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SCIENTOMETRIC ANALYSIS OF AUTHORSHIP TRENDS AND COLLABORATIVE RESEARCH IN GEOCHEMISTRY

By

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Abstract:

The study deals with the Scientometric study on the publication of "Geochemistry". The records are collected from Web of Science Databases for the period of 1989-2020. A total of 2603 papers were identified in Web of Science database. The study reveals that, most of the researchers preferred to publish their research results in journal and more numbers of articles were published in the year 2019. The authorship trend shows that, out of total 2603 literature published, 92.5% of the publication published under the joint author. Four thousand three hundred and eighty nine authors have contributed the total of 2603 articles. Further this study also identified to analyses coverage growth rates, relative growth rate, doubling time, most prolific authors, Degree of collaboration, Areas of research concentration, Price's Square Root Law and Pareto Principle and citation analysis is also noted

Keywords: Author Productivity, Geochemistry, Scientometrics, Price's square root Law, Pareto Principle.

1. Introduction

The growth rate analysis of publication could yield some useful results regarding growth pattern of literature and scientific productivity of authors in that discipline. The Scientometric analysis of scientific publications is an important aspect of research endeavor in information science in recent years. Scientometrics is now an accepted analytical tool to monitor and analyse the research performance of institutions, individuals etc. for diverse purposes and includes quantitative and qualitative analysis of research papers.

The major focus of the study is to apply the Scientometric analysis with a view to analyse the evaluation and growth and development of research output in Geochemistry. This study related to authors and their productivity; collaborative patterns and other aspects is important and useful to understand the mechanism underlying the growth of knowledge of a discipline. This

study also to analyses the evaluation growth and development and of Geochemistry research output interms of its content and coverage relative growth rates, doubling time, most prolific authors, Degree of collaboration, Areas of research concentration, Price's Square Root Law and Pareto Principle and citation analysis is also noted

2. Review of Literature

The study of the authorship pattern and collaboration is an important aspect of Scientometric analysis. Azadeh and Abdolreza (2013)¹ studied Lotka's law on the literature of applied mathematics of Mysore University, taking data from Web of Science for the period 1975-2011. They reported a very high value of $\alpha = -3.3488$, suggesting highly skewed author productivity distribution without confirming to Lotka's law. Sivakumar et al., (2013)² tested the fitness of Lotka's law on the biology literature of central universities in India from 1999-2012 on data taken from 'Science Citation Index-Expanded' and applied chi-square test and found that Lotka's law was not able to explain the author productivity distribution in this study. Chen, Yang and Yu (2011)³ applied Lotka's law on agent-based modeling literature taken from the Social Science Citation Index (SSCI) database. The value of parameters α and c were -3.2 and 0.8573 respectively and K-S test confirmed the author productivity distribution. Zafrunnisha and Pullareddy (2009)⁴ conducted the Studies related to authorship trend and collaborative researches that are considered as an important facet of modern science. Predominance of multi-authored papers over single authored papers is seen. The degree of collaboration in Psychology in 0.53. USA defenses' first by producing 42.28% of cited journals. Majority of the cited journals of Psychology (94.54%) are in English language.

3.Objectives

This article intends to identify author productivity in the research of geochemistry yield with the objectives as following:

1. To identify Year wise Distribution of Cited Reference and Authors
2. To find out the Relative Growth Rate and Doubling Time of overall output
3. To find out the top most productive authors and authorship pattern
4. To Identify Co – authorship Index(CAI) on Geochemistry research
5. To know degree of collaborations amongst authors.
6. To the applicability of Price's Square Root Law
7. To the applicability of Pareto Principle (80 X 20 Rules)

4. Data collection

For collection of the publication data, the source Web of Science (WoS) a bibliographic and citation database was used. The data was collected for the period 1989-2020. The data was obtained in September 2020. The full records were downloaded in the plain text format.

