	0.098	6.9	0	0	0	0	1	2	0	0	0	0	33	67
1986	38	87	2	3	256	0.395	38	0.184	8.1	0	0	0	0	0	2	0	0	0	0	0	100
Total:	268	549	18	29	1700		268			0	1	3	3	5	10	0	4	11	11	19	56
Percent:			7	5						0 --	of	total	supp'd								
Mean	1983- 1985:				291	0.591	41	0.164													
Mean	1984- 1986:				287	0.457	40	0.194													