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Topical Themes and New Trends in Mining Industry: Scientometric Analysis and Research Visualization

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ABSTRACT

The scientometrics has become the most important tool to evaluate and analyze the performance of scientists, cooperation between universities, the impact of public funding of science on the results of national research and development, the effectiveness of education, and others. Therefore, professionals and scientists need a range of theoretical and practical tools to measure experimental data. The purpose of this article is to provide an up-to-date overview of the various tools available for scientometric analysis, including data sources, performance analysis and visualization tools. In this study performed a scientometric analysis based on 21,180 publications from the Scopus database was conducted with only published articles in mining industry between 1960 and 2023. It also revealed that 77% of the articles were published in journals and only 2.6% corresponded to review studies. Using network analysis in VOSviewer, the publications were grouped by keywords into 5 clusters with Strength. Cartographic analysis confirmed the descriptive findings and visualized the co-authorship of authors. Using bibliographic linkage analysis, the semantic relationship between authors and their associated institutions and countries was investigated (consist of 38 clusters with 404 link). Average number of citations per keyword (3.2) will allowed the most cited area is devoted to health risks. Recent studies have focused on dust and lung diseases which can pose a serious threat to the life and health of mine workers, therefore risk of coal dust explosions, which in result poses a direct risk of injury or even loss of life.

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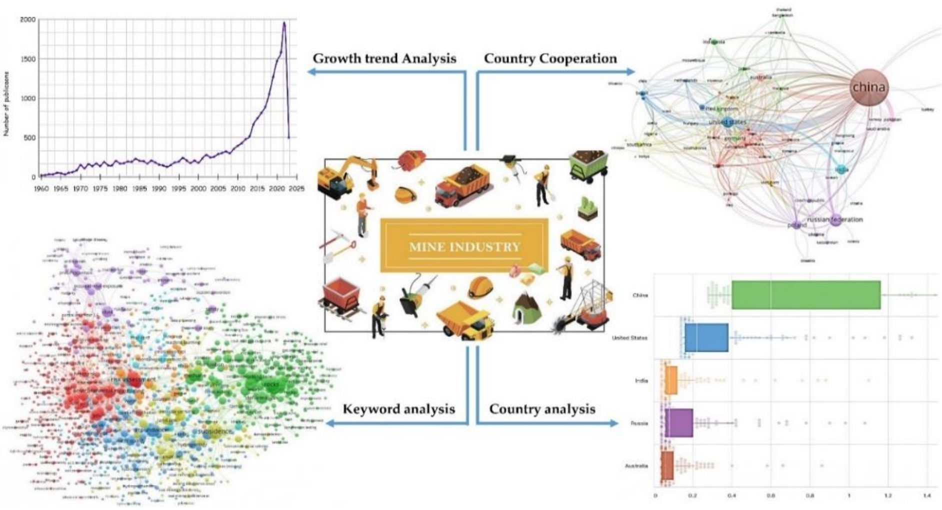
Graphical Abstract



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1. INTRODUCTION

The mining industry, a critical component of global resource extraction, finds itself at the nexus of multifaceted challenges and opportunities in the contemporary era (1-3). This sector, long renowned for its profound impact on society through the provisioning of essential raw materials, stands at a pivotal juncture influenced by intricate interplays of scientific innovation, ecological imperatives, and socio-economic dynamics (4, 5). In this context, the application of scientometric analysis and research visualization emerges as an indispensable approach to elucidate the complex, evolving landscape of mining-related research, with a profound connection to the principles of sustainable development (6, 7).

Mining, as a fundamental pillar of human civilization, has been inexorably linked to industrial progress and economic growth (8, 9). Yet, this history is punctuated by periods of environmental degradation, resource depletion, and social injustices. The modern mining industry grapples with the legacy of these issues while simultaneously seeking to chart a more sustainable and responsible path forward. Sustainable development, a cornerstone of contemporary discourse, underscores the imperative for industry sectors, including mining, to balance economic prosperity with environmental stewardship and social equity (10).

In this article, we embark on a rigorous exploration of the mining industry's scientific landscape, a journey guided by the rigorous methodologies of scientometrics and research visualization. These methodologies empower us to unravel the intricate web of scholarly publications, patents, and research outputs that constitute the mining domain. Through their lens, we gain the ability to detect patterns, quantify growth trajectories, and pinpoint pivotal moments within the rich tapestry of mining-related knowledge production (11).

Scientometrics, an empirical science in its own right, illuminates the evolutionary dynamics of mining research. It allows us to assess the proliferation of knowledge, pinpoint influential thought leaders, and identify critical nodes of intellectual convergence. By applying these systematic approaches, we set the stage for uncovering the transformative trends and thematic paradigms that coalesce around mining's journey towards sustainable development.

Scientometrics is a set of quantitative methods used to study a field of research using metadata of articles submitted to scientificometric databases (e.g., Scopus) (12). These metadata include publication title, keywords, abstract and citation records. Two main scientometric procedures are used to investigate subject areas: performance analysis and scientific mapping. Performance analysis provides a means to quantify academic output and evaluate it in terms of productivity, quality, and scholarly impact by identifying key contributors (authors, countries, organizations) and finding reliable sources of academic publications (13).

This is methods has been successfully used in the field of mining. Pouresmaieli et al. (14) analyzed 77 articles and a trend of increasing scientific interest in sustainability research in the mining industry from 1985 to 2022 was identified. Scientometric and content analysis in research Indian scientists suggested that there are few heavy metal contamination studies performed in the coal mine areas. In contrast, studies relating to assessing metal bioaccessibility and health risks in the coal mine area are relatively scarce. Finally, the gaps identified were defining the role of pH and particle size affecting bioaccessibility of metals in coal mines, the correlation between in-vitro and in vivo metal concentrations, and more clarification of Rfd values for health risk calculation (15). Likewise the result of the co-citation network study has marked the most significant authors and the highly cited sources of the database revealing Anjali and Remesan (16) as among the most cited authors with citations more than 150 in the field of our interest. The trend of publication in the research area of Water Resources showed a significant increase after 2015. The keyword occurrence map reveals that water quality studies have been extensively studied, but quantifications of the coal mining-induced changes in water regimes at river basin scales are absent (16). Also, scientometrics analysis use for trends mapping and global collaboration determination among countries, monitoring of the most productive authors, institutions, and identifying the rate of growth in recent years based on keyword analysis of authors (17).

