

# Applications Of Empirical Law In Geochemistry Research In India: A Scientometric Analysis

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## Abstract

The present study attempted to examine India level publication trends in Geochemistry and tested fitness of Empirical law. Data downloaded from web of science database. Four thousand three hundred and eighty nine authors have contributed the total of 2603 articles. This Scientometric study analyses most prolific authors, Scattering of Articles in Different Journals, Keywords. Journal of the Geological Society of India ranked first order with 571 (21.3%) articles with Global Citation Score 4105

**Keywords:** Geochemistry, Scientometrics, Bradford's Law.

## 1. Introduction

The 20<sup>th</sup> century might be portrayed as the hundred years of the improvement of metric sciences like Librametrics, Scientometrics, Cybermetrics or Webometric and lastly Informetrics. The goal is to utilize quantitative strategies and techniques to survey the information space. Scientometrics has gotten unmistakable step by step in view of the need to quantify and assess the gigantic interests in science and technology (S&T) areas, particularly in innovative work exercises. This study is an attempt to assess the geochemistry research output trend in india indexed in the web of science database.

.The main focus of the geochemistry is to understand the principles governing the distribution and re-distribution of elements, ionic species and isotope ratios in earth materials, so that we can interpret the formation of mineral assemblages: conditions (P, T, etc.), processes (magmatic crystallization, weathering, chemical precipitation, metamorphism, etc.), and even the age.

## 2. Literature Review

Some of the earlier studies have been reviewed related to the objectives of the present study and presented below.

**Anil Sagar, Basavaraj, etc., (2013)** analyzed to highlight the growth and development of dark energy literature and make the quantitative and qualitative assessment by way of analyzing various features of research output based on Web of Science database. A total of 5858 publications were published on dark energy, which received 157,581 citations during 1999-2011. The average number of publications per year was 450.62, and the average number of citations per publication was 26.90.

**Ranganathan, C and Balasubramani, R (2013)** studied with the Scientometric study on the publication of "Green Chemistry" research in India. The records are collected from Scopus Database for the period of 1999-2013. A total of 1448 papers were identified in scopus database. The study reveals that, most researchers preferred to publish their research results in journals

### **3. Objectives of the Study**

The present study was undertaken with the following objectives

1. Application of Inverse Square Law of Scientific Author Productivity
2. To identify the journals most preferred for publishing the research results
3. Application of Bradford's Law of distribution
4. To identify the keyword wise Publications
5. To verify the Zipf's Law

### **3.1 Methodology**

Web of Science Database was used for retrieving data on Geochemistry for all years using the search term "Geochemistry" in topic field. The Geochemistry research literature retrieved from web of science database from 1989 to October 2020. Overall data retrieved by the researcher are 2603 records by analyzing the present study. The data has analyzed and classified into HistCite software.

## **4. ANALYSIS AND DISCUSSION**

### **4.1 Lotka's inverse square law of scientific Author Productivity**

Lotka's law is one of the three major laws of bibliometrics that mainly explain the literature distribution of various authors' productivity in a given field (Lotka, 1926). It finds that most articles are being contributed by a few researchers, with a large proportion of researchers contributing just one publication. Therefore, Lotka summarizes the logarithmic relation between researchers and publication quantities. It states that "the number (of authors) making  $n$  contributions is about  $1/n^2$  of those making one publication; and the proportion of all

contributors, that makes a single contribution, is about 60 percent" (Lotka, 1926), as cited in Potter (1981).

P = Number of x items in table = 32

N = Sum of contributors = 13787, N: Observed value

Pao (1986) proposed the way to calculate n-value and c- value of Lotka's law as in (1) and (2)

The 'n' value is calculated by this method using the following formula

$$N = \frac{N \sum xy - \sum x \sum y}{N \sum x^2 - (\sum x)^2} \dots(1)$$

$$N = \frac{32(473.797)-(106.156*182.515)}{32(330.903)-(106.156)^2}$$

$$N = 6.194$$

**Table 1: Lotka's inverse square law of scientific Author Productivity**

No. of Contribution X	No. of Contributors	Y	$\sum X = \log x$	$\sum Y = \log y$	$\sum X * \sum Y$	$\sum X * X$
1	2909	2909	0	7.975565	0	0
2	625	1250	0.693147	7.130899	4.942762	0.480453
3	266	798	1.098612	6.682109	7.341047	1.206949
4	155	620	1.386294	6.429719	8.913484	1.921812
5	101	505	1.609438	6.224558	10.01804	2.59029
6	64	384	1.791759	5.950643	10.66212	3.210402
7	46	322	1.94591	5.774552	11.23676	3.786566
8	36	288	2.079442	5.66296	11.7758	4.324077
9	36	324	2.197225	5.780744	12.70159	4.827796
10	22	220	2.302585	5.393628	12.41929	5.301898
11	12	132	2.397895	4.882802	11.70845	5.749902
12	12	144	2.484907	4.969813	12.34952	6.174761
13	12	156	2.564949	5.049856	12.95262	6.578965
14	14	196	2.639057	5.278115	13.92925	6.964624
15	19	285	2.70805	5.652489	15.30722	7.333536
16	8	128	2.772589	4.85203	13.45268	7.687248
17	9	153	2.833213	5.030438	14.2523	8.027098
18	4	72	2.890372	4.276666	12.36115	8.354249
19	3	57	2.944439	4.043051	11.90452	8.669721

