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Visual Analysis of Activity Construction Based on Bibliometrics

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ABSTRACT

China has a well-developed active structure, with the continuous expansion of the scale of engineering construction and the continuous extension to the complex geological areas, especially the tectonic areas that are still active or will still be active in the future. Related projects are faced with many new challenges. The summative achievements on the problems related to active tectonics in China still need to be made available. This paper uses CNKI and WOS as data sources, and the documents related to active tectonics and geology from 2003 to 2022 are taken as objects. The scientific knowledge graph is visualized and analyzed by the bibliometrics software CiteSpace. The results show that: (1) the number of research literature on active tectonics at home and abroad is on the rise as a whole, (2) the number of articles published in the field of active tectonics in China is highly proportional to the number of earthquake disasters in China each year, and (3) the United States is in an absolute leading position in this field. It can help researchers in related fields to obtain the classical achievements of nearly 20 years quickly, and it is easy to find the bottleneck of current research. It can also expand the field of vision to find new research directions.

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1. Introduction

Active tectonics refers to the structures that have been active until now and will still be active in the future during the late Quaternary period. Violent tectonic movements often lead to geological disasters such as earthquakes [1-5]. In recent years, with the rapid development of human society and economy and the continuous extension of engineering activities, earthquake disasters not only bring substantial economic losses to all humanity but also seriously threaten the lives and safety of people living on tectonically active plates. For example, in 2008, it happened in Wenchuan Ms8.0 The magnitude 0 earthquake killed more than 80,000 people [6, 7].

Because the active structure originates from studying the relationship between earthquake disasters and faults, and the active fault is the main form of active structure, it is imperative to study the active fault. The essence of an earthquake is that under the action of regional tectonic stress, the energy accumulates and produces strain on the active fault zone. The energy accumulates continuously and reaches the threshold value, which leads to sudden instability and ruptures [8, 9]. Because the sudden occurrence of earthquakes makes it difficult to predict them, it is imperative to study active faults. After the 21st century, various emerging technologies, such as GPS, UAV aerial photogrammetry, radar interferometry, geophysical detection, multi-source remote sensing technology, and so on, continue developing. The study of active faults is also more in-depth. Scholars at home and abroad have published many related review journals on active tectonics. For example, Wen Xueze and others divided the active tectonic belt on the eastern boundary of the Bayan Kara block in time and space, studied the commonness and characteristics of earthquake occurrence in this active tectonic belt, and judged the possible risk of large earthquakes occurring in these seismic gaps in the future [10] Taking the Qinghai-Tibet Plateau as an example, Li Haibing and others studied the Chinese mainland tectonic deformation and seismicity. They proved that the regional crustal deformation and seismicity distribution of the Qinghai-Tibet Plateau is the critical characteristics of continental tectonic deformation [11]. Cao Yun *et al*. have comprehensively and systematically studied the distribution of Holocene active faults and paleo-earthquake sequence in the Jiangsu section of the Tan-Lu fault zone [12]. Xie Xiaoping *et al*. comprehensively used Landsat ETM+ image, ASTER GDEM digital elevation model, Google Earth image, and other data to analyze the tectonic movement of active faults in the northeast section of the Longmenshan fault zone [13]. Jiang Lei *et al*. take the Jiaoshiba-Wulong structural belt as the research area, based on fractal fracture theory and carbon, oxygen, and strontium isotope geochemistry theory, reveal the coupling between the difference of paleo-fluid activity in different structures and shale gas preservation conditions [14]. Sayed S. R. Moustafa *et al*. combined tectonic, remote sensing (RS), geophysical, and seismicity data to examine and analyze the relationship between Egyptian tectonic structure and seismicity [15]. Aldo Febriansyah Putra *et al*. used the geomorphic index to evaluate the relative tectonic activity of the North Sumatra fault [16]. Edwin Nissen CA *et al*. studied the active structure of southwestern Turkey along the strike between Fethiye near the eastern end of the Greek subduction zone and Burdur on the Anatolian Plateau [17]. However, the scientific research work of most scholars at home and abroad is mainly focused on the qualitative research of active structure, and there needs to be more quantitative research on active structure articles.

Therefore, to better understand the current situation and future trends of active tectonic research, it is necessary to analyze the current research results systematically. Therefore, this paper attempts to summarize and visually analyze the research on active tectonics in the past 20 years from a new perspective and using the method of bibliometrics.