5. Methodology

This study is conducted with a view to analyze the trend in the development of Geochemistry in Scientometric analysis. It is also focused to trace the past trends in the area of research output on geochemistry in Scientometric analysis based on the sample data. The information has investigated and ordered into HistCite software it is likewise precise in nature in sustaining the trial authenticity in view of use of sensible real instruments. The improvement speeds of yield with respect to investigate productivity are analyzed from 1989-2020.

6. ANALYSIS AND DISCUSSION

6.1 Year wise Distribution of Cited Reference and Authors

Table-1 shows that the values total Cited References and its average values, number of authors and its average authors per article values and its mean values are calculated by year wise Geochemistry research publication output. It could be noticed that from the table-1 below totally 2603 records were produced by 10056 authors for 32 years from 1989 to 2020 on Geochemistry research. Totally 143505 times cited references measured by other scientists.

The year of 2019 records were cited by highest times cited references during period. Each year records were cited more than 100 times at every article of Geochemistry. The year of 2019 had contributed the highest number of authors in 211 research publication. It is concluded from these analysis highest cited references of 17037 times cited by others in the year 2019.

Table 1: Year wise Distribution of Cited Reference and Authors

Year	Recs	CR	ACRPA	NA	AAPA
1989	8	154	19.25	22	2.75
1990	12	126	10.50	23	1.92
1991	32	454	14.19	88	2.75
1992	22	533	24.23	73	3.32
1993	34	529	15.56	81	2.38
1994	36	763	21.19	104	2.89
1995	43	991	23.05	118	2.74
1996	48	1338	27.88	125	2.60
1997	65	1909	29.37	185	2.85
1998	50	1747	34.94	170	3.40
1999	62	2567	41.40	184	2.97
2000	44	1772	40.27	143	3.25
2001	56	2380	42.50	160	2.86
2002	52	2389	45.94	188	3.62
2003	56	2271	40.55	172	3.07
2004	56	2430	43.39	169	3.02
2005	76	3076	40.47	250	3.29
2006	74	3184	43.03	227	3.07
2007	88	3984	45.27	293	3.33
2008	88	4694	53.34	326	3.70
2009	103	4980	48.35	421	4.09
2010	107	5217	48.76	380	3.55
2011	106	6561	61.90	426	4.02
2012	116	7240	62.41	490	4.22
2013	155	9333	60.21	608	3.92
2014	150	9228	61.52	698	4.65
2015	162	10241	63.22	679	4.19
2016	155	11501	74.20	754	4.86
2017	164	11574	70.57	713	4.35
2018	162	12304	75.95	736	4.54
2019	211	17037	80.95	998	4.72
2020	10	998	99.80	52	5.20
Total	2603	143505	1464.16	10056	112.09

6.2 Relative Growth Rate and Doubling Time of Overall Output

Table-2 presents data of relative growth rate and doubling time for total research output in Geochemistry. It could be noted that in 1989, 8 papers have been published in Geochemistry and the number went up to 2603 by the end of the year 2020. However, its relative growth rate has shown a declining trend.

It is seen that its relative growth rates have decreased gradually from 0.916 in 1989 to 0.003 in 2020. The mean relative growth rates for the periods 1989-2004 and 2005-2020 are 0.277 and 0.084 respectively. The whole study period record the mean relative growth rate of 0.181. Contrastingly the doubling time for publication of all sources of Geochemistry research output has increased from 0.756 in 1989 to 180.047 in 2020. The mean doubling time for the period 1989 to 2004 is worked out to 3.767 years and for the period 2005 to 2020 it is calculated as 18.698 years.