In these publications, the authors emphasize the importance of updating research methods to reflect recent technological advances and the interdisciplinary nature of sustainable development. As technology and other areas of knowledge continue to evolve and intersect with sustainability in mining, it is important to incorporate these new developments and perspectives into future research. This will help ensure the relevance and comprehensiveness of research in the field.

A scientometric analysis provides quantitative information on the development of a given topic, including trends in results and focuses, collaborative networks, thematic research clusters, historical patterns of evolution, and collaborative citation networks (18). The advantage of scientometrics over descriptive reviews is that it can quickly identify key issues of interest and guide future research. In recent years, an increasing number of studies have applied scientometric methods to explore various aspects and obtain important information (19).

The overarching goal of this study is to utilize scientometric analysis and research visualization techniques to comprehensively explore the evolving intellectual landscape of the mining industry. The main objectives of the study:

1. To mapping and understand the current state of research, identify influential works and authors, and trace the evolution of knowledge within the mining sector.
2. To demonstrate the practical application of scientometric analysis as a robust methodology for quantifying research growth and patterns in the mining field.
3. To showcase the effectiveness of research visualization techniques, such as network graphs and co-citation maps, in visually representing the intricate tapestry of mining-related research.
4. To provide valuable insights for researchers, industry practitioners, policymakers, and stakeholders, facilitating informed decisions, future research directions, and sustainable industry practices.

2. MATERIALS AND METHOD

The scientometric data used in this study were obtained from Scopus, the largest interdisciplinary database of peer-reviewed scientific literature widely recognized and frequently used for scientometric analysis (20). Using the topical search queries «mining technologies development» OR «coal mining» OR «coal technologies development» a result of 26,565 documents from 1842 to 2023 was retrieved.

For data representativeness, the sample was limited to article and review type publications from 1960 to 2023. Another 80 publications were excluded from the sample because they were duplicated, apparently this is due to errors occurring on the side of the journal or publisher (21, 22). The largest number of duplicates came from the Geological Society Engineering Geology Special Publication, a journal that publishes engineering geology proceedings from annual conferences.

In summary, the data sample consisted of 21,180 publications, each of which was downloaded from the Scopus database and consisted of many different variables (e.g., authors, publication title, abstract, keywords, citations, references, etc.). The SCImago Journal & Country Rank (23, 24), Scopus Source list (25, 26) and Journal Citation Reports (27, 28) databases were also downloaded to analyze various indicators (Figure 1).

General information on the dataset (scientometric indicators) is summarized in the Table 1.

In addition to the traditional analysis of quantitative data on publications and citations, new, more comprehensive and informative formats for assessing scientific research are now becoming available that allow processing and visualizing very large amounts of data, such as advanced research mapping (29, 30). Such maps are typically two- or three-dimensional visualizations of the scientific landscape, consisting of topics and disciplines united by cited publications and common terminology. The degree of similarity of documents determines how far apart they will be on the map, and differences in the density of publications lead to the formation of different elements on the map, such as "mountains" and "islands" of knowledge. Mapping allows analysts to see individual scientists, organizations, grantors, and journals on a map, and to assess the extent to which an organization is engaged in research in particular areas and how that engagement has changed over time (31). In this way, the maps allow for a better understanding of the current situation, as well as the identification of key players and the most in-demand or promising new research topics (32). For creating maps based on network data and for visualizing and exploring these maps use software tool VOSviewer (13, 33).

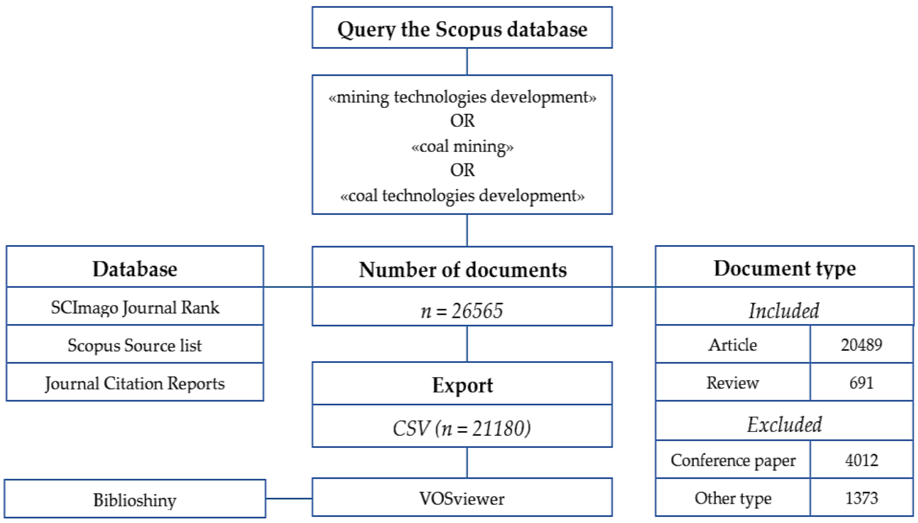


Figure 1. Methodology for determining the data set for analysis

TABLE 1. Main information

Description	Results
Timespan	1960–2023
Sources (Journals)	4170
Total documents	21180
Total citation	263865
Document average age	15.96
Article with finding	6897
Authors	46367
Single-authored documents	4660

Thus the methodology of the study can be divided into three parts:

1) Descriptive statistical analysis of the study that illustrates the current state of research in the field of mining technology development, which includes a general analysis of articles published during the sample period, as well as a network analysis of the collaboration of authors and affiliated institutions and countries. This can help researchers identify key research directions and academic leaders in the field.

2) Keyword-based coincidence analysis, which can help to understand the development of mining technology development research.