The visual analysis aims to show the relevant content of related articles through the graph, mine, and track the knowledge structure and context picture of activity structure research, and understand better, obtain, store, and manage knowledge data. It can more directly and clearly show the current academic research's hot content and development trend. First, this paper analyzes the research topics, evolution trends, and research hotspots in the field of active tectonics in the domestic CNKI database. Then take the relevant literature of the Web of Science database as the data source to analyze the development of the foreign active tectonic field. Finally, the development of the two is analyzed, conclusions are drawn, and suggestions are given, which provides new ideas for the research in active tectonics.

2. Data Sources and Research Methods

2.1. Data Sources

The research object of this paper is the literature on the related fields of active tectonics, and the data come from the China knowledge Network (CNKI) and Web of Science database. The domestic data comes from China knowledge Network (CNKI). China knowledge Network (CNKI) is China's most important scientific and technological literature index tool, and its data source is widely used in bibliometrics research. International data are derived from the Web of Science, Web of Science database, which is internationally recognized as a database reflecting the scientific research level. It contains over 8700 core academic journals in various research fields, such as natural science, engineering technology, biomedicine, etc. Although the coverage of the Scopus database is more comprehensive than that of the Web of Science, its data overlap rate is very high. Moreover, when some researchers use two kinds of databases for bibliometric analysis, the difference between the results could be more apparent. Therefore, selecting the above two databases for analysis is reasonable and practical.

Because of the different ways of importing Chinese literature CNKI and English literature Web of Science data, the search and search methods are set up respectively based on the related concepts of active construction. Active tectonics has a wide range of research fields involving many disciplines and periodicals in literature retrieval. In order to ensure the quality, quantity, and coverage of the literature as comprehensively as possible, this paper sets the retrieval condition in the CNKI journal retrieval as "the title OR abstract OR keywords contain active construction or structural activities," and the retrieval journal category is "SCI source journals (Science Citation Index). Science Citation Index), EI Source Journals (Engineering Index), Peking University Core, CSSCI (Chinese Social Science Citation Index), CSCD (China Science Citation Database). Professional search is set up in Web of Science episodic retrieval, the search format is (TS= (active tectonics or active structures)) AND (KP= (geology or active faults or earthquake or disaster)), and the periodical retrieval category is Web of Science core collection. The period of retrieval is from 2003 to 2022. After manually screening the results and removing repeated information and irrelevant articles, 3508 and 3712 pieces of valid data are left for analysis for CNKI and WOS, respectively.

2.2. Research Methods

This paper uses the CiteSpace metrology tool to analyze the knowledge graph of the literature data. CiteSpace is a powerful scientific literature data visualization analysis software developed by Professor Chen Chaomei of Drexel University in the United States. It presents the structure, law, and distribution of scientific neighborhood knowledge through visual analysis, so the visual graph obtained by this method is turned into a scientific knowledge graph [18-25]. In the knowledge graph generated by CiteSpace, the circle size of the node represents the frequency of the analysis object in the journal; the more significant the circle, the greater the frequency, and the connection between the nodes represent the relationship between the two analysis objects, and the width of the connection between the nodes represents the strength of the connection. The hue represents the passage of time from cool color to soft color, the color in the inner circle of the node is used to reflect the period when the content appears, and the color of the connection between the node and the node represents the time of the first co-occurrence.

3. Data Result Analysis

3.1. Analysis of the Number of Posts

By analyzing the annual volume of articles and their changing trend, we can quickly understand the importance and development of this research field. On the whole, the number of articles published at home and abroad in the field of active tectonics in the past two decades shows an overall increasing trend with time (Fig. **1**). On the one hand, it shows that domestic and foreign scholars have carried out much academic research in the field of active tectonics. The research of active tectonics has entered the stage of quantitative research. On the other hand, the rapid development of the global economy, the rise of various emerging technologies, and the

gradual extension of engineering construction to complex geological areas have promoted the development of research related to active structures. In addition, in recent years, the frequent occurrence of seismicity and the increasing impact of geological disasters on human beings are also important factors in the rapid development of active tectonic research [26].

