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Renjith V R  
renjithliber@gmail.com

Pradeepkumar A P  
geo.pradeep@keralauniversity.ac.in

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# Top 100 Most Cited Papers of the Journal of Geological Society of India (JGSI) in Web of Science (WoS): A Scientometric Assessment

**V. R. Renjith**

Reference Assistant  
Campus Library, Kariavattom Campus  
University of Kerala, Thiruvananthapuram, India  
ORCID: 0000-0002-2389-7338  
renjithliber@gmail.com

**A. P. Pradeepkumar**

Professor  
Department of Geology  
University of Kerala, Thiruvananthapuram, India  
ORCID: 0000-0002-4629-509X  
geo.pradeep@keralauniversity.ac.in

## ABSTRACT

*Citations of the top 100 most cited papers of the 'Journal of Geological Society of India', the premier geology journal published from India, in Web of Science (WoS), are analysed. The parameters used include publication year, citation count, age of publications, contributing authors, institutions, countries and most occurring keywords. Spearman's rank rho ( $\rho$ ) is used to ascertain the association between citation count and age of publications. The study found that there is a no association between citation count and age of publications of 100 most cited papers of the journal in WoS. Among 272 authors of the 100 most cited papers, the largest contribution was made by Chadwick B and Gupta H K ( $n = 6$  each). Most of the papers originated from India ( $n = 62$ ) with the most contributions ( $n = 10$ ) coming from Geological Survey of India (GSI). Among 623 keywords, Evolution and Geochemistry, Dharwar Craton, Geochronology etc. were the most frequently used. The Journal of the Geological Society of India caters mostly to papers authored by Indian geologists, and publishes more papers in the areas of earth evolution and geochemistry, with the most cited papers too being from this area of research. To improve the journal's impact factor it is recommended that more review papers, increased international authorship, and broadening of subject areas of publication may be attempted.*

**Key Words:** 100 Most Cited Papers, Bibliometric Analysis, Citation Analysis, Journal of Geological Society of India (GSI), Indian Geology Journal, Scientometric Assessment, Web of Science (WoS)

## 1. Introduction

Scientometrics is the statistical or mathematical analysis of scientific literature by which the publications in a given research field by an individual author, country, journal or organisation etc. can be quantitatively analysed. Scientometric techniques are also used to quantify the most highly cited papers of a particular journal in a given subject field (Yang et al., 2013). Highly cited papers of a journal are generally considered as the most impactful or influential of the research papers published in that journal. Citation analysis is one amongst the scientometric techniques used for the identification of major works from the peer-reviewed scholarly communications (Bornmann & Daniel, 2008). It ranks articles and journals by the number of times these are cited and can be used to assess research performance. Citation analysis within specific journals and subject areas has become a popular method to assess the impact of a journal, article or author (Callahan, Wears & Weber, 2002; Cantú-Ortiz, 2018). According to Moed (2009), the significance of a journal paper can be assessed by the number of times it has been cited by other researchers.

The aim of this study is to identify and analyze the characteristics of the 100 most-cited articles published in the most well-established and influential Indian Geology journal '*Journal of Geological Society of India*' (JGSI) over the past 30 years, based on Clarivate Analytics' Web of Science (WoS). This analysis may be of value to the editorial board and authors by providing some insights into the type of manuscripts that appear to be of interest to the audience of JGSI, and in turn to the authors. The journal ([springer.com/journal/12594](http://springer.com/journal/12594)) has continuously been in publication since 1959. The journal aims to promote the cause of advanced study and research in all branches of geology connected with India and to certain extent across the world, and to disseminate the findings of geological research through peer-reviewed papers under the category of review papers, research papers, short communications, notes, corporate news, correspondence, discussion and book review.