3) Detecting bursts of co-citation of references, which was conducted to analyze hot topics and emerging trends in terms of cited references.

3. RESULTS

Based on the search results, the growth of publications on this topic can be divided into 4 phases: the beginning phase from 1960 to 1985, the decline phase from 1986 to 1993, the slow growth phase from 1994 to 2012, and the fast growth phase from 2013 to 2022 (Figure 2), and Table 2 shows the most cited articles of each phase.

In the first 25 years, only 3,163 articles were published, representing only 15% of the total number of publications. From 2013 to the current moment, publications in the mining industry have more than 11,403 articles, their rapid growth can be correlated with the data on the world leaders in coal mining. According to the results of 2017, the world leader is China (share in global coal production - 44.6%), followed by India, which moved to second place (9.6%), displacing the United States (9.3%), which is now in third place; Australia (6.6%), which took fourth place; Indonesia (6.4%) - fifth place. Russia retained its sixth place in the world in coal production, its share amounting to 5.4% (5.5% in 2000) (Figure 3).

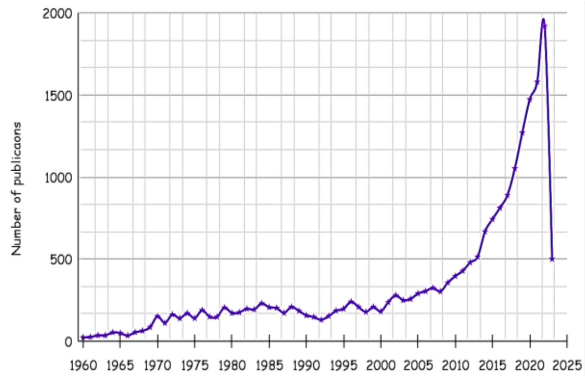


Figure 2. The annual number of publications from 1960 to 2023. The data for this article were downloaded on April 21, 2023, and therefore, only 5 months of data were included in 2023

TABLE 2. Most cited articles from 1960 to 2023

Title	Journal	h-index	Year	Cited
A thermophilic, acidophilic mycoplasme isolated from a coal refuse pile	Science	1283	1970	237
Clinically important respiratory effects of dust exposure and smoking in British coal miners	American Review of Respiratory Disease	268	1988	160
Coal mine methane: A review of capture and utilization practices with benefits to mining safety and to greenhouse gas reduction	International Journal of Coal Geology	160	2011	866
Research and development of rock mechanics in deep ground engineering	Chinese Journal of Rock Mechanics and Engineering	93	2015	469

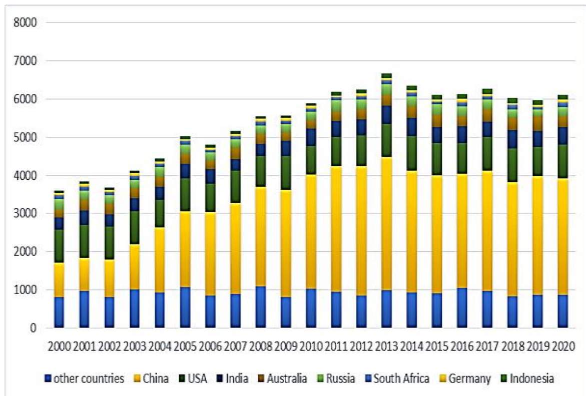


Figure 3. Coal production in major countries of the world

In the period from 2000 to 2020, the following structural changes occurred in the global coal industry under the influence of technological and price trends:
- China, India, Indonesia coal production grew at a high rate, which allowed them to occupy a market share equal to 60.7% by the end of the period, which is 22.9% more than in 2000. This growth in coal production was ensured mainly due to the increase in domestic demand, in particular in the electric and thermal power industry, as well as in machine building;
-in Australia, Russia, Kazakhstan, and South Africa, where coal production growth was driven mainly by increased coal exports, coal production increased by a combined 46.9%, but their share of the world market in 2017 declined to 16.8% from 18.8% in 2000;
- in the USA, Germany, and Poland, coal production in 2017 fell by a total of 25% compared to the 2000 level, primarily due to a reduction in the use of coal in the power sector as a result of the transition to "green" technologies. At the same time, the share of these countries in the global market more than halved and amounted to 13.3% in 2017. 13,3%.

3. 1. Analysis Journals and Journal Co-citation

A total of 4,170 scientific journals published articles between 1960 and 2023. Of these, 2,506 journals are still in existence, and 1,664 journals have ceased to exist, so for representativeness and updating of the data from the list of scientific journals, it was decided to limit the period from 2005 to 2023. Table 3 summarizes the top 20 journals in the field of mining (Only active journals were considered). In first place is the Journal of the China Coal Society with 652 papers and in second place is Coal Science and Technology with 267 papers, both published

TABLE 3. Top-20 journals publishing articles on mining industry

Source title	No. of documents	Publisher	Country	JIF	SJR	h-index	Cites per document (2 years)
Journal of the China Coal Society	652	China Coal Society	China	-	0.896	73	3,29
Coal Science and Technology	267	China Coal Society	China	-	0.55	16	1,94
Science of the Total Environment	209	Elsevier	Netherlands	9.8	1.95	317	10,94
Environmental Science and Pollution Research	193	Springer Science	Germany	5.8	0.94	154	6,18
International Journal of Coal Geology	177	Elsevier	Netherlands	5.6	1.64	160	6,03
Environmental Earth Sciences	177	Springer Verlag	Germany	2.8	0.6	141	2,88
Journal of Mining and Safety Engineering	171	China University of Mining and Technology	China	-	0.58	36	2,11
Sustainability	171	MDPI AG	Switzerland	3.9	0.66	136	4,39
Geofluids	170	Hindawi Limited	United Kingdom	1.7	0.35	64	1,67
Ugol	167	Ugol'	Russian Federation	-	0.38	15	0,78
International Journal of Environmental Research and Public Health	161	Frontiers Media S.A.	Switzerland	-	0.83	167	4,53
Energies	160	MDPI AG	Switzerland	3.2	0.63	132	3,66
Geotechnical and Geological Engineering	138	Springer Netherlands	Netherlands	1.7	0.51	71	2,02
PLoS ONE	130	Public Library of Science	United States	3.7	0.89	404	3,75
International Journal of Rock Mechanics and Mining Sciences	128	Elsevier BV	United Kingdom	7.2	1.97	187	7,2
Safety Science	120	Elsevier	Netherlands	6.1	1.43	140	7,19
Environmental Monitoring and Assessment	120	Springer Netherlands	Netherlands	3	0.63	132	3,14
Mining Informational and Analytical Bulletin	119	Publishing house Mining book	Russian Federation	-	0.42	15	1,11
International Journal of Mining Science and Technology	106	Elsevier	Netherlands	11.8	1.99	61	11,99
Journal of Liaoning Technical University	105	Liaoning Engineering Technology University Editorial	China	-	0.16	18	0,38