Table 2: Relative Growth Rate and Doubling Time of Overall Output

Year	No. of Output	Cum. No. of Output	Log _e 1 ^P	Log _e 2 ^P	R(a)	Mean — R(a)= W ₂ - W ₁	Dt=0.693 R(a) —	Mean Dt (a)
1989	8	8	-	2.079442	-	0.277	-	3.767
1990	12	20	2.079442	2.995732	0.91629		0.756311	
1991	32	52	2.995732	3.951244	0.955512		0.725266	
1992	22	74	3.951244	4.304065	0.352821		1.964169	
1993	34	108	4.304065	4.682131	0.378066		1.833013	
1994	36	144	4.682131	4.969813	0.287682		2.40891	
1995	43	187	4.969813	5.231109	0.261296		2.652165	
1996	48	235	5.231109	5.459586	0.228477		3.033128	
1997	65	300	5.459586	5.703782	0.244196		2.837884	
1998	50	350	5.703782	5.857933	0.154151		4.495592	
1999	62	412	5.857933	6.021023	0.16309		4.249188	
2000	44	456	6.021023	6.122493	0.10147		6.829605	
2001	56	512	6.122493	6.238325	0.115832		5.982803	
2002	52	564	6.238325	6.335054	0.096729		7.164346	
2003	56	620	6.335054	6.429719	0.094665	7.320551		
2004	56	676	6.429719	6.516193	0.086474	8.01397		
2005	76	752	6.516193	6.622736	0.106543	0.084	6.504416	18.698
2006	74	856	6.622736	6.75227	0.129534		5.349947	
2007	88	914	6.75227	6.817831	0.065561		10.57031	
2008	88	1002	6.817831	6.909753	0.091922		7.539	
2009	103	1105	6.909753	7.007601	0.097848		7.082414	
2010	107	1212	7.007601	7.100027	0.092426		7.49789	
2011	106	1318	7.100027	7.183871	0.083844		8.26535	
2012	116	1434	7.183871	7.268223	0.084352		8.215573	

2013	155	1589	7.268223	7.37086	0.102637		6.751951	
2014	150	1739	7.37086	7.461066	0.090206		7.682416	
2015	162	1901	7.461066	7.550135	0.089069		7.780485	
2016	155	2056	7.550135	7.628518	0.078383		8.841203	
2017	164	2220	7.628518	7.705262	0.076744		9.030022	
2018	162	2382	7.705262	7.775696	0.070434		9.838998	
2019	211	2593	7.775696	7.860571	0.084875		8.164948	
2020	10	2603	7.860571	7.86442	0.003849		180.0468	
					0.1886	0.181		11.232

6.3 Ranking of Authors Productivity Based on Publications

Table 3 indicates ranking of authors by number of publications. Authors ‘Balaram V’ published highest number of articles for the study period with 64 records and also had highest citation score of 1087. The following authors ‘Santosh M’ published next highest number of articles for the study period with 61 records and also had next highest citation score of 1512. ‘Thus, the most-cited authors are distinguished from the most-published ones. It is found from the analysis that Lotka’s law may be applicable with regard to author productivity in proliferation of research in Geochemistry as the research papers.

Table 3: Scientometric Profile of Top 25 Most Productive Authors

S. No	Author	Re cs	Per cent	TL CS	TLC S/t	TLC Sx	TGC S	TGCS /t	TLC R	TLC Sb	TLC Se
1	Balaram V	64	2.5	239	15.99	132	1087	93.71	226	26	47
2	Santosh M	61	2.3	362	55.32	122	1512	237.40	578	126	50
3	Srivastava RK	60	2.3	382	28.62	204	1069	82.41	314	47	87
4	Rao NVC	52	2.0	299	36.69	84	777	101.18	466	61	30
5	Kumar A	48	1.8	163	20.05	101	863	119.64	184	25	13
6	Manikyamba C	45	1.7	347	31.57	138	1020	103.84	402	55	63
7	Singh AK	45	1.7	128	10.76	68	604	71.01	185	15	10
8	Kumar S	44	1.7	93	9.37	52	504	58.68	176	17	11
9	Satyanarayanan M	34	1.3	139	20.58	36	600	91.62	224	44	17
10	Rajamani V	33	1.3	364	18.50	250	1083	57.25	107	43	71
11	Ahmad T	32	1.2	235	13.25	166	873	52.71	127	14	26
12	Rao DVS	32	1.2	153	14.69	75	436	44.01	147	22	20
13	Naqvi SM	28	1.1	280	14.86	146	794	41.58	101	39	47
14	Balakrishnan S	27	1.0	86	7.80	62	276	29.54	189	7	8