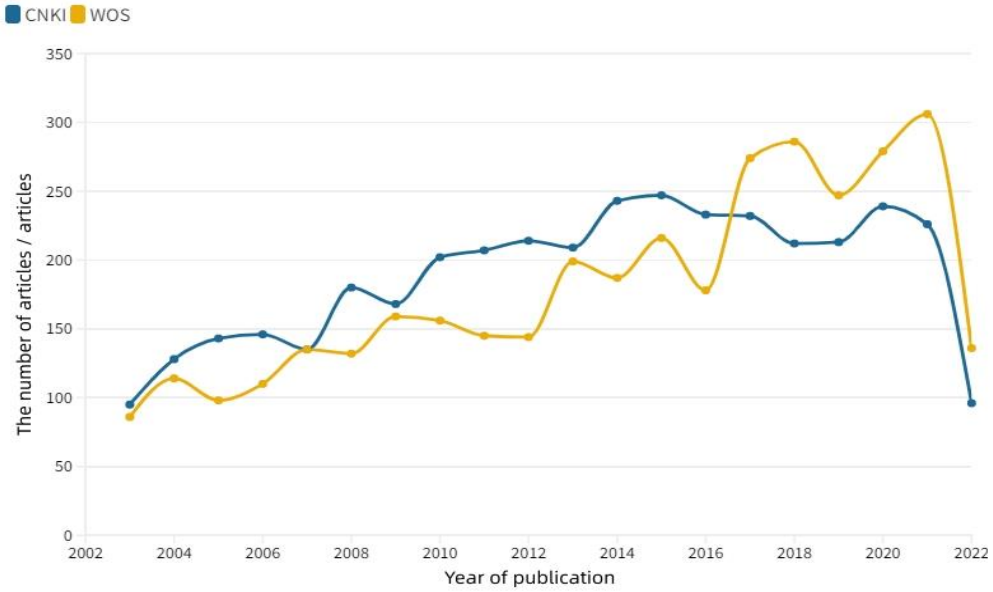

Figure 1: Number of papers published on active Construction of CNKI and WOS databases from 2003 to 2022.

It can be seen from the picture that the domestic volume of articles once led the international volume from 2003 to 2016. However, in 2017 and after that, domestic active tectonic research volume showed a slight downward trend. Compared with the figure below (Fig. **2**), it can be seen that there is a highly positive correlation between the number of earthquake disasters and the number of articles published in the field of active tectonics in China. Due to the lack of some years of data in the national database, the relevant statistics are only made on

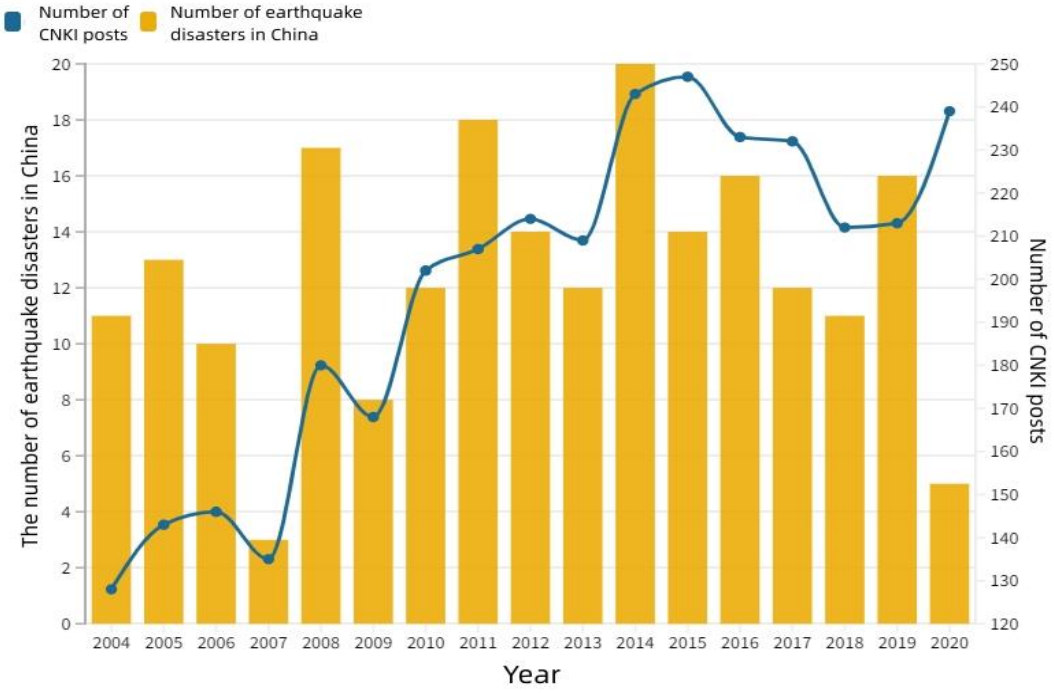

Figure 2: The number of papers published on CNKI active tectonics from 2004 to 2020 and the number of earthquake disasters in China.

