Research Article

Spatial Multifractal and $b$ Value Characteristics of Mine Earthquakes under High Tectonic Stress

Hongguang Ji, Dongsheng Chen, Xiaobo Su, Zhen Fu, and Daolu Quan

1School of Civil and Resource Engineering, University of Science and Technology Beijing, Beijing 100083, China
2Beijing Key Laboratory of Urban Underground Space Engineering, University of Science and Technology Beijing, Beijing 100083, China

Correspondence should be addressed to Dongsheng Chen; beikecds@163.com

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Mining-induced earthquake is one of the common risk factors affecting the safety of mining engineering. In order to reveal the information characteristics of mine seismicity and predict the high-energy mine seismicity, based on the microseismic monitoring data of 250105 working face in Huating Coal Mine, the spatial multifractal and magnitude-frequency distribution relationship of mine seismicity activity are analyzed. It was found that under high tectonic stress, the spatial multifractal characteristics of mine seismicity are obvious, and the magnitude-frequency distribution satisfies the Gutenberg-Richter law.

There is a positive linear correlation between the fractal dimension $D_2$ and $b$ value, and the spatial distribution of mine seismicity is correlated with the magnitude-frequency distribution. In terms of $D_\infty$ and $D_2-D_\infty$, the seismic aggregation degree and fractal structure uniformity are discussed, respectively, and the parameter variation is related to rock burst events. The variations of $D_2$ and $b$ values are strongly correlated with the main earthquake. The descending gradient of $b$ value and $D_2$ is the largest in the region where the main shock occurred, and the $b$ value and $D_2$ take on lower values. The significant decrease of $b$ value and $D_2$ can be regarded as the precursor feature of the main shock.

1. Introduction

With the lack of mineral resources, mining engineering marches into the deep [1], and the seismicity caused by deep mining poses a serious threat to the safety of mine production. The cause of mine seismicity mainly includes two aspects: tectonic movement earthquakes caused by small-scale fault dislocation, and the mine seismicity caused by changes in the mechanical state of underground structures due to human underground engineering activities such as large-scale mining, etc. [2, 3]. The essence of mine seismic activity is that the dislocation and cracking of the discontinuous surface of the rock releases energy and emits sound waves, which can be detected by specific seismic monitoring instruments. As a response to the failure mode of rock mass induced by mining, the microearthquake monitoring instrument can be used to monitor the main key information of mine seismicity [4, 5], such as focal space location coordinates [2, 6], occurrence time, frequency, magnitude and distribution, etc., and record, describe, analyze, and explain the mine seismicity. The damage degree of the mine seismicity to the underground engineering structure depends mainly on the energy released by the mine seismicity and the distance of the earthquake source. For the mining-induced earthquake, most of the magnitude is less than 0, and the energy released is low, which is regarded as a microearthquake event. A small number of mine seismicity have high magnitude, large energy release, and strong destructive force to the underground supporting structure and may induce engineering disasters such as rock burst, so high-magnitude mine seismicity has become the main research object affecting mining safety.

Mine seismicity is a kind of instability and self-organizing critical phenomenon. The prediction and analysis of high-
energy mine seismicity is a very complex problem. Numerous scholars have conducted a lot of research on the spatiotemporal distribution and energy release information of mining earthquakes collected and on the induced mechanism of mining earthquakes and the prediction of high-energy mining earthquakes [7, 8]. The processing of spatiotemporal information of mine seismicity and the study of magnitude of mine seismicity have become key points. Si et al. [9] use principal component analysis and kernel density estimation method to parameterize the spatiotemporal information of mining-induced mine seismicity and realize the prediction of high-energy earthquake events. Fuzzy evaluation and probability evaluation methods are also applied to quantify and predict earthquake disasters [10, 11]. Numerical simulation methods such as RFPA have also been applied to explore the process of mine seismic fault initiation [12]. The method of fractal geometry brings new exploration to the study of mine seismicity [13–15]. Mine seismicity has obvious self-similarity, and fractal dimension \( D \) is introduced to evaluate the spatiotemporal information of mine seismicity. Many observations show that there are many similarities between mine seismicity and natural earthquakes, and the magnitude distribution obeys the power law relationship, Therefore, the magnitude-frequency relationship of the Gutenberg and Richter (G-R relation) is introduced, which ignores small earthquakes and takes logarithmic coordinates to obtain the linear relationship between frequency and magnitude. The slope \( b \) value in the G-R relation is an important parameter, which represents the relative ratio between large and small earthquakes. A large number of studies have shown that the dimension \( D \approx 2b \), the magnitude and spatial distribution of mine seismicity are self-similar. The \( b \) value has a statistically significant change in all types of earthquakes, which is related to the earthquake-induced stress state [16]. The \( b \) value change curve before an earthquake has significant precursor characteristics [17]. A rapid decrease in \( b \) value, a sharp increase in energy release, an unusually pronounced increase in pressure, and a lower dominant frequency can be judged as a signal of increased risk [18]. The aggregation phenomenon during the occurrence of strong earthquakes increases obviously, accompanied by the decrease of spatial fractal and \( b \) value [19]. The sudden decrease of \( b \) value and fractal dimension can be regarded as an indicator of damage development or a precursor of impending catastrophic failure [20].