## 2. Review of Literature

Methods for processing of the top 100 most-cited articles are well-established, and ranges from using the WoS, Scopus, Google Scholar databases etc. from which data is extracted, and analysed using parameters like citation counts, citation density, publication year, authorship, contributing institutions and countries, paper topic, study design and keywords, randomized controlled trials, retrospective matched cohort studies, retrospective nonmatched studies, impact factor, the number of highly cited papers, cited

half-life of published papers, and h-index. These are then used to arrive at conclusions on the topics of most importance to a journal, nationality of authors, topics which receive most citations, the institutions that generate the most cited papers etc. This information is useful for the journals as well as for the authors, and also for science policy makers, which could probably make certain funding decisions based on the results of such studies. Recently, Ahmad et al. (2020) conducted a bibliometric analysis of the top 50 most cited papers published in '*Dental Traumatology*' to highlight the contribution of the journal to scientific and clinical progress in areas of adult and pediatric dental traumatology. Scopus database was used for extraction of data, which was analysed using parameters like citation counts, citation density, publication year, authorship, contributing institutions and countries, paper topic, study design and keywords. It was found that the publication year of a paper was neither significantly associated with citation count nor citation density. Landreneau et al. (2020) studied the top 100 most cited American Surgical Association (ASA) publications in the *Annals of Surgery* using the Scopus database and evaluated the key characteristics. The 100 most cited papers from the ASA were published between 1955 and 2010 with an average of 609 citations. The outcome of the study, which was designed on the basis of randomized controlled trials, retrospective matched cohort studies, retrospective nonmatched studies, and others, was the identification of the most common subjects of study reported, the most productive institutions, and the most prolific nations. Mokhtari, Roumiyani and Saberi (2019) studied the number of papers, highly cited papers, the most prolific authors, the most active research institutions and countries, keywords and term occurrences of papers published in the '*Journal of Artificial Societies and Social Simulation (JASSS)*' between 2000 and 2018. The study showed that the number of citations received had increased from one citation in 2000 to 1287 in 2018 for the papers published in the journal. Ren et al. (2018) applied citation analysis to the 100 most cited papers in the history of *Journal of NeuroInterventional Surgery (JNIS)*. The study showed that the total number of citations for the 100 most cited articles in *JNIS* ranged from 18 to 132 (median 26.0). Most articles (75%) were published between 2012 and 2015 and originated in the USA (79%). Eighteen authors have contributed five or more articles to the top 100 list. The most common topics are related to acute ischemic stroke and cerebral aneurysm. Xu, Yu and Wang (2018) used bibliometric methods to study the citation characteristics, international co-operation and institutional co-operation, the authors' cooperation rate and cooperation degree, geographical distribution of papers in the '*International Journal*

of *Machine Learning & Cybernetics*' between 2010 and 2017 and reported an increasing trend in the number of publications, the total number of authors, the cooperation rate, and the degree of cooperation. Journal metrics like impact factor, the number of highly cited papers, cited half-life of published papers, and h-index from the Web of Science, Scopus and Google Scholar for journals in the SCI category "geological engineering" and SCI category "multidisciplinary geosciences" were used by Mikoš (2017) to determine whether the journal '*Landslides*' is truly international in scope. Rutenstock et al. (2012) identified, analysed and categorized the characteristics of the 100 most cited articles in the journal *Pediatric Surgery International* since its founding in 1986, using the WoS. The 100 most-cited articles received a total of 3,309 citations with a mean of 33.09 (range 24–81), with the articles being published between 1987 and 2007, with 73 articles published after 1997. Leading countries were USA, Australia, UK and Ireland. The most prolific authors were from seven different institutions, having published 37 articles, and received 36.66% of all citations.

### **3. Objectives**

The specific objectives of the study are to;

- 1) trace out the classic papers published in the '*Journal of Geological Society of India*' (JGSI) in WoS.
- 2) find out the year-wise publications and citations of the top cited papers.
- 3) determine the association of citation count with age of publication of top cited papers.
- 4) identify the highly prolific authors of top cited papers.
- 5) identify the organisations contributing top cited papers.
- 6) find out the countries contributing top cited papers.
- 7) identify the co-occurrence of keywords of top cited papers

### **4. Methodology**

Clarivate Analytics's Web of Science (WoS) is considered to be the world's leading scientific citation search and analytical information platform for the scientific scholarly community across the globe. It is widely used for scientometric studies because of its selection and coverage of most prestigious and visible publications, from 1899 to the present. This database allows the users to determine which articles have been cited most frequently.