the number of domestic articles and domestic earthquake disasters from 2004 to 2020. From 2004 to 2007, under the background of active fault exploration in China presided over by Xu Xiwei [27, 28], the number of documents on active tectonics increased slowly but decreased slightly in 2007. at the same time, the number of earthquake disasters in China also showed a downward trend. In 2008, an Ms8.0 earthquake occurred in Wenchuan, China, which also stimulated our country to conduct more in-depth research on earthquake disasters. More attention has been paid to the risk of active tectonics and large earthquakes. In the same year, the number of documents in active tectonics increased sharply, an increase of 33.33% over last year. From 2009 to 2014, the number of documents showed a trend of rapid growth, which is related to the frequent earthquake disasters and the growing scientific research team in China at this stage, which can be the stage of rapid development in the field of active tectonic research. From 2015 to 2020, the number of earthquake disasters in China decreased yearly, while the number of documents on active tectonics showed a slow downward trend.

Generally speaking, the annual paper volume of active tectonics at home and abroad has fluctuated and increased in the past 20 years, in the annual paper volume in China has had a slow downward trend in recent years, and the number of earthquake disasters in China has also decreased slightly at this stage. The research on active tectonics and seismology in China still needs to be revised. We should strengthen the basic research of active tectonics and attach importance to the theoretical innovation of active tectonic seismology to take precautions.

3.2. Analysis of Published Periodicals

Analyzing the distribution of published journals in the research field is helpful for scholars to collect intelligence information in this field and point out the direction for early data collection and knowledge accumulation. At the same time, high-quality academic journals reflect the level of discipline development to a certain extent. This paper makes statistics on the top ten journals of active tectonic research at home and abroad from 2003 to 2022, as shown in Table **1-2** below. It can be seen that the journals with the most published papers at home and abroad are “The Journal of Geology” (158 articles) and “ECTONOPHYSICS” (335 articles), respectively, and their influencing factors are 2.938 and 3.660, respectively. In addition, it can be seen from the table that the number of articles published in the top five journals in the world is more than 100, which shows that international research in the field of active tectonics is extensive and highly concerned. In addition, the compound influence factors of domestically published journals are between 2.006 and 7.158, with a large span, among which the journals with an impact factor greater than 5 are only Petroleum Exploration and Development, which is the ninth in volume. It reflects that papers on active tectonics in China are slightly uneven, and the research level has been further improved.

Table 1: Top 10 journals published in the CNKI database from 2003 to 2022.

S. No.	Periodical	Number of Articles	Compound Influence Factor (2021)
1	“Journal of Geology”	158	2.938
2	“Journal of Rock”	96	3.316
3	“Journal of the Earth”	87	2.362
4	“Petroleum and Natural Gas Geology”	64	4.928
5	“A Review of Geology”	61	3.014
6	“Quaternary Studies”	53	2.048
7	“Journal of Petroleum”	48	4.478
8	“Natural Gas Geoscience”	39	2.006
9	“Petroleum Exploration and Development”	36	7.158
10	“Petroleum Experimental Geology”	33	3.009

Table 2: Top 10 journals published in the WOS database from 2003 to 2022.

Serial Number	Periodical	Number of Articles	Influence Factor (2021)
1	"TECTONOPHYSICS"	335	3.660
2	"JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH"	270	4.390
3	"GEOPHYSICAL JOURNAL INTERNATIONAL"	242	3.352
4	"TECTONICS"	165	5.261
5	"JOURNAL OF ASIAN EARTH SCIENCES"	114	3.374
6	"EARTH AND PLANETARY SCIENCE LETTERS"	97	5.785
7	"BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA"	91	3.140
8	"GEOMORPHOLOGY"	75	4.406
9	"JOURNAL OF SEISMOLOGY"	74	1.606
10	"PURE AND APPLIED GEOPHYSICS"	72	2.641

3.3. Cooperative Analysis

Scientific cooperation is one of the important forms of modern scientific production, and it has been widely used in cooperation with countries, institutions, scientific research institutes, authors, and other subjects. This paper will analyze the cooperative relationship in related fields from two aspects: micro (author) and macro (country).

3.3.1. Analysis of the Author's Cooperative Knowledge Graph

The co-occurrence analysis of the author is helpful for scholars to have a further understanding of this field. Tables **3-4** list the ten researchers who published most frequently in active tectonics based on the two databases from 2003-2022, respectively. The top 10 papers published by researchers in active tectonics at home and abroad are more than 10, and the strength of the whole scientific research team is relatively muscular. Among them, the top five authors with the highest frequency of publication are all Chinese researchers, namely Yuan Daoyang (41 times), Zhu Yiqing (31 times), Wu Zhonghai (29 times), Li Yong (28 times) and Zheng Wenjun (28 times). They enjoy a particular reputation in active tectonics and are important researchers. In addition, among the ten researchers with the most significant number of papers published abroad, Chinese researchers account for 5, which reflects that Chinese researchers have a strong influence in the field of active world tectonics and highlight the vast development situation in the field.