15	Pandit MK	27	1.0	76	5.91	49	578	54.38	149	11	8
16	Ramanathan AL	27	1.0	141	9.09	97	996	99.22	55	13	19
17	Singh S	27	1.0	45	4.45	24	219	26.26	86	4	
18	Banerjee S	26	1.0	98	9.73	66	523	67.49	71	10	10
19	Achyuthan H	25	1.0	28	6.26	9	185	35.71	92	1	
20	Dayal AM	25	1.0	75	6.44	46	274	26.71	51	20	12
21	Ganguly S	25	1.0	90	15.75	29	300	58.84	287	20	20
22	Sial AN	24	0.9	69	4.53	38	293	19.25	82	10	3
23	Singh SK	24	0.9	76	7.27	49	607	56.63	98	16	13
24	Nath BN	23	0.9	82	4.87	56	483	39.60	52	9	10
25	Subramanian V	23	0.9	219	10.23	169	791	48.60	50	16	31

6.4 Authorship Pattern

The study of authorship pattern is a significant angle in scientometric analysis. It target at analyzing the performance of scientists in contributing research output either individually or collectively. Hence, there is a need to analyze the equivalent with the end goal of present study.

Table-4 indicates the authorship pattern in Geochemistry research output. It could be observed that two author contributed papers occupies the first position (22.01%), followed by three authors contributed papers occupies the second position(21.86) in respect to total number of papers published during the period of analysis. From this study the multi-author publication is the highest compare to single-author publication. In thirty two years analysis, year 2019 has recorded highest publication of 211 record (8.11%), followed by the year 2017 has recorded 164 publications (6.30%).

Table 4: Authorship Pattern of Papers Published

Year	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten and above	Total
1989	1	3	2	1	1						8
1990	5	3	4								12
1991	5	12	8	4	-	2	1				32
1992	1	5	7	7	1	-	-	1			22
1993	7	12	10	5							34
1994	2	13	13	3	5						36
1995	5	20	9	4	3	-	1	1			43

1996	7	20	11	6	3	1					48
1997	8	25	15	7	8	-	2				65
1998	8	11	4	14	9	2	1	1			50
1999	10	22	14	9	4	1	1			1	62
2000	4	12	14	4	4	5	1				44
2001	8	22	12	5	4	3	2				56
2002	8	10	9	7	9	4	4	1			52
2003	11	12	15	5	8	3	2				56
2004	5	17	17	11	3	2	-	1			56
2005	11	19	16	16	4	4	4	1	1		76
2006	9	19	19	16	7	4	-				74
2007	7	30	16	19	9	3	1	1	1	1	88
2008	11	14	20	16	14	7	1	3	1	1	88
2009	4	19	30	20	14	6	3	3	1	3	103
2010	6	28	25	25	8	8	3	3		1	107
2011	7	19	20	28	12	11	4	2		3	106
2012	6	17	25	29	11	10	11	2	3	2	116
2013	11	27	30	37	19	19	5	3	3	1	155
2014	6	20	33	23	25	18	14	5	1	5	150
2015	9	32	31	31	16	17	12	6	6	2	162
2016	1	19	33	23	23	22	16	8	6	4	155
2017	5	28	27	36	26	15	16	6	3	2	164
2018	2	30	30	30	23	20	16	4		7	162
2019	5	32	47	26	36	31	12	9	5	8	211
2020		1	3	1		2	1	1		1	10
Total	195	573	569	468	309	220	134	62	31	42	2603
%	7.49	22.01	21.86	17.98	11.87	8.45	5.15	2.38	1.19	1.61	