The spatiotemporal fractal characteristics of mine seismicity contain multiple levels, and each level has different statistical characteristics, so it is of great significance to study the spatiotemporal distribution characteristics of mine seismicity by using multifractal characteristics. The multifractal characteristic \( D_q \) of mine seismicity is closely related to mine activity [15]. However, there are relatively few studies on the correlation between multifractal dimension and \( b \) value, and the relationship between multifractal dimension and \( b \) value with high-energy mine seismicity is not clear. Identifying the multifractal characteristics and \( b \) value characteristics of mine mining disturbance and mine seismic response and exploring the correlation between mining-induced high-energy seismic activity and multifractal variation and \( b \) value variation are of great significance for the identification and evaluation of spatial and temporal information of mine seismic parameters and the prediction of high-energy seismic in mines.

In this paper, the seismicity of Huating Coal Mine is continuously monitored based on the microseismic monitoring system established in the Mine. Taking the microseismic information during the impending period of rock burst event as the research object, the magnitude, frequency, and source location of mine seismicity before and after rock burst are analyzed, and the spatial multifractal and \( b \) value characteristics of seismicity sequence are analyzed. By studying the relationship between multifractal dimension \( D_q \) and \( b \) value, the correlation between spatial distribution of mine seismicity activity and magnitude frequency distribution is discussed. By calculating the value of seismicity \( b \) in each time domain, the variation law of \( b \) value with the occurrence stage of rock burst is explored, the characteristics of spatial fractal dimension of source in each stage are studied, and the relationship between spatial distribution of mine source and multifractal dimension \( D_{q0} \) and \( D_2 - D_{q0} \) is discussed, to explore the precursory information evaluation and prediction method of high release energy underground engineering disasters such as rock burst by exploring the relationship between multifractal dimension, \( b \) value and main shock with time, and evaluating the characteristics of parameters such as mine seismicity space and magnitude distribution.

2. Engineering Background and Calculation Method

2.1. Engineering Background. Huating Coal Mine is located in Gansu Province, China, and the mining area is located in the area of fold structure, with high horizontal tectonic stress and high stress concentration. Due to the influence of high tectonic stress and mining activities, the characteristics and laws of mine activities become complex. Mine seismicity is the response of rock mass failure caused by mine stress activity. As shown in Figure 1, mine seismicity under high tectonic stress shows unique complexity: mine seismicity is affected by tectonic stress and mining disturbance stress, and its formation reason is complex; mine seismicity points are nonuniformly distributed on roof, floor, and working face, its spatial position is complex, and mine seismicity occurs in tension, compression, and other complex stress states. Therefore, it is difficult to reflect the activity characteristics of mine seismicity by using traditional statistical methods, and the multifractal method can be used to describe the seismic information of Huating Coal Mine.

The 250105 working face was mainly mined in 2014, and many impact pressure events occurred in mining. On April 8, 2014, the strongest impact with a magnitude of 2.3 occurred, resulting in the damage of transport roadway [21]. Using the microearthquake monitoring system to monitor and analyze the space-time and energy information of mine seismicity before and after the occurrence of rock burst (from March 1 to May 15, 2014), more than 2200 micro-earthquake events were recorded. As shown in Figure 2,
the spatial location information of mine seismicity during this period is projected on the $x$-$y$ horizontal plane.

2.2. Calculation Method of Spatial Multifractal for Mine Seismicity. For some simple problems, a multiple fractal dimension can show its fractal characteristics. Mine seismicity activity has multiple levels, and its statistical characteristics at a finer level cannot be reflected by the fractal dimension of one parameter, so it is necessary to express it with multifractal.