The most cited papers in '*Journal of Geological Society of India*' was identified by a search in the database of Clarivate Analytics - Web of Science (WoS), using the search term "SO = Journal of Geological Society of India". Records for the journal are

available only from 1989 onwards in the WoS. The search was conducted in WoS Core Collections on 28<sup>th</sup> October 2020. The top cited 100 papers were identified based on their citation counts. For every selected paper, full record with cited references was extracted as .csv file and imported into Excel datasheet for further analysis. The statistical program SPSS version 22.0 was used for analysis. The Shapiro-Wilk test was employed to detect departures from normality. The Spearman rank test was used to determine correlations between citation counts and age of publications. Furthermore, the downloaded data were analysed by using VOSviewer software, a bibliometric or scientometric software for visual analysis. The VOSviewer software supports the WoS files (Van Eck & Waltman, 2010) for constructing and visualization of bibliometric maps. The methodology adopted in the current study is an accepted one, and has been used by several authors, who have used Spearman's test to establish correlations (Yan-qing Huo et al., 2015; Ahmad et al., 2020; Landreneau et al., 2020), and citation analysis to arrive at top 100 papers (Ren et al. 2018), or a combination of parameters to arrive at the internationality of journals (Mikoš, 2017) and to visualize the relations between citation parameters (Yuetian et al., 2020).

## **5. Analysis and Interpretation**

### **5.1 The Classic Papers of the JGSI in WoS**

The top 100 most cited papers received a total of 5637 citations with a citation range of 32-165 (minimum 32 and maximum 165) in Web of Science (WoS). The average citation per paper is 56.37. Table 1 lists the classic papers of the journal JGSI in WoS. To consider a paper as a "classic paper", in this study, it must have had at least 100 citations. Out of 100 top cited papers, there are only nine classic papers with at least 100 or more citations. The first ranked most cited paper with 165 citations (citation density 7.17) in WoS was "SHRIMP U/Pb zircon ages of acid volcanic rocks in the Chitradurga and Sandur groups, and granites adjacent to the Sahdur schist belt, Karnataka" authored by Nutman, Chadwick and Rao et al. in 1996. The second ranked most cited paper with 164 citations (citation density 7.13) was "Major ion chemistry of groundwater in Delhi area: chemical weathering processes and groundwater flow regime" by Datta and Tyagi, also in 1996. These two are the first and second classic papers with highest citation density and citation counts in WOS respectively. The third ranked most cited paper with 152 citations (citation density 5.43) was "SHRIMP U-Pb geochronology of the Closepet Granite and Peninsular Gneiss, Karnataka, South-India" by Friend and Nutman in 1991. The classic papers listed in the Table 1 received a total of 1185 (21.02%) citations out of

5637 citations of the 100 top cited papers. The remaining citations (4452: 78.98%) are shared by other papers cited <100 times.

**Table 1**  
**The Classic Papers of the Journal of Geological Society of India (JGSI) in WoS**

Sl.No.	Article	Citation Count (WoS)	Age of Publication	Citation Density
1	Nutman, A. P., Chadwick, B., and Rao, B.K. et al. (1996). SHRIMP U/pb zircon ages of acid volcanic rocks in the Chitradurga and Sandur groups, and granites adjacent to the Sahadur schrist belt, Karnataka. <i>JGSI</i> , 47(2). 153-164.	165	23	7.17
2	Datta, P.S. & Tyagi, S.K. (1996). Major ion chemistry of groundwater in Delhi area chemical weathering processes and groundwater flow regime. <i>JGSI</i> , 47(2). 179-188.	164	23	7.13
3	Friend, C.R.L. & Nutman, A.P. (1991). SHRIMP U-PB geochronology of the closepet granite and peninsular gneiss, Karnataka, South India. <i>JGSI</i> , 38(4). 357-368.	152	28	5.43
4	Nutman, A.P., Chadwick, B., & Ramakrishnan, M. et al. (1992). SHRIMP U-PB ages of detrital zircon in Sargur supracrustal rocks in western Karnataka, South India. <i>JGSI</i> , 39(5). 367-374.	137	27	5.07
5	Radhakrishna, B.P. (1989). Suspect tectono-stratigraphic terrane elements in the Indian sub-continent. <i>JGSI</i> , 34(1). 1-24.	120	30	4.00
6	Acharyya, S.K., & Roy, A. (2000). Tectonothermal history of the Central Indian tectonic zone and reactivation of major faults/shear zones. <i>JGSI</i> , 55(3). 239-256.	114	19	6.00
7	Hashimi, N.H., Nigam, R. & Nair, R.R. et al. (1995). Holocene sea-level fluctuations on western Indian continental-margin- an update. <i>JGSI</i> , 46(2). 157-162.	113	24	4.71
8	Gupta, H.K., Harinarayana, T. & Kousalya, M. et al. (2001). Bhuj earthquake of 26 January, 2001. <i>JGSI</i> , 57(3). 275-278.	112	18	6.22
9	Prabhakar, K.N. & Zutshi, P.L. (1993). Evolution of southern part of Indian east-coast basins. <i>JGSI</i> , 41(3). 215-230.	108	26	4.15