6.5 Single Vs Multiple-Authored Research Output and Degree of Collaboration

The single version multi-author research output during the period 1989–2020 is observed. It is observed that from the above table shows, the single-author contributed papers constitute 7.49% of the total publications where-as the remaining majority 92.51% of the papers are contributed by multi-authorship. In order to determine the collaboration in quantitative terms, the formula suggested by K. Subramanyam was tested. It is inferred from Table 5 that at the aggregate level, the degree of collaboration is 0.10 during the study period 1989–2020.i.e., out of total 2603 literature published, 92.51 % of them were published under the joint authors of publications in geochemistry research output. The period wise analysis indicates that its level is somewhat less in the first period [1989-2004: 0.15] and it has shown. An decreasing trend during

the period [2005-2020: 0.06]. Based on this study, the result of the degree of collaboration $C=0.10$ i.e., 10 percent of collaboration authors articles published during the study periods.

Table - 5: Single Vs Multiple Authored Research output and Degree of Collaboration

Year	Single Authors		Multiple Authors		Total	%	Degree of Collaboration	Mean in Degree of Collaboration
	No. of Output	%	No. of Output	%				
1989	1	12.50	7	87.50	8	0.31	0.125	0.15
1990	5	41.67	7	58.33	12	0.46	0.416667	
1991	5	15.63	27	84.38	32	1.23	0.15625	
1992	1	4.55	21	95.45	22	0.85	0.045455	
1993	7	20.59	27	79.41	34	1.31	0.205882	
1994	2	5.56	34	94.44	36	1.38	0.055556	
1995	5	11.63	38	88.37	43	1.65	0.116279	
1996	7	14.58	41	85.42	48	1.84	0.145833	
1997	8	12.31	57	87.69	65	2.50	0.123077	
1998	8	16.00	42	84.00	50	1.92	0.16	
1999	10	16.13	52	83.87	62	2.38	0.16129	
2000	4	9.09	40	90.91	44	1.69	0.090909	
2001	8	14.29	48	85.71	56	2.15	0.142857	
2002	8	15.38	44	84.62	52	2.00	0.153846	
2003	11	19.64	45	80.36	56	2.15	0.196429	
2004	5	8.93	51	91.07	56	2.15	0.089286	
2005	11	14.47	65	85.53	76	2.92	0.144737	0.06
2006	9	12.16	65	87.84	74	2.84	0.121622	
2007	7	7.95	81	92.05	88	3.38	0.079545	
2008	11	12.50	77	87.50	88	3.38	0.125	
2009	4	3.88	99	96.12	103	3.96	0.038835	
2010	6	5.61	101	94.39	107	4.11	0.056075	
2011	7	6.60	99	93.40	106	4.07	0.066038	
2012	6	5.17	110	94.83	116	4.46	0.051724	
2013	11	7.10	144	92.90	155	5.95	0.070968	
2014	6	4.00	144	96.00	150	5.76	0.04	
2015	9	5.56	153	94.44	162	6.22	0.055556	
2016	1	0.65	154	99.35	155	5.95	0.006452	
2017	5	3.05	159	96.95	164	6.30	0.030488	
2018	2	1.23	160	98.77	162	6.22	0.012346	
2019	5	2.37	206	97.63	211	8.11	0.023697	
2020	0	0.00	10	100.00	10	0.38	0	
Total	195(7.49)		2408		2603(92.51)			0.10

6.6 Pattern of Co-authorship Index

It is observed from below table-6 the Co-Authorship Index for single authors is declined from 166.859 in the year 1989.