in China. Of the top 20 journals, 6 journals are from the Netherlands, four journals are from China, three journals are from Switzerland, Germany, United Kingdom and Russian Federation with two journals each, and one journal is from the United States. Seven journals are not indexed in the scientometric database Web of Science, and the top 10 journals have a JIF >2.0. The journal with the highest JIF and SJR is International Journal of Mining Science and Technology, and also in terms of Citations per document over two years.

3. 2. Analysis of Cooperation Analyzing the collaborative network based on country of origin can reflect the collaborative relationships between countries as well as the distribution of influential countries in the field. Figure 4 shows the scientific cooperation network obtained by VOSviewer, the node size represents the number of publications based on country/region, institution or author. According to the observation results, out of 72 countries/region, 37 published more than 25 articles, among which China ranks first with 55.96%. China is followed by Russia, USA, India, Poland, Australia, Germany, UK, Indonesia, Canada and Czech Republic with 30.3% publications in aggregate.

In addition, different countries have entered into close cooperation, which emphasizes, relevance, so the thickness and number of links connecting different nodes indicate more cooperation between developed countries and less cooperation between China and other countries. Developed countries have a larger proportion of the total number of publications, which can be explained by objective and subjective factors. As for objective factors, developed countries spend more money on scientific research. As for subjective factors, the development of mining industry as well as breakthrough technologies in developed countries is higher, which also confirms the relevance of the study.

As stated earlier, the leading position by number of publications is occupied by China - 14 073 publications, United States- 3 616 publications, Russia - 1989 publications, India- 1490 and Australia - 783 publications (Figure 5).

3. 3. Analysis of Institutional Cooperation Analyzing the collaborative network of institutions is important to understand the collaborative relationships among key institutions in mining research. Figure 6 shows that the institution collaboration network consisted of 38 clusters with 404 links. In the network, the size of the nodes represents the number of articles published by the respective institution. The thickness of the network links represents the degree of collaboration among these institutions country in mining research. Specifically, judging by the number of publications as well as the centrality index between them, China university of mining and technology has made the greatest