Table 3: Top 10 researchers in the CNKI database from 2003 to 2022.

Ranking	Author	Frequency	Ranking	Author	Frequency
1	Yuan Daoyang	41	7	Yuna Wanming	18
2	Zhu Yiqing	31	8	Guo Changbao	17
3	Wu Zhonghai	29	9	Zhang Bo	16
4	Li Yong	28	9	Shao Yanxiu	16
4	Zheng Wenjun	28	9	Zhang Yongshuang	16
6	Zhnag Peizhen	19	-	-	-

Table 4: Top 10 researchers in the WOS database from 2003 to 2022.

Ranking	Author	Frequency	Ranking	Author	Frequency
1	DAPENG ZHAO	17	6	BING YAN	11
2	AIMING LIN	16	6	WENJUN ZHENG	11
3	ALEX COPLEY	13	6	CARMELO MONACO	11
4	XIWEI XU	12	10	HASAN SOZBIKIR	10
4	GIANLUCA VALENSISE	12	10	R I WALKER	10
6	JAMES JACKSON	11	-	-	-

In CiteSpace, the node type (Node Types) is set to the author (Author), and the selection criterion (Selection Criteria) sets the threshold to Top=50. Because the data sample is too large, the author's cooperative knowledge graph with 8 or more frequent posts is displayed after adjustment and screening (Fig. **3-4**). In Fig. (**3-4**), each node represents an author, the node's size represents the author's posting frequency, and the connection between the node and the node is regarded as a cooperative relationship between the author.

The cluster analysis shows that the leading authors in China take Yuan Daoyang, Zhu Yiqing, Wu Zhonghai, Li Yong, and Zheng Wenjun as the core to form their research teams. There is a close relationship between the team and the team, especially between the Yuan Daoyang, Zhu Yiqing, Li Yong, and Zheng Wenjun teams. In addition to this network, there are a small number of small cooperative networks with a low volume of posts, less contact with authors, and scattered individual authors. In addition, Zhang Peizhen made a significant contribution in the early stage of the study of active tectonics (the node circle is white-gray as a whole), the link is complex in cooperation with various authors, and Yuan Daoyang is late in this field (most of the node circle is warm). The paper's publication is mainly concentrated in the middle and later stages. In addition, the distribution of foreign authors is relatively scattered; However, the overall volume of articles is more, the number of high-volume authors is relatively small, and nearly half of the authors have only published articles once or twice in this field. They have yet to form several excellent scientific research teams.

Figure 3: Study on CNKI active tectonics from 2003 to 2022 knowledge graph of the author.

3.3.2. Analysis of Knowledge Graph of National Cooperation

The co-occurrence analysis of national cooperation helps judge each country's degree of attention and scientific research strength in this field. To a certain extent, it can also reflect the degree of seismological disasters

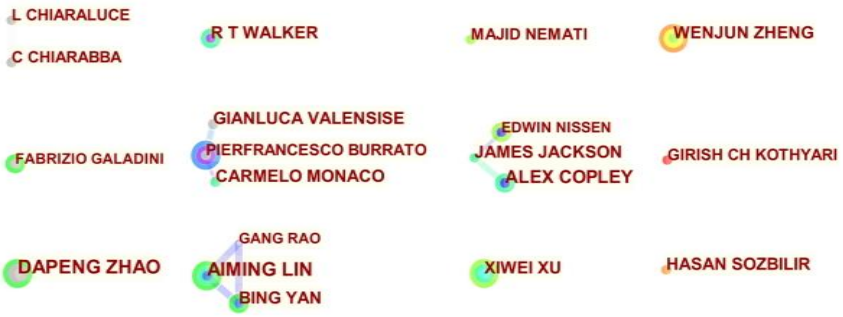

Figure 4: Study on WOS active tectonics from 2003 to 2022 knowledge graph of the author.

the country suffers. In CiteSpace, the node type (Node Types) is set to country (Country), and the selection criterion (Selection Criteria) sets the threshold to Top=50. Fig. (**5**) and Table **5** are obtained. Fig. (**5**) shows the countries and regions where the number of posts exceeds 35. In the figure, each node represents a country, the node's size represents each country's posting frequency, and the connection between nodes is regarded as a cooperative relationship between countries. The node's centrality represents the close cooperation between the country and other countries. Among them, 1153 pairs of cooperative relations exist in these countries and regions. Among all the countries, the United States has the highest frequency and centrality of publishing articles. American geological research work is generally considered to represent the highest book review in the world. Although the frequency of publishing articles in China ranks third, it could be higher in terms of centrality, which is related to the short course of development of geological work in China; domestic scholars need more communication between research and external cooperation, and most of them.