The methods for calculating the spatial fractal dimension of mine seismicity include the box counting method [22] and the generalized correlation integral [15, 23]. In this paper, the generalized correlation integral method is used to calculate the multifractal dimension. It is assumed that the number of mine seismicity in the analyzed spatiotemporal domain is $N$, the spatial location coordinate of each source is $x_i (i = 1, 2, N)$, and the local density function $n_j (r)$ is defined as

$$n_j (r) = \frac{1}{N-1} \sum \theta (r - |x_j - x_k|) = \frac{1}{N-1} \sum \theta (r - r_{jk}). \quad (1)$$

In the formula, $r_{jk}$ is the Euclidean spatial distance of mine seismicity, $\theta (x)$ is Heaviside function, and there are

$$\theta (r - r_{jk}) = \begin{cases} 1 & (r - r_{jk}) \geq 0 \\ 0 & (r - r_{jk}) < 0 \end{cases}. \quad (2)$$

The generalized correlation integral function and the fractal dimension $D_q$ are expressed by equations (3) and (4):

$$C_q (r) = \left[ \frac{1}{N} \sum_{j=1}^{N} (n_j (r))^{q-1} \right]^{\frac{1}{q}} \sim r^{D_q}, \quad (3)$$
\[
D_q = \lim_{r \to 0} \lim_{r \to \infty} \frac{\ln (C_q(r))}{\ln r},
\]  
(4)

when \( q \) takes different values, \( D_q \) represents the different fractal dimensions, when \( q = 0 \), \( D_0 \) represents the capacity dimension of mine seismicity; when \( q \) takes 1, \( D_1 \) represents the information dimension of mine seismicity; when \( q \) takes 2, \( D_2 \) represents the correlation dimension of mine seismicity. The relationship between them is satisfied: \( D_0 \geq D_1 \geq D_2 \geq \cdots \geq D_{\infty} \).

2.3 Calculation Method of Magnitude and \( b \) Value. From the Gutenberg formula, the relationship between frequency and magnitude can be obtained:

\[
\lg (N(\geq M)) = a - bM.
\]  
(5)

In the formula, \( N \) is the number of events, \( M \) is magnitude, \( a \) and \( b \) are constants, \( a \) represents the activity level of seismicity in statistical space-time domain, and \( b \) represents the proportional relationship between the number of earthquakes of different magnitudes.

The transformation relationship between magnitude and energy of each earthquake detected by microseismometer is as follows:

\[
\lg E = 1.5M + A.
\]  
(6)

In the formula, \( A \) is the constant, generally taking the value 4.8 [8], \( E \) is the energy. When calculating the relationship between magnitude and frequency, the gradient of the magnitude is set to \( \Delta M = 0.1 \), and Figure 3 shows the relationship between the frequency and magnitude within the measured event segment.

3. Spatial Multifractal and \( b \) Value Characteristics of Mine Seismic

3.1 Spatial Multifractal and \( b \) Value of Mine Seismicity when Rock Burst Occurs. The earthquake time region used for calculation is from March 1 to May 15, 2014, and the spatial domain used for calculation is the 250105 working face and the area affected by rock burst. \( D_q (q \geq 2) \) is calculated by formula (4). In practical engineering calculation, \( r \) can only take finite values, so the approach in this paper is to take a series of values for \( r \) and use the double logarithm correlation \( \ln (C_q(r)) - \ln r \) to calculate \( D_q \). It can be seen from equations (2) and (3) that when the value range of \( r \) is too large, any two seismic events in the space are related, \( \theta(r - r_0) = 1, C_q(r) = 1 \), and the value is 0 when the logarithm is taken, so a reasonable \( r \) range is particularly important for the calculation of multifractals. Figure 4 shows the variation curve of \( q \) with different values from April 5 to April 8 (during the period of rock burst in mining stage). Combined with the size of the analysis area and the verification and adjustment of \( r \) value, if the value of \( r \) is too large or too small, there is no greater engineering significance due to the engineering scale and positioning accuracy, and it can be seen from Figure 4 that when the value of \( r \) is 20-200 m, the linear relationship of \( \ln (C_q(r)) - \ln r \) is obvious, the fractal characteristics of earthquake location in time-space domain are significant.