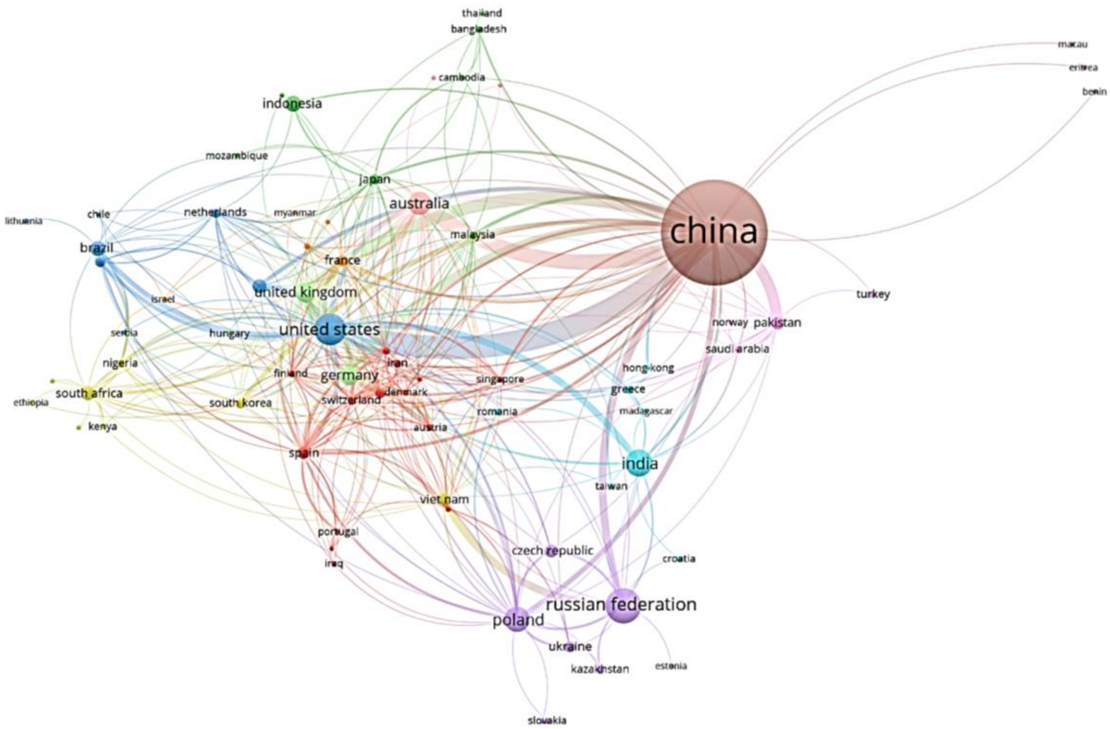


Figure 4. Country Cooperation Network on mining-related publications

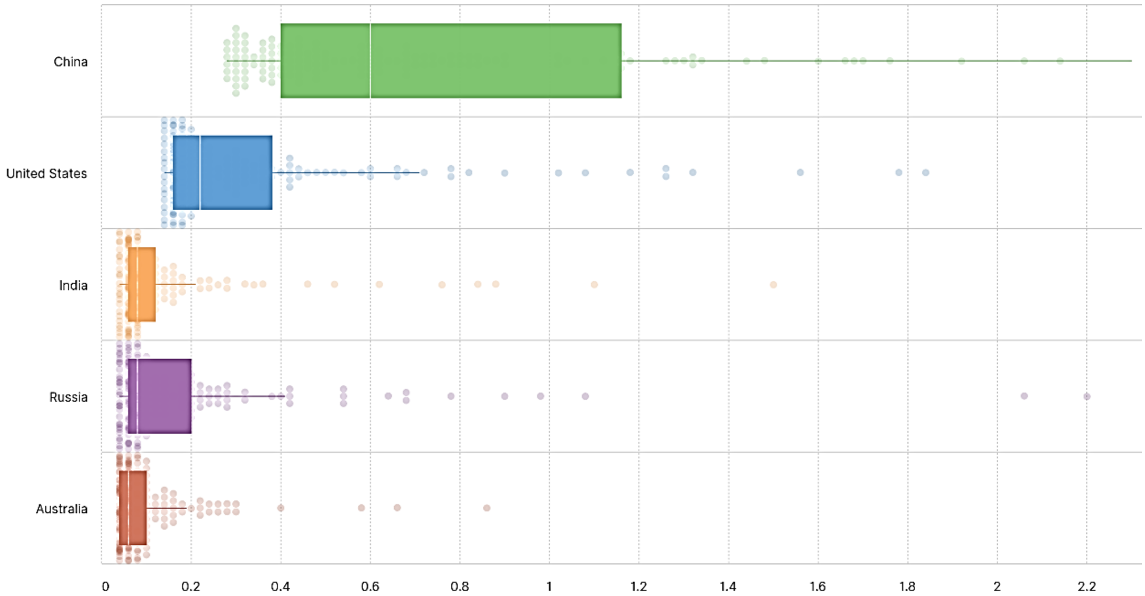


Figure 5. Top-5 countries by number of publications

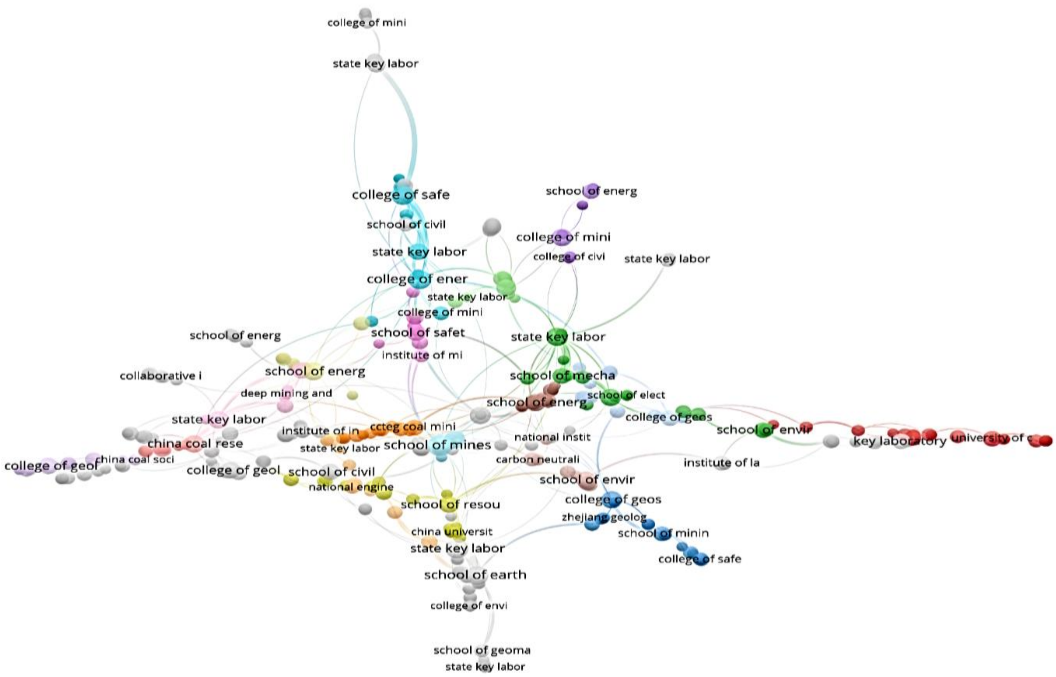


Figure 6. The institution collaboration network on mining-related publications

contribution with 44 departments or laboratories (2369 publications), followed by Shandong university of science and technology with 20 departments or laboratories (481 publications), Anhui university of science and technology with 9 departments or laboratories (375 publications), and China coal research institute with 5 departments or laboratories (228 publications).

3. 4. Analysis of the Authors Collaboration

The development and improvement of an academic scientific discipline depends on collaboration between researchers in the field. Analysis of the knowledge mapping resulting from the generation of the co-authorship network allows us to identify the most influential authors in Figure 7.

Mapping such a network can help researchers to establish collaborative relationships. According to

Scopus data, the author collaboration network created using the VOSviewer tool was disjointed and fragmented. The thickness of the links reflects the degree of collaboration between different authors. The color of the nodes reflects the time when the collaboration between authors started. The most significant collaborations in the network were those published by Wang. (34 publications) from China University of Mining and Technology (CUMT). The publication with the highest number of authors -99 (The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels) was noteworthy. We also conducted a quantitative analysis of scientists' contributions, according to the results of which 76% of authors published only one article in their field only once, 12.5% two articles, 4.75% three articles, 2.2% four articles, and only 4.55% of scientists published 5 or more articles. Let us consider the Top 15 scientists with the most publications in the mining industry (Table 4).