20	3	60	2.995732	4.094345	12.26556	8.974412
21	5	105	3.044522	4.65396	14.16909	9.269117
22	2	44	3.091042	3.78419	11.69709	9.554543
23	2	46	3.135494	3.828641	12.00468	9.831324
24	2	48	3.178054	3.871201	12.30289	10.10003
25	3	75	3.218876	4.317488	13.89746	10.36116
26	1	26	3.258097	3.258097	10.61519	10.61519
27	4	108	3.295837	4.682131	15.43154	10.86254
28	1	28	3.332205	3.332205	11.10359	11.10359
32	2	64	3.465736	4.158883	14.41359	12.01133
33	1	33	3.496508	3.496508	12.22557	12.22557
34	1	34	3.526361	3.526361	12.43522	12.43522
44	1	44	3.78419	3.78419	14.32009	14.32009
45	2	90	3.806662	4.49981	17.12926	14.49068
48	1	48	3.871201	3.871201	14.9862	14.9862
52	1	52	3.951244	3.951244	15.61233	15.61233
60	1	60	4.094345	4.094345	16.76366	16.76366
61	1	61	4.110874	4.110874	16.89928	16.89928
64	1	64	4.158883	4.158883	17.29631	17.29631
		<b>10033</b>	<b>106.156</b>	<b>182.515</b>	<b>473.797</b>	<b>330.903</b>

#### 4.2 Journal wise distribution of publications

Table 2 shows that top 20 ranking of journals according to their productivity with minimum of 10 publications. Journal of the Geological Society of India ranked first order with 571 (21.3%) articles (Global Citation Score 4105) and next to Current Science and Journal of Asian Earth Sciences ranked second order with 109 publications (Global Citation Scores 789 and 1988) and the remaining journals are ranked in the below table according to their publications and citations. During the study period scientists has published 2603 publications in 312 source titles.

**Table 2: Scattering of Articles in Different Journals**

S.No	Journal	Publication	Percent	TLCS	TLCS/t	TGCS	TGCS/t	TLCR
1	Journal of the Geological Society of India	571	21.9	1486	95.12	4105	305.55	1184
2	Current Science	109	4.2	174	13.83	789	67.70	233
3	Journal of Asian Earth Sciences	109	4.2	483	49.58	1988	212.96	599
4	Journal of Earth System Science	108	4.1	143	13.83	777	95.26	529

5	Environmental Earth Sciences	106	4.1	144	16.81	1322	190.74	407
6	Precambrian Research	91	3.5	954	82.96	3482	325.74	567
7	Gondwana Research	83	3.2	555	48.25	2306	216.79	363
8	Arabian Journal of Geosciences	68	2.6	54	7.28	557	92.13	241
9	Environmental Monitoring and Assessment	61	2.3	126	11.97	1576	164.95	177
10	Chemical Geology	59	2.3	395	26.77	1837	149.66	217
11	Geochimica Et Cosmochimica Acta	59	2.3	202	13.59	1427	101.38	129
12	Environmental Geology	43	1.7	331	19.25	1802	111.72	74
13	Geological Journal	41	1.6	41	9.15	239	62.75	336
14	Lithos	41	1.6	209	25.58	895	121.37	279
15	Proceedings of The Indian Academy of Sciences-Earth and Planetary Sciences	27	1.0	148	6.84	583	26.84	56
16	International Geology Review	26	1.0	98	10.64	513	52.57	192
17	Ore Geology Reviews	26	1.0	44	6.19	404	55.60	127
18	Himalayan Geology	24	0.9	55	5.76	124	14.59	72
19	Mineralogy and Petrology	24	0.9	111	8.27	308	25.31	118
20	Palaeogeography Palaeoclimatology Palaeoecology	22	0.8	53	6.68	515	58.02	44

#### 4.3 Bradford's Law of scattering

The Bradford law was formulated in the year 1948. It examines essentially that a group of journals are arranged in an order of decreasing productivity. It means the journals that yield that most relevant article coming first and the most unproductive in the last.

**Table 3: Bradford's Law of scattering (312 Journals) of Geo Chemistry Research Publications**

S.No	No. of Journals	No. of Articles	Total no. of Articles	Cumulative No. of Articles
1	1	571	571	571
2	2	109	218	789
<b>3</b>	<b>1(4)</b>	<b>108</b>	<b>108</b>	<b>897(868)</b>
4	1	106	106	1003
5	1	91	91	1094
6	1	83	83	1177
7	1	68	68	1245
8	1	61	61	1306
9	2	59	118	1424
10	1	43	43	1467
11	2	41	82	1549
12	1	27	27	1576
13	2	26	52	1628
14	2	24	48	1676
15	1	22	22	1698
16	1	20	20	1718
<b>17</b>	<b>2(19)</b>	<b>19</b>	<b>38</b>	<b>1756(1735)</b>
18	1	17	17	1773
19	4	16	64	1837
20	2	15	30	1867
21	2	14	28	1895
22	2	13	26	1921
23	1	12	12	1933
24	3	11	33	1966
25	2	10	20	1986
26	1	9	9	1995
27	11	8	88	2083
28	6	7	42	2125
29	7	6	42	2167
30	8	5	40	2207
31	21	4	84	2291
32	24	3	72	2363