Table 6: Pattern of Co-Authorship Index (CAI)

Year	Single Authors		Multiple Authors		Total
	No. of Output	CAI	No. of Output	CAI	
1989	1	166.859	7	94.58576	8(0.31)
1990	5	556.1966	7	63.05717	12(0.46)
1991	5	208.5737	27	91.20769	32(1.23)
1992	1	60.67599	21	103.1845	22(0.85)
1993	7	274.8265	27	85.84253	34(1.31)
1994	2	74.15954	34	102.0926	36(1.38)
1995	5	155.2177	38	95.52847	43(1.65)
1996	7	194.6688	41	92.33371	48(1.84)
1997	8	164.2919	57	94.79364	65(2.50)
1998	8	213.5795	42	90.80233	50(1.92)
1999	10	215.3019	52	90.66284	62(2.38)
2000	4	121.352	40	98.27092	44(1.69)
2001	8	190.696	48	92.65543	56(2.15)
2002	8	205.3649	44	91.46754	52(2.00)
2003	11	262.207	45	86.86447	56(2.15)
2004	5	119.185	51	98.4464	56(2.15)
2005	11	193.2051	65	92.45224	76(2.92)
2006	9	162.3493	65	94.95095	74(2.84)
2007	7	106.183	81	99.4993	88(3.38)
2008	11	166.859	77	94.58576	88(3.38)
2009	4	51.83968	99	103.9	103(3.95)
2010	6	74.85262	101	102.0364	107(4.11)
2011	7	88.15191	99	100.9595	106(4.07)
2012	6	69.04509	110	102.5067	116(4.45)
2013	11	94.73284	144	100.4265	155(5.95)
2014	6	53.39487	144	103.7741	150(5.76)
2015	9	74.15954	153	102.0926	162(6.22)
2016	1	8.612076	154	107.4006	155(5.95)
2017	5	40.69731	159	104.8023	164(6.30)
2018	2	16.4799	160	106.7635	162(6.23)
2019	5	31.63203	206	105.5364	211(8.07)
2020	0	0	10	108.098	10(0.38)
Total	195	4415.3501	2408	3101.5809	2603

On the other hand, the Co-Authorship Index for multiple authors is enhanced from 94.59 in the year 1989 to 108.10 in the year 2020, which indicates the pattern of co-authorship is increasing among the contributions of the journal.

6.7 Price's Square Root Law

In order to validate whether the distribution status of authors fulfill Price's Square root law and the calculation is based on:

$$PSQ = \sqrt{N} = 100.161 \quad N = 10033$$

Based on Price's square root law, the only one contributor produced and 64,61,60,52,48,44,34,33,28,26 numbers of articles by single contributor are given publications, the square root value located at just 1.25 percent of publications. Most of the authors are contributed very less number of times in geochemistry research. The contribution percentage of 125 (Nearly closed are root value of 10033) contributors is located at 1.25 percent of publications. The value is very far away from 50 % (half of the literature on a subject); so this result is not in compliance with Price's Square Root Law.

Table: 7 Price's Square Root Law for Geochemistry Research Productivity

No. of Contribution A	No. of Contributors B	% of 4388	A*B	% of A*B	% Cumulated value of A*B	Cumulated value of A*B
64	1	0.02	64	0.64	0.64	64
61	1	0.02	61	0.61	1.25	125
60	1	0.02	60	0.60	1.85	185
52	1	0.02	52	0.52	2.37	237
48	1	0.02	48	0.48	2.85	285
45	2	0.05	90	0.90	3.75	375
44	1	0.02	44	0.44	4.19	419
34	1	0.02	34	0.34	4.53	453
33	1	0.02	33	0.33	4.86	486
32	2	0.05	64	0.64	5.50	550
28	1	0.02	28	0.28	5.78	578
27	4	0.09	108	1.08	6.86	686
26	1	0.02	26	0.26	7.12	712
25	3	0.07	75	0.75	7.87	787
24	2	0.05	48	0.48	8.85	835
23	2	0.05	46	0.46	8.81	881