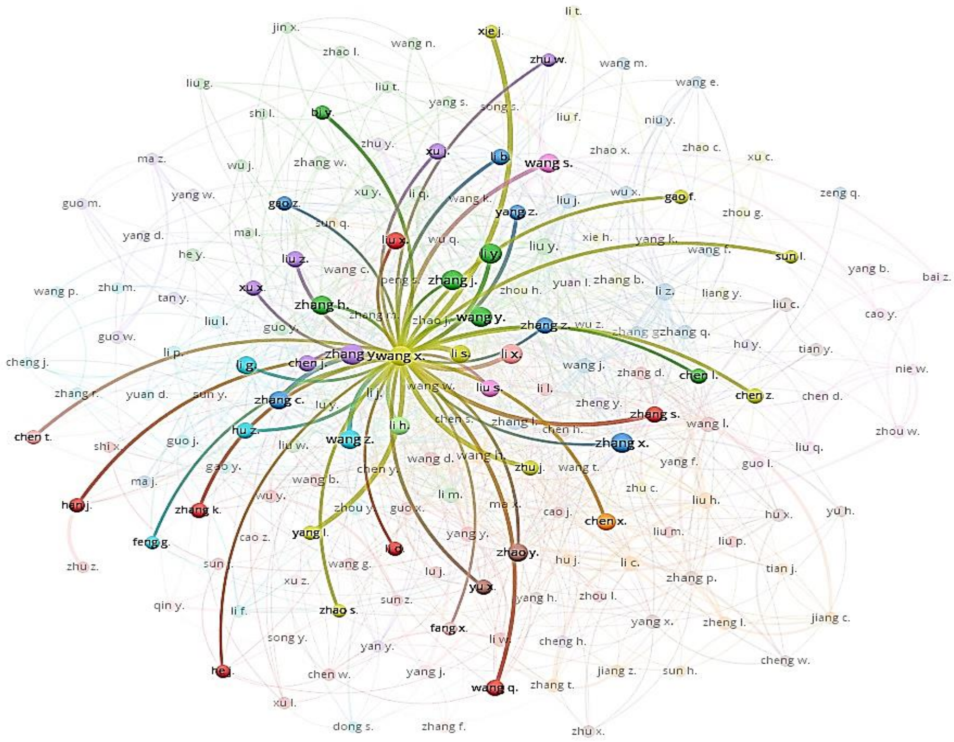


Figure 7. The author collaboration network on mining-related publications

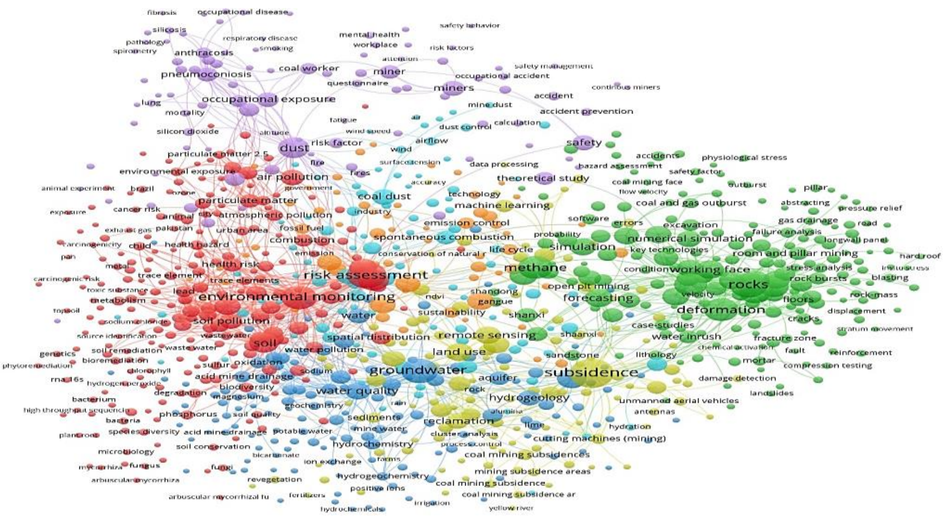
TABLE 4. Top 15 scientists with the most publications in the mining industry

Scopus ID	Publications on the subject	h-index	Affiliation	First author	Single author
56027289900	108	44	CUMT	27	0
8257473500	83	28	CUMT	29	3
8701261700	68	19	XUST	44	0
7103314735	55	30	CUMT	10	0
12789995400	54	30	CUMT	7	0
7006661811	51	46	CUMT	16	0
7407004934	50	39	CUMT	6	2
25028121800	46	22	CUMT	8	0
36620043400	44	26	CUMT	22	0
7404915620	43	57	CUMT	10	0
7405359875	42	26	CUMT	20	0
55649649900	42	32	CUG	1	1
36112316100	42	42	CUMT	19	10
57204661209	40	29	CUMT	16	0
55588306400	40	31	CUMT	9	4

The results of the analysis indicate that institutional proximity plays an important role in scientific collaboration. In most cases, collaboration first occurred between researchers and their doctoral students, the next most common type of collaboration was collaboration between different colleagues at the same university or institute, followed by collaboration between researchers who had a past working relationship, which also confirms the lack of non-co-authored papers among scientists and their colleagues.