Table 5: Top 10 sending countries.

Ranking	Country	Frequency	Centrality
1	USA	694	1.03
2	ITALY	594	0.13
3	CHINA	481	0.05
4	FRANCE	457	0.29
5	INDAN	299	0.07
6	TURKEY	293	0.03
7	ENGLAND	292	0.15
8	GERMANY	256	0.10
9	JAPAN	213	0.09
10	IRAN	199	0.04

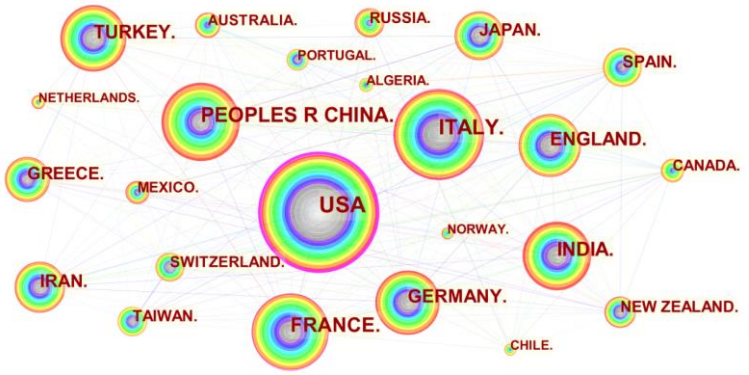

Figure 5: Knowledge graph of the sending country.

3.4. Keyword Analysis

Keywords are a high summary of a periodical's subject concepts and core ideas. By extracting the keywords of the core content of the journal in a specific field and excavating its prominent frequency at different times, we can reveal the research hotspots and development trends in this research field. In CiteSpace, the node type is set to (Node Types) to the keyword (Keyword). After many experiments, the threshold of the selection standard (Selection Criteria) is set to Top=10 and g-index Knowledge 5. The keyword spatiotemporal atlas based on CNKI and WOS databases is drawn by the network finder algorithm (Pathfinder) and slicing network (Pruning sliced networks), respectively (Fig. **6-7**).

Based on the spatiotemporal map of CNKI keywords, it can be divided into two stages: 2003-2012 and 2013-2022. In the CNKI database, the keywords with a high frequency of active tectonic research from 2003 to 2012 are tectonic activity, evolution, active structure, oil and gas accumulation, sequence stratigraphy, Wenchuan earthquake, earthquake, structure, tectonic movement, sedimentary facies, seismicity, and GP. At the beginning of the 21st century, due to the development of geological methods, GPS, trench excavation, radar interferometry, UAV aerial photogrammetry, and other new technologies in the fourth quarter, the study of active tectonics in China has become diversified and deepened. From 2003 to 2012, the major project "Urban Active Fault Detection and Seismic Hazard Assessment" was carried out in China. Active fault detection was carried out in 23 medium and large cities in China. A large-scale distribution map of active faults has been gradually drawn, and the basic pattern of active tectonics in China has been preliminarily identified [29, 30].

From 2013 to 2022, at this stage, the research work of active tectonics in China focused on the large-scale survey of active faults. The mapping plan of seismically active fault layers in China has also made remarkable achievements. 1: 500000 zonal geological-geomorphological mapping of seismically active faults, 1: 50 digital Chinese mainland active fault distribution map, and 1: 250000 active fault distribution map of main seismotectonic belts are comprehensively compiled. A comprehensive seismic observation system covering mainland China has been built, the earthquake monitoring technology has reached the most advanced level in the