Figure 5 shows the relationship between the spatial multifractal dimension \( D_q \) and \( q \) of mine seismicity in the region when \( r = 20-200 \) m. It can be seen from Figure 5 that the range of multifractal dimension is 1.15-1.57. With the increase of \( q \), the fractal dimension \( D_q \) decreases, and the rate of change gradually decreases with the increase of \( q \), when \( q = 100 \), \( dD_q/dq = -1.3 \times 10^{-4} = 0 \). Therefore, it is advisable to take the fractal dimension as \( D_0 \) when \( q = 100 \), that is, \( D_0 = D_{100} \). The multifractal \( D_q \) varies with the value of \( q \), indicating that the spatial multifractal of mine seismicity is obvious during the occurrence of rock burst.

The magnitude of mine seismicity is calculated by formula (6). The corresponding relationship between mine seismicity frequency and magnitude is shown in Figure 6. It can be seen from formula (5) that if the magnitude distribution obeys the Gutenberg relation, the value \( b \) can be calculated through its linear relationship. Figure 6 shows the \( \lg N-M \) curve of mine seismicity activity frequency and magnitude during the occurrence of rock burst. Four mine seismicity with magnitude greater than 1.5 during the occurrence of rock burst. Among them, the highest magnitude is 2.3, and the magnitude is relatively isolated from small earthquakes, and the linear relationship of \( \lg N-M \) is not obvious for the segment: \( 1.5 \leq M \leq 2.3 \). However, when the magnitude range is \( 0.4 \leq M \leq 1.5 \), it is the frequency region of most mine seismicity, and the linear relationship of \( \lg N-M \) is obvious, which is obtained by linear fitting of G-R relation:

\[
\lg N(0.4 \leq M \leq 1.5) = 3.05 - 1.49M.
\]  
(7)

Within the time and space range of rock burst, the \( b \) value of magnitude distribution of mine seismicity is 1.49, and the correlation coefficient is 0.97. The magnitude
distribution of mine seismicity conforms to the Gutenberg relation.

3.2. The Relationship between Multifractal and b Value. The spatial distribution characteristics of source and the relationship between magnitude and frequency are particularly important in the research and prediction of mine seismicity, and they are closely related to each other. For example, when a large earthquake occurs, the spatial distribution of mine seismicity is more concentrated, which means that the fractal dimension \( D \) decreases. At the same time, the frequency of high magnitude increases, resulting in a decrease in \( b \) value. Aki and Xie [17] found that the fractal dimension \( D \) of earthquakes is proportional to the value of \( b \) (\( D_0 = \frac{3b}{c} \)), in general, the value of \( c \) is 1.5. By calculating the double fractal dimension of seismic plane projection, Hirata [24] finds that there is a negative correlation between \( D \) and \( b \) value: \( D = 2.3 - 0.73b \). In order to further analyze the relationship between multifractal dimension \( D_q \) and \( b \) of mine shock, we divide seven calculation time domains. The relationship between \( \ln N \) and magnitude \( M \) in each region is shown in Figure 6 (s3: occurrence of rock burst) and Figures 7(a)–7(f), where s1 and s2 are the time domain before the occurrence of rock burst, s4 is the adjacent period after rock burst, and s5–s7 is the time domain after rock burst for a long time. The calculated values of \( D_2 \) and \( b \) are shown in Table 1. In order to analyze the relationship between \( D_2 \) and \( b \), the first-order linear regression equation of \( D_2 \) and \( b \) is obtained by linear regression in Figure 8:

\[
D_2 = 0.26b + 1.17. \tag{8}
\]

The correlation coefficient between formula (8) and the measured data is 0.96, indicating that the positive linear correlation between \( D_2 \) and \( b \) value is significant. Mine seismicity with smaller magnitude is divided by large earthquakes. After segmentation, the spatial distribution of small earthquakes diverges, the fractal dimension decreases, and the relative frequency of small earthquakes increases, and according to the G-R relationship, \( b \) value decreases; on the contrary, fractal dimension and \( b \) value increase. It shows that the positive correlation of formula (8) between \( D_2 \) and \( b \) values is in accordance with the expectation.