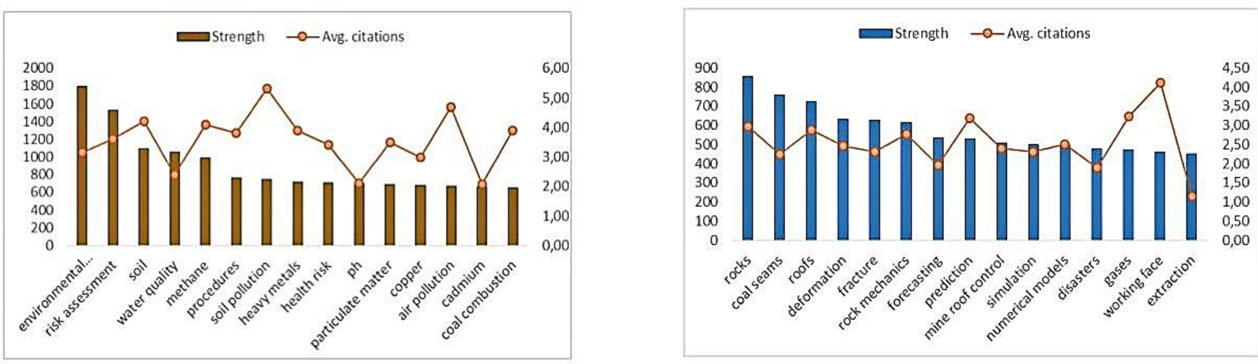
3. 5. Keyword Analysis Keywords are an important indicator for understanding the main content of scientific articles. The study of emerging trends in a particular scientific field can be found by analyzing keyword evolution maps. Before proceeding, it should be noted that the documents downloaded from the Scopus database contain information on keywords only since 2005. This is due to the fact that the information contained in papers published before this date is incomplete. Thus, the keyword analysis in this study covers the period from 2005 to 2023. The keywords indicate hotspots and future trends in the research field. Keyword clustering is formed from keywords with similar research topics and each cluster is marked with frequently used keywords in articles. Keywords with a match frequency >40 were included in the keyword clustering map (Figure 8). The keywords were categorized into five clusters comprising 194 nodes. The node size and node color reflect the number of keywords and clusters. Lines of different colors indicate that two keywords occurred in the same article. Additionally, top 10 keywords were highlighted with Strength, i.e., the overall strength of the links of a given keyword with others. Cluster 1 (93 items) relates to environmental monitoring (Average citations = 3.06); cluster 2 (80 items) relates to rocks (Average citations = 1.65); cluster 3 (55 items) relates to groundwater (Average citations = 1.61); cluster 4 (42 items) relates to subsidence (Average citations = 2.66); cluster 5 (38 items) relates to health risks (Average citations = 3.2).

We summarised the top 15 keywords of each cluster to systematically understand mining industry and provide suggestions for future research (Figure 9).

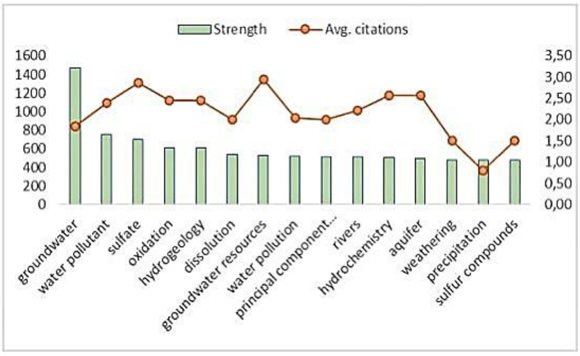


Top 10 Keywords	environmental monitoring	risk assessment	groundwater	soil	subsidence	water quality	methane	dust	aquifers	health risks
Strength	1799	1532	1464	1093	1084	1056	993	942	855	800

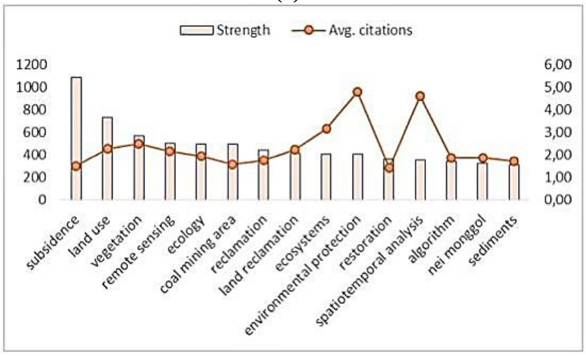
Figure 8. Co-occurrence of keywords and top 10 keywords with the strongest citation bursts



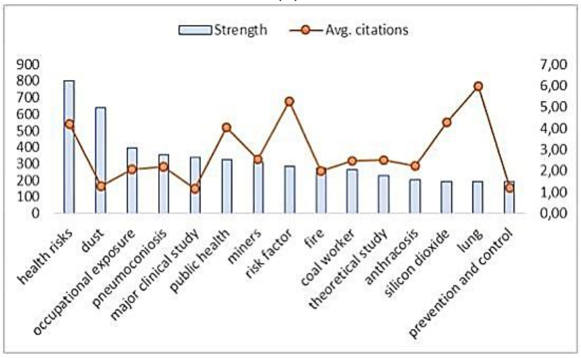
(a) (b)



(c)



(d)



(e)

Figure 9. The top 15 keywords of five co-occurrence keywords clusters, (a) environmental monitoring; (b) rocks; (c) groundwater; 9d) subsidence; (e) health risks

Calculating the average number of citations per keyword will allow us to determine how popular a particular area of research is in a given period. We can see that articles using the keywords risk factor (5.28), lung (6.0), working face (4.1), environmental protection (4.8), soil pollution (5.3), air pollution (4.7) gain more citations, which indicates the importance of the development of these areas.

4. DISCUSSION

A scientometric analysis and visualization of the bibliographic data were carried out and provide an insight into the most influential publication sources; most used keywords; most active and influential researchers; most active institutions, and literature with the highest impact. From the analysis, clusters were identified which grouped the literature based on the similarity of their keywords and abstract.

It was found that 54% of the articles were published between 2013 and 2023, confirming the prospectivity and prevalence of the research area. The contribution of China University of Mining and Technology to the development of this area can be separately noted, of the top 15 scientists in the world, 86% of scientists represent this organization.

The study confirmed the fact that it is impossible to assess the level of publication activity of a university by the volume of scientific research, so, according to QS World University Rankings for Engineering - Mineral and Mining, only 11 out of 25 universities are leaders in their field according to four criteria (Table 5). The first two are global surveys of academics and employers conducted by QS, which are used to assess the international reputation of institutions in each subject area. The second two indicators assess the impact of research based on the number of citations per paper and the h-index for the relevant subject (data are taken from Elsevier's Scopus database).