22	2	0.05	44	0.44	9.25	925
21	5	0.11	105	1.05	10.30	1030
20	3	0.07	60	0.60	10.90	1090
19	3	0.07	57	0.57	11.47	1147
18	4	0.09	72	0.72	12.19	1219
17	9	0.21	153	1.52	13.71	1372
16	8	0.18	128	1.28	14.99	1500
15	19	0.43	285	2.84	17.83	1785
14	14	0.32	196	1.95	19.78	1981
13	12	0.27	156	1.55	21.33	2137
12	12	0.27	144	1.44	22.77	2281
11	12	0.27	132	1.32	24.09	2413
10	22	0.50	220	2.19	26.28	2633
9	36	0.82	324	3.23	29.51	2957
8	36	0.82	288	2.87	32.38	3245
7	46	1.05	322	3.21	35.59	3567
6	64	1.46	384	3.83	39.42	3961
5	101	2.30	505	5.03	44.45	4456
4	155	3.53	620	6.18	50.63	5076
3	266	6.06	798	7.95	58.58	5874
2	625	14.24	1250	12.46	71.04	7124
1	2909	66.29	2909	28.99	100	10033
Total	4388		10033			

6.7.1 Pareto Principle (80 X 20 Rules)

The researcher has used for this analysis in same values from the below table to validate Pareto Principle and test whether 80 percent of contributions have come from 20 percent of contributors. Since total authors number is **10033**, that mean the 20 percent of total authors number is 2007 and its 80 percent of publications value is 8026.

Table 8: Pareto Principle (80 X 20 Rule) Law for Research Productivity

No. of Contribution A	No. of Contributors B	A*B	% of A*B	% Cumulated value of A*B	Cumulated value of A*B
64	1	64	0.64	0.64	64
61	1	61	0.61	1.25	125
60	1	60	0.60	1.85	185
52	1	52	0.52	2.37	237
48	1	48	0.48	2.85	285
45	2	90	0.90	3.75	375
44	1	44	0.44	4.19	419

34	1	34	0.34	4.53	453
33	1	33	0.33	4.86	486
32	2	64	0.64	5.50	550
28	1	28	0.28	5.78	578
27	4	108	1.08	6.86	686
26	1	26	0.26	7.12	712
25	3	75	0.75	7.87	787
24	2	48	0.48	8.85	835
23	2	46	0.46	8.81	881
22	2	44	0.44	9.25	925
21	5	105	1.05	10.30	1030
20	3	60	0.60	10.90	1090
19	3	57	0.57	11.47	1147
18	4	72	0.72	12.19	1219
17	9	153	1.52	13.71	1372
16	8	128	1.28	14.99	1500
15	19	285	2.84	17.83	1785
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7	46	322	3.21	35.59	3567
6	64	384	3.83	39.42	3961
5	101	505	5.03	44.45	4456
4	155	620	6.18	50.63	5076
3	266	798	7.95	58.58	5874
2	625	1250	12.46	71.04	7124
1	2909	2909	28.99	100	10033
Total	4388	10033			

Based on analysis, the value of "Accumulated % of A*B" is 21.33 percent of authors contributed more than twenty percent of contributions, once the "Accumulated Contributors" is 2137 (but 20 percent of authors 2007). In 80 X 20 rule view, the value should be very close to 80 percent. Remaining 80 (78.67) percent of author's publications are 7896. It can conclude this that the result is close to Pareto Principles. The finding of this study does not correspond to the Price's Square Root Law and not fit for Pareto Principle (80 X 20 Rule) for author contribution.

