



Research status of shale gas: A review

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ABSTRACT

The shale gas revolution has resulted in a sharp growth in the number of researchers and collaborative work in this area, particularly during the past few decades. This study aims to provide unprecedented and invaluable shale gas information to businesses, policymakers, and any part of society involved in shale gas development. Using bibliometric and collaboration techniques, our study focuses (on an individual level) on the development trends in shale gas research. We examine the most influential authors and explore the characteristics and implications of collaboration networks and patterns in shale gas literature between 1990 and 2014. Much of our information was obtained from the Science Citation Index Expanded (SCIE) database. Author collaboration analysis software that has been independently developed was used to further explain core author contributions and trends, as well as collaboration networks. We primarily focus on three research areas: (1) the quantity and growth trend of the number of authors exploring shale gas, (2) author productivity distribution, and (3) an analysis of author collaboration networks. First, our results reveal three developmental stages. The period from 1990 to 2008 was the early stage and characterized by steady development. The years between 2008 and 2013 witnessed rapid growth, before that growth slowed notably after 2013. The annual growth rate of the number of new authors was determined to be approximately 980%. This finding also indicates that shale gas is becoming a fast-developing and popular research topic. Furthermore, Horsfield B from the German Research Centre for Geosciences has been the dominant contributor to date, followed by Krooss BM and Ballice L. The top 15 authors are mainly from Germany, the USA, Canada, Estonia, Jordan, and China. Our collaboration network and pattern analysis reveals that the two biggest clusters of cooperation are comprised of Horsfield B and Ballice L. We also discovered that most authors have a specific collaboration, such as that between Williams PT and Jaber JO, both of whom are from the Al-Ahliyya Amman University.

1. Introduction

Natural gas is a mixture of light, flammable hydrocarbons, primarily composed of methane (CH₄). The discovery of natural gas is one of the most important energy revolutions of our time, virtually transforming the global energy marketplace [1–8]. Shale gas represents a new opportunity to strengthen energy security while reducing emissions [2,4,9–14]. As a typical emerging technology, shale gas has attracted significant attention from researchers, resulting in a virtual information explosion [15,16]. The unfolding shale gas revolution has experienced sharp growth in the number of researchers and collaborative work in the field of shale gas research, particularly during the past few decades. At present, the development of shale gas not only brings innovation opportunities; some uncertain results have also arisen, due to unknown factors. However, international collaboration speeds up the research process and reduces the degree of risk. This is significantly beneficial to those involved in the exploration of shale gas technology.

As a consequence, a need exists for information specialists, who can help explore and identify information, the properties of the scientific activities and collaboration networks that are useful to specific stakeholders.

It is widely assumed that collaboration is a good thing and should be encouraged [17,18]. Countries from all over the world have fostered the development of collaboration between researchers. The level of international collaboration has been increased, in the sincere belief that collaboration will bring about many benefits, such as cost-savings and more impactful research. With the growing need for scientific collaboration, bibliometric studies of research collaboration have also extended quickly, from country and institutional levels to the most detailed individual level [19–22]. Even relationships between authors that are based on the characteristics of published literature have been studied for decades [23–26]. However, despite the increasing amount of research being conducted in the field of shale gas engineering and patent analysis, few attempts have been made to gather systematic data

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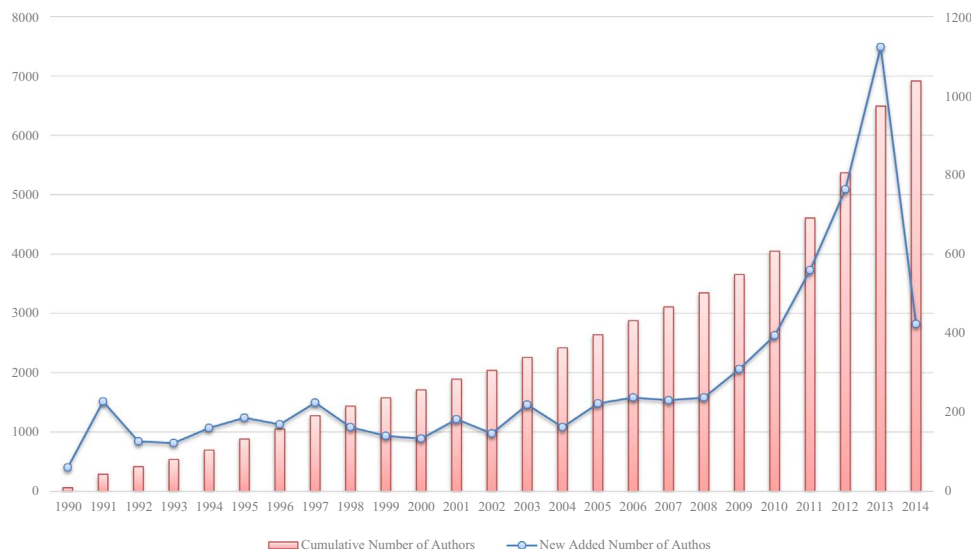