## 5.2 The Year-wise Publications and Citations of Top Cited Papers

Table 2 reveals that the top 100 cited papers of JGSI in WoS has been published between 1989 and 2016. The largest number of top cited papers (22) were published between 2009-2012, followed by 21 papers in the year period 1997-2000. The highest number of citations (1182) were received by papers (21) published between 1997-2000, followed by 1105 citations for the papers published between 1989-1992. The highest

average citation (68.81) is for the papers published between 1993-1996 followed by the next highest average citation of 61.39 for the papers published between 1989-1992.

**Table 2**  
**Year of Publications and Citations**

<b>Year of Publication</b>	<b>No. of Papers</b>	<b>Total Citations</b>	<b>% of Total Citations (5637)</b>	<b>Mean Citation</b>
1989-1992	18	1105	19.60%	61.39
1993-1996	16	1101	19.53%	68.81
1997-2000	21	1182	20.97%	56.29
2001-2004	10	564	10%	56.40
2005-2008	10	487	8.64%	48.70
2009-2012	22	1030	18.27%	46.82
2013-2016	3	168	2.98%	56.00
<b>Total</b>	<b>100</b>	<b>5637</b>	<b>100%</b>	<b>56.37</b>

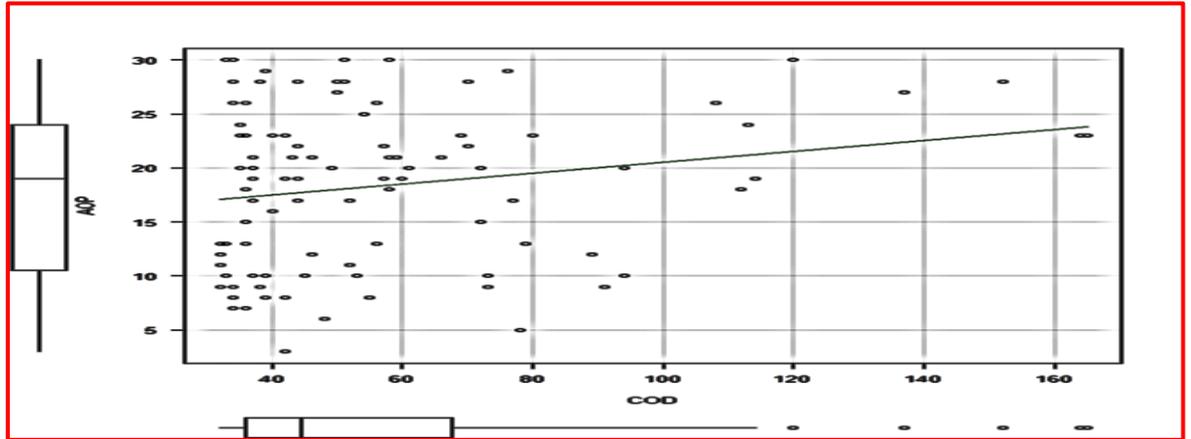
### 5.3 Association of Citation Count with Age of Publication of Top Cited Papers

The citation count and the age of publications are not normally distributed (Shapiro-Wilk test;  $p < 0.01$ ). The Spearman's rho (non-parametric correlation test) (Table 3) shows that there is a non-significant trend toward greater citation count (correlation coefficient = 0.138,  $p = 0.171$ ) with age of publication (figure 1).