7. Major Findings:

1. Totally 2603 records were produced by 10056 authors for 32 years from 1989 to 2020 on Geochemistry research. Totally 143505 times cited references measured by other scientists. The year of 2019 records were cited by highest times cited references during period. Each year records were cited more than 100 times at every article of Geochemistry. The year of 2019 had contributed the highest number of authors in 211 research publication. It is concluded from these analysis highest cited references of 17037 times cited by others in the year 2019.
2. To find out author 'Balaram V' published highest number of articles for the study period with 64 records and also had highest citation score of 1087. The following authors 'Santosh M' published next highest number of articles for the study period with 61 records and also had next highest citation score of 1512.
3. From the outcome of this study, we come to realize that the multi-author distribution is the most elevated contrast with single-author distribution. In thirty two years analysis, year 2019 has recorded the most noteworthy distribution appropriation of 10.70% followed continuously 2017,2018 recorded next highest records.
4. It could be noted that in 1989, 8 papers have been published in Geochemistry and the number went up to 2603 by the end of the year 2020. However, its relative growth rate has shown a declining trend.
5. It is observed from this study the Co-Authorship Index for single authors is declined from 169.86 in the year 1991 to 0 in the year 2020. On the other hand, the Co-Authorship Index for Multiple authors is enhanced from 94.59 in the year 1989 to 108.10 in the year 2020, which indicates the pattern of co-authorship is increasing among the contributions of the journal.
6. The findings of degree of collaboration analysis reveal the following facts that the case of single author contributed papers is less. It brings out clearly the high level prevalence of collaborative research in Geochemistry. Based on this study, the result of the degree of collaboration $C=0.10$ i.e., 10 percent of collaboration authors articles published during the study periods.
7. The findings of the square root value located at just 1.25 percent of publications. Most of the authors are contributed very less number of times in geochemistry

research. The contribution percentage of 125 (Nearly closed are root value of 10033) contributors is located at 1.25 percent of publications. The value is very far away from 50 % (half of the literature on a subject); so this result is not in compliance with Price's Square Root Law

8. It is found that the total number of authors is 10033, that mean the 20 percent of total authors number is 2137 and its 80 percent of publications value is 7896. The finding of this study does not fit for Pareto Principle (80 X 20 Rule) for author contribution.

References:

1. Azadeh, S. T. & Abdolreza, N. C. (2013). Empirical examination of Lotka's Law for applied mathematics. *Life Science Journal*, 10(5) 601-607.
2. Sivakumar, N., Sivaraman, P., Tamilselvan, N., & Sevukan, R. (2013). Application of Lotka's law in biology literature of central universities in India. *International Journal of Library and Information Science*, 2(1) 61-70.
3. Chen, S. H., Yang, Y. H., & Yu, W. J. (2011). A bibliometric study of agent-based modeling literature on the SSCI database. *Agent- Based Approaches in Economic and Social Complex Systems*, 8, 189-198.
4. Zafrybusga, N., & Pullareddy, V. (2009). Authorship pattern and degree of collaboration in psychology. *Annals of Library and Information Studies*, 56(4), 225-261.
5. Kumar, K. (2020). "Author Productivity of COVID-19 Research Output Globally: Testing Lotka's Law" *Library Philosophy and Practice* (e-Journal).
6. Pillai Sudhir, K.G (2013). "Lotka's Law and Pattern of Author Productivity in the area of Physics Research" *DESIDOC Journal of Library and Information Technology*, Vol. 33, No.6, pp.457-464.
7. Farldeh Osareh and Esmaeel Mostafavi (2011). "Lotka's Law and authorship distribution in Computer Science using Web of Science(WOS) during 1986-2009" *Collnet Journal of Scientometrics and Information Management*, Vol. 5, No.2, pp.171-183.
8. Muthukrishnan, M and Senthilkumar, R (2017). "Author Productivity of Oncology Research Output in India: Testing Lotka's Law" *International Journal of Information Dissemination and Technology*, Vol. 7, No.3, pp.187-189.
9. Ranganathan, C and Balasubramani, R (2013). "Mapping of Green Chemistry Research in India: A Scientometric Analysis" *Journal of Advances in Library and Information Science*, Vol.2, No.4., pp-221-229.
10. Shehbaz Husain Naqvi and Nishat Fathima (2017). "Authorship Patterns In International Business Literature: Applicability of Lotka's Law" *DESIDOC Journal of Library and Information Technology*, Vol. 64, No.6, December 2017, pp.253-259.