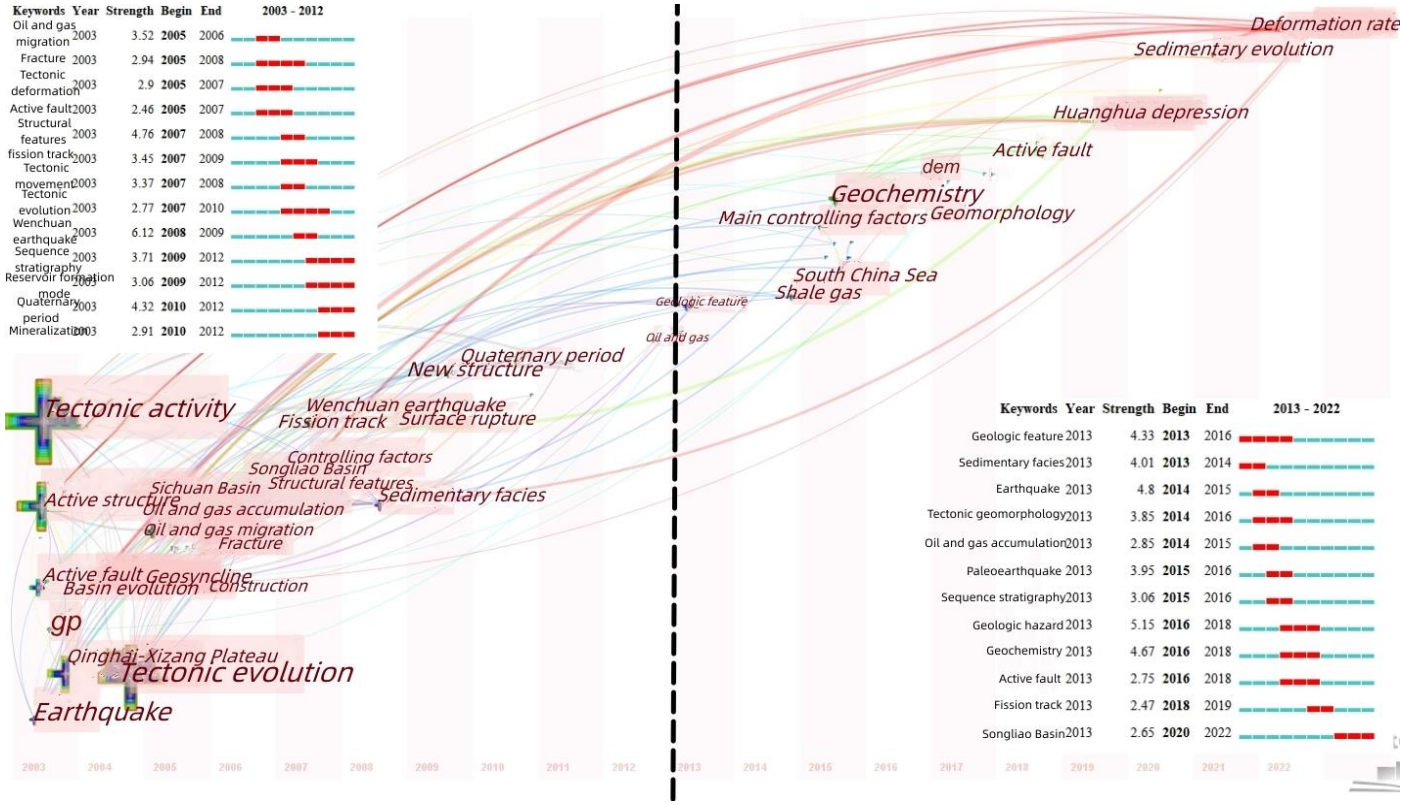

Figure 6: Keyword knowledge graph of CNKI active structure research from 2003 to 2022.