**Table 3**  
**Correlation of Citation Count (COD) with Age of Publications (AOP)**

			<b>COD</b>	<b>AOP</b>
Spearman's rho	<b>COD</b>	Correlation Coefficient	1.000	.138
		Sig. (2-tailed)	.	.171
		N	100	100
	<b>AOP</b>	Correlation Coefficient	.138	1.000
		Sig. (2-tailed)	.171	.
		N	100	100

**Figure 1**  
**Scatterplot Examining the Relationship between Age of Papers and Citation Counts**



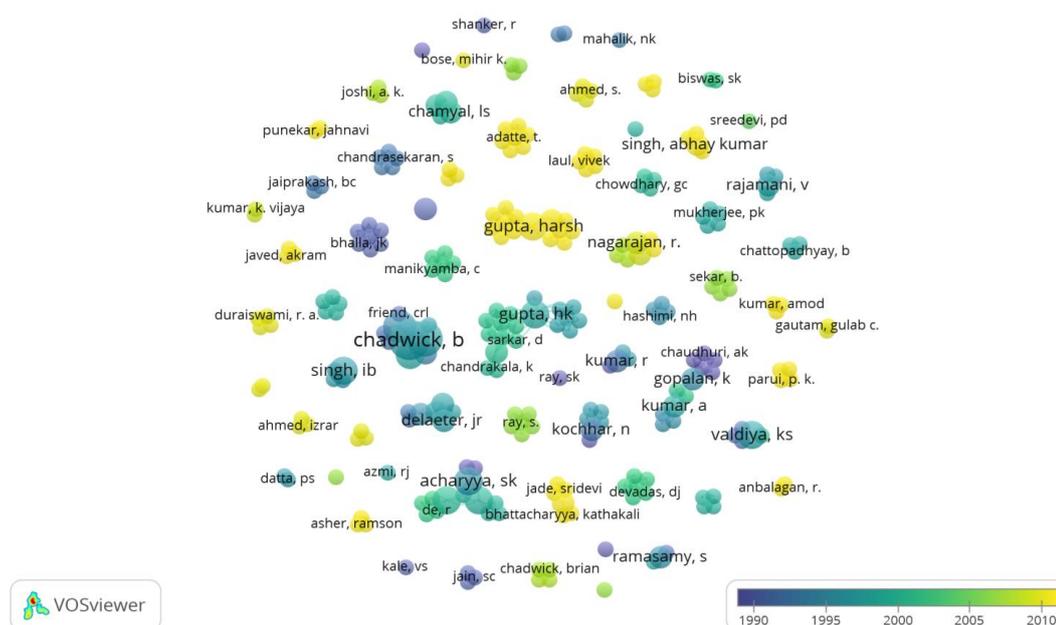
#### 5.4 Highly Prolific Authors of Top Cited Papers

Table 4 and Figure 2 display the prolific authors of the top cited papers of the *JGSI*. A total of 272 different authors contributed to the list of top 100 most cited papers in *JGSI*. Of the 272 authors, authors with minimum of three papers are listed in the Table 4. Thus ten highly prolific authors are listed in Table 4. Chadwick B and Gupta H K are the top contributors with six distinguished papers each followed by Vasudev V N with five papers. The next highest contribution of four highly cited papers is by Nutman A P. The remaining six authors contribute three papers each.

The highest number of citations (516) is received by the papers by Chadwick B., followed by 514 citations for the papers by Nutman A. P. The next highest citations are 379 for the papers by Vasudev V. N. These three authors share first, second and third positions respectively with regard to percentage of total citations for the top cited papers. Nutman A. P. ranks first with average citation of 128.50 followed by Chadwick B (86) and Roy A (77.33). Acharyya S. K., Valdiya K. S. and Gupta H. K. from amongst the most-cited and highly prolific authors of papers in *JGSI* find a mention in the recent Stanford University's Subject-wise ranking of top 2% scientists from India (Ioannidis, Boyack & Baas, 2020).

**Table 4**  
**Highly Prolific Authors of Top Cited Papers**

Sl. No.	Authors	No. of Papers	Citations	% of Total Citations (5637)	Average Citations
1	Chadwick B.	6	516	9.15%	86.00
2	Gupta H. K.	6	308	5.46%	51.33
3	Vasudev V. N.	5	379	6.72%	75.00
4	Nutman A. P.	4	514	9.12%	128.50
5	Acharyya S. K.	3	218	3.87%	72.67
6	Hegde G. V.	3	134	2.38%	44.67
7	Kayal J. R.	3	127	2.25%	42.33
8	Roy A.	3	232	4.12%	77.33
9	Singh I.B.	3	141	2.50%	47.00
10	Valdiya K. S.	3	144	2.55%	48.00