Fig. 1. The trend of cumulative and newly added number of authors by year.

at an individual level. In addition, very few studies have considered the turn-number of authors (the number of papers with first, second, or subsequent-named authorships). As such, the degree of contributions in the field has not been reflected. A review of author collaborations is also needed, in order to refine the assessing impact [27].

This study aims to reveal the basic properties of the scientific activities related to shale gas. We also evaluate research performance and examine the most influential authors and collaboration networks on an individual level. Our objective is to provide unprecedented and invaluable shale gas information to businesses, policymakers, and society, and we would undoubtedly wish to promote the international collaboration and innovation processes involved in the field of shale gas development.

Our paper focuses (on an individual level) on investigating the current development trends in shale gas research. We examine the most influential authors and explore the characteristics of collaboration networks, as well as any patterns in shale gas literature from 1990 to 2014. We obtained much of this information from the Science Citation Index Expanded (SCIE) database. To this end, our research is focused on three goals: (1) to explore the quantity and growth trend of authors; (2) to reveal the core researchers in the field of shale gas by identifying the total number of papers produced by specific authors, according to sequence (i.e., first, second or subsequent-named authors) and by discovering the top 15 authors published on a yearly basis, and (3) to disclose the characteristics of scientific collaboration in shale gas literature, based on the authors.

2. Methodology and data

2.1. Data sources

The widely-accepted Science Citation Index (SCI) database is deemed to be the most reliable bibliographic resource and has been widely applied to reveal patterns in a variety of scientific fields [28–31]. To obtain our data source, we accessed the online version of the Web of Science SCI Expanded database, as this database covers most of the important journals in the fields of natural and medical sciences [32,33]. We used the subject of “shale gas” as the research term to collect 3407 papers, all of which were published from 1990 to 2014.

2.2. Methods

The extent of collaboration cannot be easily determined using the traditional methods of survey and observation. Bibliometric methods

offer a convenient and non-reactive tool for studying research collaboration. As a valuable tool for literature analysis, bibliometrics can effectively capture the rules of discipline development. Bibliometrics also has a wide application in different knowledge domains [34,35]. Bibliometric quantification is an effective way to show the emergence and development of a new technology [32,36,37], because bibliometrics is effectively a set of methods used to quantitatively analyze scientific and technological literature [38–40]. Most historians generally recognize that bibliometrics owes its systematic development largely to Price and Garfield, as the method's founders [40–42]. The traditional bibliometric method analyzed the research trends of certain fields mainly from their publication output, subject category and journal, author, country and research institute, keyword frequencies, and other factors [43–46]. In recent years, however, bibliometric network analysis has been increasingly applied as a means to analyze the relationships between keywords, countries and research institutes, and authors. The common network analysis includes a co-word analysis [47], co-citation analysis [48,49], co-authorship analysis [50,51], and co-publication analysis [52], among others.

Collaboration network analysis is one type of social network analysis. A social network is a network of social relationships, effectively reflecting the relationships between the participants [53–55]. In large-scale research projects, a team of researchers can collaborate in areas such as data collection, data processing, and idea generation. Common modes of author collaboration include those between teacher and pupil, and between colleagues, supervisor and assistant, as well as related-field collaboration between different institutions or countries [35]. Author collaboration network and pattern analysis provides a comprehensive visual resource at the individual level. In this paper, we use the software Insight to conduct the collaboration network analysis [56].

3. Analysis results and discussion

3.1. Quantity of authors and growth trend

As indicated earlier, the shale gas-related literature published from 1990 to 2014 was obtained from the SCIE database. According to the statistical analysis results on this literature, the SCIE database contained 6915 researchers who wrote about shale gas during this time span. The number of authors in this field is an important indicator in measuring the development trend of specific scientific research.

Fig. 1 shows the trend of development in the number of newly added authors, as well as the cumulative number of authors by year.

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