3.3. Aggregation Degree of Mine Seismicity and Uniformity of Multifractal. According to the definition of \( D_q \), when the value of \( q \) increases, the influence coefficient of mine seismicity events with dense spatial aggregation increases, and when \( q \) is infinite, the influence coefficient of the maximum value of local density function \( \max (n_j(r)) \) in formulas (1) and (3) is infinitely magnified:

\[
\lim_{q \to \infty} C_q(r) = \lim_{q \to \infty} \left[ \frac{1}{N} \sum_{j=1}^{N} (n_j(r))^{q-1} \right]^{\frac{1}{q-1}} = \max (n_j(r)). \tag{9}
\]
Figure 7: lgN-M distribution curves in each computational time domain.

Table 1: $D_2$, $D_\infty$, and $b$ values in each time domain.

| Domain | s1       | s2       | s3       | s4       | s5       | s6       | s7       |
|--------|----------|----------|----------|----------|----------|----------|----------|
| Time   | Mar.1-23 | Mar.24-Apr.4 | Apr.5-8 | Apr.9-12 | Apr.13-20 | Apr.21-May.1 | May.1-15 |
| $D_2$  | 1.70     | 1.66     | 1.57     | 1.56     | 1.62     | 1.67     | 1.60     |
| $D_\infty$ | 1.31     | 1.20     | 1.15     | 1.29     | 1.14     | 1.15     | 1.23     |
| $D_2 - D_\infty$ | 0.39     | 0.46     | 0.42     | 0.27     | 0.48     | 0.52     | 0.37     |
| $b$    | 1.97     | 1.86     | 1.49     | 1.44     | 1.76     | 1.88     | 1.69     |
The value of $D_2$ is 0.26 $b$ + 1.17.

Formula (9) is substituted for formula (4),

$$D_\infty = \lim_{r \to 0} \frac{\ln \max(n_j(r))}{\ln r}. \quad (10)$$

It can be seen from equations (1) and (10) that $D_\infty$ is related to the correlation number of mine seismicity events with the largest local density function $\max(n_j(r))$, which reflects the degree of aggregation of the remaining events around this mine seismicity, and $D_\infty$ is the slope of the double logarithmic relationship $\ln \max(n_j(r))$ ~ $\ln r$ between correlation number of this earthquake point with the remaining mine seismicity and $r$. Therefore, $D_\infty$ is the correlation dimension between the mine seismicity point and other events. The growth of mine seismicity is accompanied by the rupture of rocks and the sliding of cross sections, and many small rupture waves are detected as small earthquakes. For mine seismicity, large earthquakes are accompanied by a large number of small earthquakes, and large earthquakes can be regarded as events at the maximum of local density function. Therefore, $D_\infty$ can be regarded as the correlation between the single large earthquake and other small earthquakes, indicating the aggregation degree of large earthquakes and other small earthquakes. The larger the value of $D_\infty$, the higher the aggregation of small earthquakes around the main shock, and the smaller the value of $D_\infty$, the lower the clustering degree of small earthquakes around a large earthquake.

The change of $D_q$ caused by the change of $q$ from 2 to $\infty$ reflects the change of fractal structure of mine seismicity events. Figure 9 shows the change of $D_q$ with $q$ in each time domain. Tang et al. [16] use $D_2 - D_\infty$ to express the uniform degree of multifractal of mine seismicity. The larger the value is, the higher the influence of $q$ value on multifractal dimension is, and the more inhomogeneous the fractal structure is.

As shown in Table 1 and Figure 9, the value range of $D_2 - D_\infty$ in each time domain is 0.27-0.52, indicating that the mine seismicity is a nonuniform fractal with obvious multifractal characteristics. The minimum value is taken at s4 time domain: $D_2 - D_\infty = 0.27$ and $D_\infty = 1.29$, and the value of $D_\infty$ is only lower than s1. This stage is in the time domain immediately after the occurrence of magnitude 2.3 rock burst. The results show that after the occurrence of rock burst, the fractal dimension of mine seismicity in the time domain is relatively uniform, and the clustering degree of small earthquakes around large earthquakes is high. In the time domain of s6, the maximum value of $D_2 - D_\infty = 0.52$ is taken, and $D_\infty = 1.15$, and the value is only slightly higher than that of s5. This stage is in the time domain long after the occurrence of rock burst. A mine seismicity with $M = 1.37$ occurred in s6 time domain, which is lower than that in other time domain, the main shock is not obvious, the fractal dimension of the mine seismicity is uneven, the aggregation degree of small earthquakes around the main shock is lower, and the earthquake points are more scattered.