**Figure 2**  
**Prolific Authors of Top Cited Papers (Overlay Visualisation)**  
(The figure shows the papers with only its first author's name. The size shows the number of papers and the colour shows the publication years)

### 5.5 Institutions Contributing Top Cited Papers

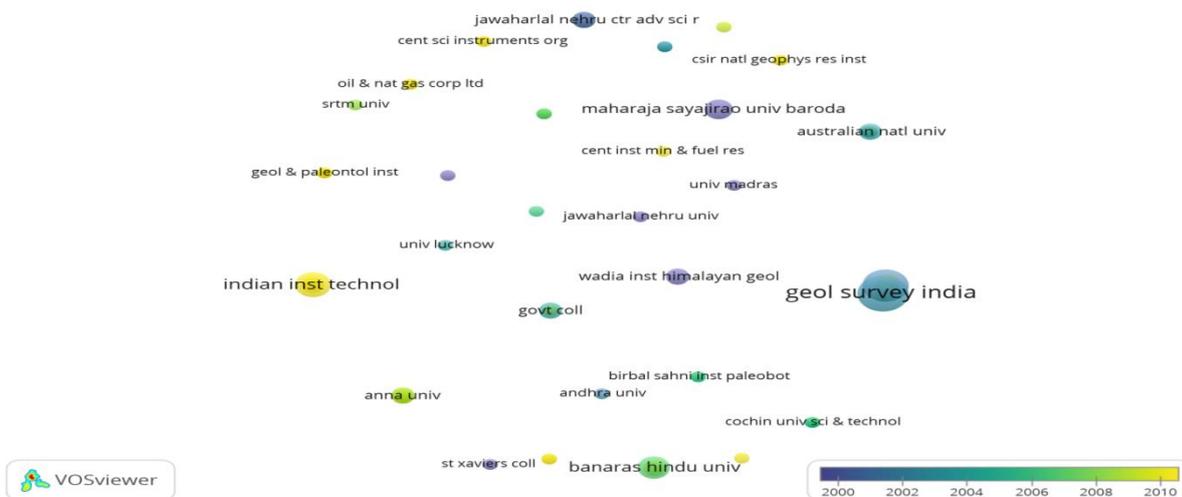
The productivity of the author publications based on the collaborative institutions is revealed in the Table 5 and Figure 3. There are a total of 69 institutions with which the corresponding authors were affiliated in the top 100 cited papers in *JGSI*. Table 5 depicts the five most prolific institutions with minimum three papers in *JGSI*. Geological Survey of India (GSI) topped with ten papers followed by National

Geophysical Research Institute (NGRI) (8), Indian Institute of Technologies (IITs) (5), Banaras Hindu University (4) and Maharaja Sayajirao University Baroda (3).

Another commonality that can be seen among these institutions is that these five institutions respectively are ranked one to five in position with respect to citations, percentage of total citations and average citations of top cited papers.

**Table 5**  
**Institutions Contributing Top Cited Papers**

Sl.No.	Institution	No. of Papers	Citations	% of Total Citations (5637)	Average Citations
1	Geological Survey of India	10	577	10.24%	57.70
2	National Geophysical Research Institute	8	460	8.16%	57.50
3	Indian Institutes of Technology	5	266	4.72%	53.20
4	Banaras Hindu University	4	200	3.55%	50.00
5	Maharaja Sayajirao University Baroda	3	142	2.52%	47.33



**Figure 3**

**Institutions Contributing Top Cited Papers (Overlay Visualization)**

(The size shows the number of papers and the colour shows the publication years)

**5.6 Countries Contributing Top Cited Papers**

The top 100 most cited papers of *JGSI* originated from 13 countries. According to the number of publications, India holds first position with 62 papers followed by USA (3), Mexico (2), Australia (2) and England (2) (Table 6). Highest number of citations were received by papers contributed by Indian authors (3109), followed by

USA (167) and England (154). With regard to percentage of total citations, these countries were also positioned first, second and third respectively. England was ranked one in the average citations for the top cited papers with 77 citations followed by Australia (74.5).