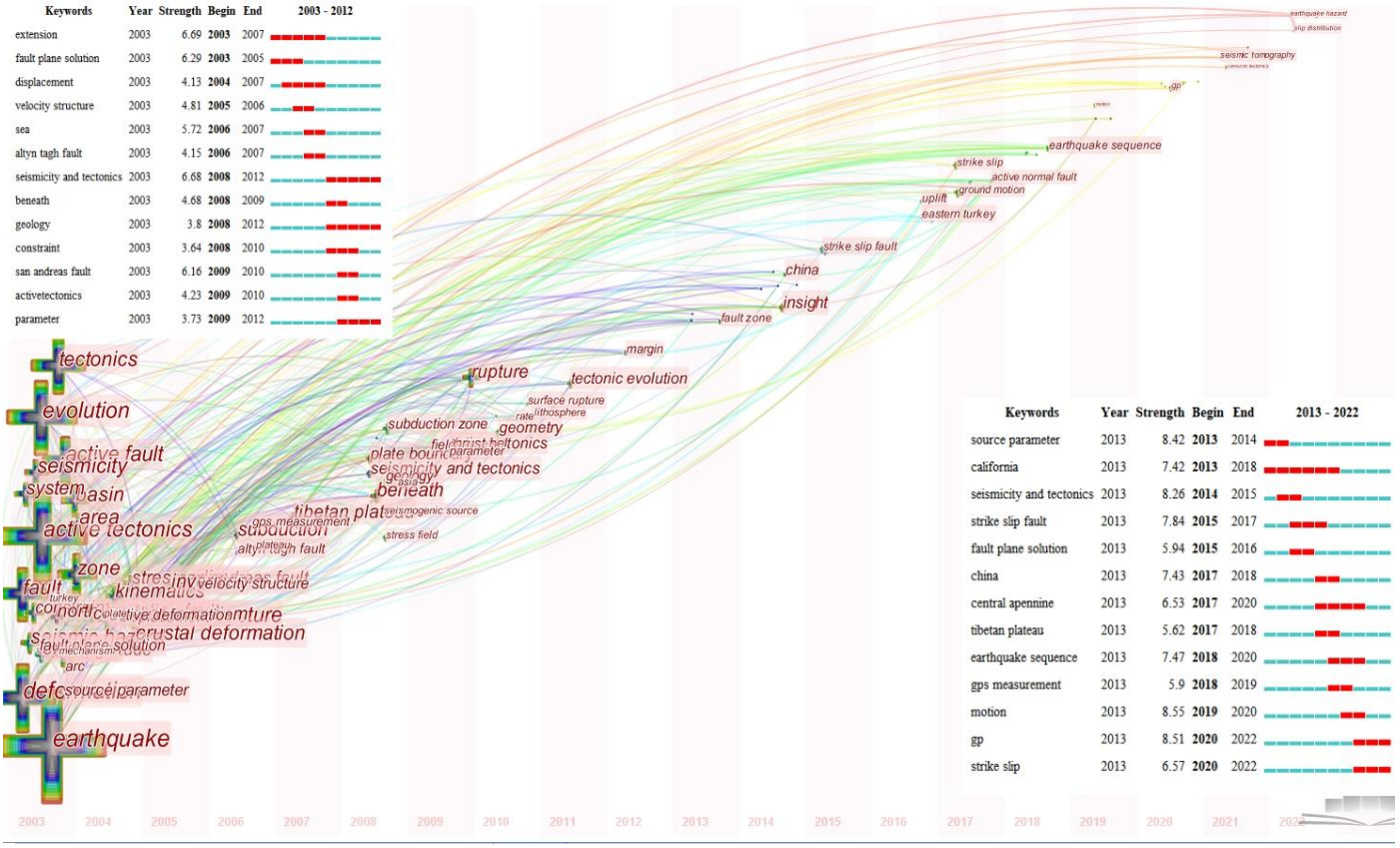

Figure 7: Keyword knowledge graph of WOS active structure research from 2003 to 2022.

world, the ability of medium-and long-term prediction has been steadily improved, and considerable progress has been made in earthquake science and technology. The supporting role of earthquake prevention and disaster reduction has been strengthened. A national earthquake emergency rescue system has been established.

Foreign developed countries all attach great importance to the large proportion of filling and mapping of active tectonics; for example, the United States completed the active national fault filling work in the 20th century; Japan has put forward the 1: 2 million fourth-quarter fault map as early as 1963, so based on the keyword space-time map in WOS database, most of the keywords are concentrated in the early stage.

4. Conclusion

Based on the CNKI (domestic) and WOS (foreign) databases, this paper makes a statistical and visual analysis of the literature and periodicals related to active tectonics in the past 20 years by using the knowledge graph visualization software CiteSpace, and draws the following conclusions:

(1) Based on the quantitative study of the number of active tectonics research literature at home and abroad, it is found that the number of articles published shows an upward trend as a whole. Before 2017, the number of articles published in China showed a leading trend, and from 2017 to now, the number of articles published abroad has exceeded.

(2) It is found that the annual number of articles in the field of active tectonics in China is highly proportional to the number of earthquake disasters in China, which reveals that the basic research work in active tectonics and seismogeological work in China still needs to be improved. Although accurate earthquake prediction cannot be fully realized under the current science and technology, scientific and in-depth geological work cannot be fully realized. It is still possible to identify where earthquakes may occur, their magnitude, disaster types, etc.

(3) It is necessary to take precautions. At the national level, the United States is in the leading position in this field, and the number of posts and centrality rank first. Although China ranks third in the number of posts, there are few transnational opportunities to cooperate, and the centrality could be higher. It means that there is still much room for improvement in the influence of our country in the field of active tectonics.

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