33	46	2	92	2455
34	148(289)	1	148	2603
<b>Total</b>	<b>312</b>		<b>2603</b>	

Table-3 indicates that the first 4 journals covered more than one third of the total articles published. Next 19 journals covered another one third of the published articles. According to Bradford's distribution the relationship between the zones is 1: a: a<sup>2</sup>, while the relationship in each zone of the present study is 4:19:289 which does not fit Bradford's distribution.

#### 4.4 Keyword wise distribution of publications

Publications convey precisely the thought contents of the papers. The potency of information concentrated on the titles of the papers is more than the rest of the section of the papers. Therefore, if a word occurs more frequently than expected it to occur, then it reflects the emphasis given by the authors about the research field of their interest. The below mentioned table explains what are the find key word and how many times it is used. "India" is used 1496 times, Geochemistry in 819 times and "Implications" in 305 times. A total word count 4568.

**Table- 4 showing Word Frequency in the Publications**

S.No	Word	Recs	Percent	TLCS	TGCS
1	India	1496	57.5	5698	28133
2	Geochemistry	819	31.5	3553	14181
3	Implications	305	11.7	1192	5550
4	Basin	276	10.6	846	4200
5	Craton	257	9.9	1505	4946
6	Sediments	246	9.5	764	5048
7	Central	235	9.0	892	3575
8	Geochemical	234	9.0	801	3715
9	Southern	227	8.7	1155	5136
10	Eastern	224	8.6	1035	4155
11	Groundwater	203	7.8	450	4377
12	District	196	7.5	481	2481
13	Indian	190	7.3	727	3472
14	Western	189	7.3	668	3237
15	Rocks	185	7.1	824	2767
16	Belt	184	7.1	852	2798
17	River	154	5.9	606	3962
18	Dharwar	143	5.5	935	3202
19	Evidence	139	5.3	638	2466
20	South	139	5.3	470	2474

#### 4.5 Zipf's Law of Word Occurrence

Zipf's law states that, "in a long textual matter if words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word" i.e.  $rf$  {where 'r' is rank and 'f' is frequency}

$$rf = c \text{ (where, c is constant)}$$

Taking log on both the sides,  $\text{Log}(f) + \log(r) = \log c$

$$\text{Or } \log(f) + \log(r) = c \text{ {where 'c' is constant}}$$

To apply this law, the words (terms) were collected from the title of the articles and ranked according to their frequency of occurrence in decreasing order.

Only those top Thirty words occupying frequency up to 4568 items are given in Table-8 on applying this law, it was found that log of frequency of occurrence of words when added to log of their rank; the results are almost same for each word. The log of frequency of three most potent words appeared in the titles "INDIA" is given below:

1. Word : INDIA
- Frequency : 1496
- Rank : 1
- Log of frequency + log of rank
- Log 1496 + log 1
- = 7.31 + 0
- = 7.31 word

Thus, it is proved that Zipf's law is valid even today.

**Table 5: Ranking of Word Occurrence in Zipf's Law**

S.No	Word	Recs(F)	Rank(R)	Log F	Log R
1	India	1496	1	7.31	0.00
2	Geochemistry	819	2	6.71	0.69
3	Implications	305	3	5.72	1.10
4	Basin	276	4	5.62	1.39
5	Craton	257	5	5.55	1.61
6	Sediments	246	6	5.51	1.79
7	Central	235	7	5.46	1.95
8	Geochemical	234	8	5.46	2.08
9	Southern	227	9	5.42	2.20
10	Eastern	224	10	5.41	2.30
11	Groundwater	203	11	5.31	2.40



12	District	196	12	5.28	2.48
13	Indian	190	13	5.25	2.56
14	Western	189	14	5.24	2.64
15	Rocks	185	15	5.22	2.71
16	Belt	184	16	5.21	2.77
17	River	154	17	5.04	2.83
18	Dharwar	143	18	4.96	2.89
19	Evidence	139	19	4.93	2.94
20	South	139	19	4.93	2.94

### Major Findings:

1. Inverse Square Law of Author Productivity does not fit
2. Journal of the Geological Society of India ranked first order with 571 (21.3%) articles (Global Citation Score 4105) and next to Current Science and Journal of Asian Earth Sciences ranked second order with 109 publications (Global Citation Scores 789 and 1988)
3. The Bradford's Law of distribution does not fit
4. The findings of high frequency keywords were "INDIA" is topped with 1496 publications with the Global Citation Score of 28133; next "GEOCHEMISTRY" has with the Global Citation Score of 14181 respectively.
5. The formulated of the applicability of Zipf's law of is identified as validated.

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