### 3.4. Relationship between Mine Seismicity Activity, Fractal, and $b$ Value

Figure 10 shows the relationship between $b$ value and multifractal with the time of main shock occurrence calculated by us using the seismic activity induced by the Huating Coal Mine. As can be seen from Figure 10(a), the $b$ value and fractal dimension $D_q$ of magnitude 2.3 rock burst on April 8 and in a short period after the occurrence are significantly lower than those in any other period. The $b$ value in the period of rock burst is 1.49, which is 20% lower than that in the previous period. The value of $D_2$ in the occurrence period of rock burst is 1.57, which is 5.4% lower than that in the previous period. Mine activity is closely related to the spatial multifractal and $b$ value of mine seismicity. Generally speaking, the changing trend of $b$ value
and fractal dimension $D_2$ decreases before the main earthquake, approaches the trough when the rock burst occurs, reaches the lowest at the near stage after the rock burst occurs, and then rises to the highest value. Therefore, there is an obvious decreasing point of $b$ value and fractal dimension $D_2$ during the occurrence period of rock burst. The significant changes of $b$ value and $D_2$ show that there is a strong correlation between $b$ value, $D_2$, and rock burst (main shock). The main shock occurs in the area with the largest decreasing gradient of $b$ value and $D_2$. In this time domain, the ratio of the frequency of large to small earthquakes increases. The spatial distribution of sources is denser, and the possibility of potential high-energy mine seismicity is higher. The significant decrease of $b$ value and $D_2$ can be used as an important index for predicting the occurrence of main shock.

Figure 10(b) shows the time variation trend of $D_∞$ and $D_2 - D_∞$. It can be seen from the chart that the value range of $D_∞$ is 1.14-1.31. The overall variation trend of $D_∞$ is similar to but slightly different from that of $D_2$. $D_∞$ represents the aggregation degree of small earthquakes around the main source. Before the occurrence of magnitude 2.3 rock burst, $D_∞$ continued to decrease, and after the rock burst occurred, $D_∞$ began to increase and reached the maximum on April 12. $D_2 - D_∞$ reflects the uniformity of multifractal, and its change trend is opposite to that of $D_∞$. The change range is small before the rock burst occurs, but decreases significantly and reaches the minimum after the rock burst occurs, and then increases and maintains a relatively stable level. $D_∞$ and $D_2 - D_∞$ can be used as important parameters to evaluate the aggregation degree and fractal uniformity of the main shock, but as an index for predicting the main shock, the precursors are difficult to determine. In the data of this paper, the variation characteristics of $b$ value and $D_2$ are more significant.

4. Conclusions

The spatial source and magnitude distribution are important information for the evaluation of mine seismicity activities. Parameterization of mine seismicity information and prediction of mine seismicity disaster are of great significance to the safety of mining engineering. Based on the monitoring data of mine seismicity in Huating Coal Mine, the spatial multifractal of the source and the $b$ value of the magnitude distribution are studied in this paper. The main results are as follows:

1. Mining-induced earthquakes have obvious fractal characteristics, the fractal dimension $D_2$ at the time of the impact event is in the range of 1.13-1.57, which decreases with the increase of this $q$. The mine seismic magnitude distribution satisfies the Gutenberg-Richter relationship, and its $b$ value is 1.49.

2. The fractal dimension $D_2$ and the $b$ value are calculated to satisfy the positive linear correlation: $D_2 = 0.26b + 1.17$, the formula has a high correlation with the microseismic data of Huating Coal Mine, which shows that there is a strong correlation between magnitude distribution and source spatial distribution. When large earthquakes increase, $b$ value decreases and source spatial fractal dimension decreases; on the contrary, large earthquakes decrease, $b$ value increases, source spatial fractal dimension increases.

3. The aggregation degree of small earthquakes around large earthquakes is discussed by $D_∞$, the uniformity of fractal structure is discussed by $D_2 - D_∞$, and the changing trend of fractal structure with the occurrence of rock burst is analyzed, and the change characteristics of its parameters are obvious, but as an
index for the prediction of main shock, the precursory property is insufficient.

(4) There is a strong correlation between the changes of $D_2$ and $b$ values and the main shock. The main shock occurs in the area with the largest decreasing gradient of $b$ value and $D_2$, and at this time, the values of $b$ and $D_2$ are lower. The significant decrease of $b$ value and $D_2$ can be regarded as the precursory characteristics of the main shock.

Data Availability

All data included in this study are available upon request by contact with the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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