**Table 6**  
**Countries Contributing Top Cited Papers**

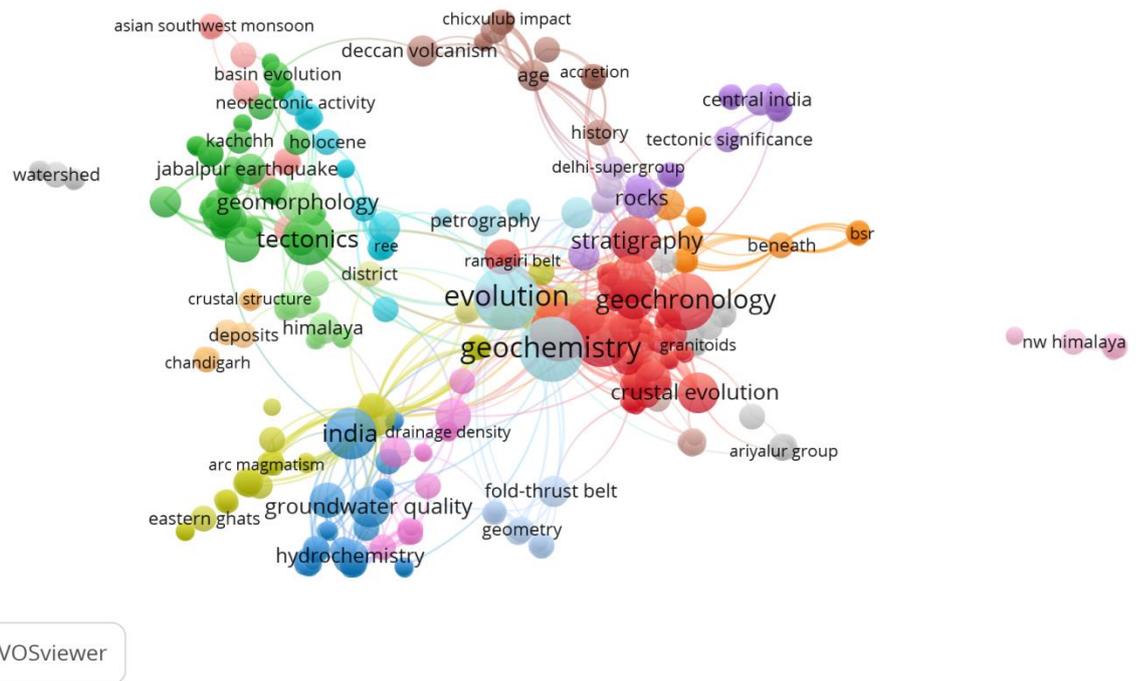
Sl. No.	Countries	Papers	Citations	% of Total Citations (5637)	Average Citations
1	India	62	3109	55.15%	50.15
2	USA	3	167	2.96%	55.67
3	Mexico	2	84	1.49%	42
4	Australia	2	149	2.64%	74.5
5	England	2	154	2.73%	77

### 5.7 Keywords Occurrence of Top Cited Papers

Co-occurrence is a technique for identifying the significant and highly frequent terms and keywords used in a document (Laengle et al., 2018). The total numbers of keywords identified are 623. Figure 4 displays the network of co-occurrence of keywords. The top nine subject keywords that seem to occur most in the top cited papers of the *JGSI* are given in Table 7. The most frequent keywords are “Evolution” and “Geochemistry” (13 each), “Dharwar Craton” (11), “Karnataka” and “Geochemistry” (10 each), “Tectonics” and “India” (8 each). Though the *JGSI* covers all areas of geosciences, traditionally it has had a thrust on petrology, geochemistry, Archaen geology, and tectonics, which is reflected in the analysis and visualized very well by the VOSviewer keyword map. The most cited papers in *JGSI* deal with geochemistry and geochronology of cratonic blocks of India, as well as their evolution. Another popular area of research represented in the journal is hydrogeology and geochemistry as well as recent tectonics and geomorphology.