TABLE 5. Impact of universities on the QS World University Rankings for Engineering - Mineral and Mining

University	Country	Publucation	Rank/ Score
China University of Mining and Technology	China	3468	17/ 74.9
Pennsylvania State University	United States	164	17/ 74.9
Virginia Polytechnic Institute and State University	United States	161	28/ 70.9
University of Kentucky	United States	144	50/ 65.6
Indian Institute of Technology	India	287	25/ 71.5
Indian Institute of Technology Kharagpur	India	78	39/ 67.8
National University of Science and Technology	Russia	154	23/ 72.3
Saint Petersburg Mining University	Russia	118	3/ 83.8
The University of Queensland	Australia	179	5/ 82.1
UNSW Sydney	Australia	136	4/ 82.6
The University of Newcastle	Australia	71	31/ 69

These figures show that these institutions have had a particularly strong impact on the field of mining research. We would also like to mention the universities that carried out scientific research together with scientists from China - National university of science and technology «MISIS», Saint Petersburg state university (department of applied ecology), Saint Petersburg Mining university, Kyushu university (department of earth resources engineering), Balochistan university of information technology (department of mining engineering), Technische Universität Bergakademie Freiberg.

This dominance reflects China's position as a global leader in the mining industry, highlighting its strategic investment in research and development through funding from various finding (Table 6).

China's transformative impact on the global coal industry is undeniable. Its dominance in consumption, production, and technology innovation has ripple effects across the world, shaping the industry's trajectory. As China continues to balance its energy needs with environmental and health concerns, the global coal landscape will remain in flux, with implications for economies, energy markets, and environmental sustainability. The coal industry's future hinges on how China navigates this complex terrain and collaborates with the international community to address shared challenges.

Also the mining production process is exposed to a series of different hazards. Coal boom came at a substantial environmental and health cost. Severe air pollution, hazardous working conditions, and health-related issues prompted the leading countries in coal production to take action. Stringent environmental regulations, enforced through various policies and initiatives, have been introduced to reduce emissions, improve air quality, and address the negative impacts of coal mining and combustion. Average number of citations per keyword will allow us to determine how popular a particular area of research is in a given period. The most cited area is devoted to health risks (Average citations = 3.2). One of the main themes is the accumulation of dust and lung diseases which can pose a serious threat to the life and health of mine workers, therefore risk of coal dust explosions, which in result poses a direct risk of injury or even loss of life. The network analysis carried by keywords into confirms this fact. Recent studies have focused on both mining safety and the environment, what indicate a growing awareness of the socio-economic and health impacts of mining activities.

TABLE 6. The top documents by funding sponsor

Funding	Articles
National Natural Science Foundation of **China**	3020
Fundamental Research Funds for the Central Universities	625
National Key Research and Development Program of **China**	523
China Postdoctoral Science Foundation	299
China University of Mining and Technology	250
Natural Science Foundation of **Shandong Province**	201
Program of **Jiangsu** Higher Education Institutions	185
National Basic Research Program of **China**	156
Ministry of Education of the People's Republic of **China**	129
State Key Laboratory of Coal Resources and Safe Mining	125
Natural Science Foundation of **Jiangsu Province**	117
China Scholarship Council	104
National Science Foundation	98
European Commission	79

5. CONCLUSIONS

In the present study, a quantitative analysis of research using international scientometric databases Scopus, SJR and JCR and their data visualization tools VosViewer, Scimago Graphica and Python was conducted on the field of mining. Our results revealed the high-impact countries and institutions, journals, references, research hotspots, and key research fields in mining industry research. Since 2016 increasing publications and China leads the research on mining industry. Recent studies have focused on both mining safety and the environment. The «hot spots» of the studies include risk factor, lung, working face, environmental protection, soil pollution, air pollution. The results identified countries and institutions, journals, research hotspots, and key mining research. Thus scientometric analysis is a complete substitute for subjective literature review for academic researchers, as it allows for literature-related discoveries that would not be possible using other methods. Therefore scientometric analysis and research visualization offer valuable insights into the evolving landscape of the mining industry. From sustainable practices to technological advancements, these methods help us understand the trends and themes shaping the future of mining. As the industry continues to adapt to global challenges, scientometrics will remain a crucial tool for monitoring and guiding its development.

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Persian Abstract

چکیده

علم سنجی به مهم ترین ابزار برای ارزیابی و تحلیل عملکرد دانشمندان، همکاری بین دانشگاه ها، تأثیر بودجه عمومی علم بر نتایج تحقیق و توسعه ملی، اثربخشی آموزش و غیره تبدیل شده است. بنابراین، متخصصان و دانشمندان برای اندازه‌گیری داده‌های تجربی به طیف وسیعی از ابزارهای نظری و عملی نیاز دارند. هدف از این مقاله ارائه یک نمای کلی به روز از ابزارهای مختلف موجود برای تجزیه و تحلیل علم سنجی، از جمله منابع داده، تجزیه و تحلیل عملکرد و ابزارهای تجسم است. در این مطالعه تجزیه و تحلیل علم سنجی بر اساس 21180 مقاله از پایگاه داده اسکوپوس انجام شد که تنها با مقالات منتشر شده در صنعت معدن بین سال های 1960 تا 2023 انجام شد. همچنین نشان داد که 77 درصد از مقالات در مجلات منتشر شده و تنها 2.6 درصد با مطالعات مروری مطابقت دارد. . با استفاده از تحلیل شبکه در VOSviewer، نشریات بر اساس کلمات کلیدی در 5 خوشه با Strength گروه بندی شدند. تجزیه و تحلیل نقشه‌برداری، یافته‌های توصیفی را تأیید کرد و هم‌نویسی نویسندگان را به تصویر کشید. با استفاده از تحلیل پیوند کتابشناختی، رابطه معنایی بین نویسندگان و موسسات و کشورهای مرتبط با آنها بررسی شد (شامل 38 خوشه با 404 پیوند). میانگین تعداد نقل‌قول‌ها به ازای هر کلمه کلیدی (3.2) اجازه می‌دهد بیشترین استناد منطقه به خطرات سلامتی اختصاص داده شود. مطالعات اخیر بر گرد و غبار و بیماری های ریوی متمرکز شده است که می تواند تهدیدی جدی برای زندگی و سلامت کارگران معدن باشد، بنابراین خطر انفجار گرد و غبار زغال سنگ، که در نتیجه خطر مستقیم آسیب یا حتی از دست دادن جان افراد را به همراه دارد.