**Table 7**  
**Subject Analysis based on Keywords**

Sl. No	Keyword	No. of Occurrences
1	Evolution	13
2	Geochemistry	13
3	Dharwar Craton	11
4	Karnataka	10
5	Geochronology	10
6	Tectonics	8
7	India	8
8	South India	7
9	Stratigraphy	7



**Figure 4**  
**Network Analysis of Keywords of Top Cited Papers**

(The size of the nodes represents the frequency of the keywords, with larger nodes indicating higher frequency. The thickness of the edges is related to the closeness of the interactions between two nodes. Note that the colours of the nodes of the keywords indicate the cluster to which keywords belong)

## 6. Findings

The major findings of the study are the following:

- i) Out of 100 most cited papers in the journal *JGSI*, only nine papers are cited at least 100 or more times and thus are termed as ‘classic’ papers, as per criteria of this study. This shows that the editorial board need to take keen interest in publishing top quality papers in this journal, so that the papers get more citations and in turn, the *JGSI* gets more visibility among geoscientists across the world and citation impact in the concerned research topics increases. The topmost Indian geoscientist in WoS search under ‘Geology’ as well as ‘Earth Science’ is M Santosh (*h*-index 96), but he has authored less than 20 papers in *JGSI* between 1989 and 2020, and the maximum citations received is 15.
- ii) The publication year of a paper has an undeniable impact on the citation of that paper. It is generally accepted that the true influence of a research paper can be properly determined after a definite period following its publication. This is somewhat true here

also in that those papers (55) published between 1989 and 2000 received 60.1% of total citations in the top cited papers. Older the published papers higher may be the citations, due to the cumulative effect.

- iii) The Spearman's rho (correlation test) shows that there is a non-significant trend toward greater citation count (correlation coefficient = 0.138,  $p = 0.171$ ) with age of publication. The correlation analysis has thus revealed that statistically, the total citation of a paper had no significant relation with its age. An older paper may not be cited more than a younger paper. For example the papers published between 2009 and 2012 received 1030 citations (18.27%). Scholars may tend to cite updated literature in their latest research publications.
- iv) Chadwick B., Gupta H. K., Nutman A. P., and Vasudev V. N. are the top authors with respect to number of contributions, citations received, and percentage of total citations received of top cited papers. *JGSI* authors Acharyya S. K., Valdiya K. S., Gupta H. K. who are in the most-cited and highly prolific authors of papers in *JGSI* are amongst the top 2% of scientists from India.
- v) Geological Survey of India (GSI) contributed 10 papers followed by National Geophysical Research Institute (NGRI) (8). These two Indian geoscience research institutions also rank first and second in respect of their papers' citation count, percentage of total citations and average citations.
- vi) With regard to top contributing countries, India holds first position with 62 top cited papers followed by USA (3). Mexico, Australia and England contributed two top cited papers each. Indian contributed papers received highest number of citations (3109) followed by USA (167) and England (154). These countries are also positioned at the same rank in case of percentage of total citations of top cited papers. It shows that *JGSI* being an Indian geology journal, Indian geoscientists prefer more to publish papers in this journal, compared to foreign geoscientists, and naturally Indian authored papers get more visibility among Indian geoscientists, thereby citation impact increases for publications in *JGSI*. Moreover, *JGSI* is one amongst the very few geology journals published from India, with high quality of papers and impact, generated by the Indian geoscience research institutions.
- vii) Among 623 unique key words, "Evolution" and "Geochemistry" are the most frequent (13 times) terms in the top cited papers. "Dharwar Craton" occurred 11 times. It shows that the papers related to evolution, geochemistry, geochronology of cratons, and tectonics were the hot topics of research most cited.

## 7. Conclusions

Citation count is a common bibliometric tool used to determine the long term impact and performance of journal papers. In general, the higher the number of citations, the greater the perception of quality for that article. The limitation of this study is that it is based on the citations received in WoS database and does not take into consideration the citations received by the same papers in the Scopus database. Moreover the papers' citation may be related to many factors, such as the impact factor (IF) of the journal, publication age and accessibility. The 2019 impact factor of the *JGSI* in Journal Citation Reports (JCR) of WoS is 0.899 and the 5-year impact factor is 0.895. *JGSI* is not an open access journal and access restrictions may limit the citations to the journal. The journal may be in a vicious cycle wherein top Indian geologists do not publish in it because the IF is low, and since they do not publish the IF remains low, despite the fact that a number of top geoscientists of the world, based in India, have published high impact papers in *JGSI*. Thus the *Journal of the Geological Society of India* needs to attract well-cited authors, as well as authors from different countries, to contribute papers to it, so that the journal gains visibility and in turn improves its impact factor. Turning to an open access mode might help gain more citations, as well as bringing out regular review papers.

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