



Discussion on the Seismicity Trend of Zone in Fujian Province and Adjacent Area

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Abstract: Fujian province and its adjacent area have ever happened in the history of the land in the strong earthquake, for the local people's lives and property caused a certain degree of loss. Now in Fujian coastal area is densely populated and the economy is very developed area, if more than moderate earthquake, will cause serious influence to the local people's social life. Short-term and impending earthquake predictions at present all over the world to also do not pass, but the medium and long term earthquake prediction has certain reliability. In Fujian province and its adjacent area for more than twenty-five years there was no greater than 5 magnitude. Continue to keep this quiet period? If you can to make a more accurate prediction of medium-strong earthquakes, will have a good on the local economic value and social value. If you can to make a more accurate prediction of medium-strong earthquakes, will have a good on the local economic value and social value. To earthquake trend for the future of Fujian province and its adjacent area has a more reliable prediction. This article through to the historical earthquakes in Fujian, seismic tectonic background and have a seismoscope since records began in 1971 the region seismic activity characteristics were analyzed, and at the same time using the software was used to ride the area is greater than the 1.5 -magnitude quake data through ride temporal curves is analyzed, Think: Fujian region - Lord - before an earthquake has the characteristics of the aftershock and swarm, in recent years the strain energy accumulation for effective release and then in a low, and there is in a state of stress accumulation, in Fujian province and adjacent areas should be paid attention to land the next 1-3 years have greater than 5 magnitude earthquake in May.

Keywords: Fujian Province Area, Seismicity, Characteristic Analysis, Trend Discussion

1. Introduction

Fujian province and its adjacent area has ever happened in the history of the land in the strong earthquake [1, 2], for the local people's lives and property caused great damage. Since 1400, local Chronicles records on most of the medium-strong earthquakes in the coastal areas [3, 4]. To enter in the late 1990 s, the earthquake situation has changed, on May 31, 1997 wing on the 5.2 magnitude earthquake happened in the mainland, March 13, 2007 in 4.9 and 4.7 magnitude earthquake struck Shun Chan, March 6, 2008, ShuiKou reservoir in the small earthquakes clusters has induced the thousands times and on the basis of the 4.8 magnitude earthquake, on September 4, 2013 in Xianyou 5.0 reservoir

earthquake happened again. From the wing on the earthquake to now has 26 years in Fujian province and adjacent regions have no more than magnitude 5 earthquake, in the quiet period. Continue to keep this quiet period? If you can to make a more accurate prediction of medium-strong earthquakes, will have a good on the local economic value and social value. In Fujian province and its adjacent area earthquake trend prediction has important scientific significance and provide the basis for the local earthquake disasters. Due to short-term and impending earthquake predictions at present all over the world to also do not pass, the medium and long term earthquake prediction in exploration. This article through to the Fujian area greater than 5 historical earthquake since 1400 and have a seismoscope since records began in 1971 is greater than the 1.5 -magnitude quake data through ride software is analyzed, the main area in

Fujian province and adjacent regions.

2. Fujian Regional Seismicity Background Since 1400 M5.0 or Higher

Fujian is located in the strong earthquake active zone along the southeast coast of China, and its seismic dynamic action is mainly the result of the interaction of two forces in different directions caused by the collision between Indian Ocean plate

and Himalayan region and the collision between Philippine Sea plate and Taiwan Province island arc in western Pacific subduction zone. There are two earthquake concentration areas in Fujian, one is the northeast earthquake zone along the coastal fault zone, and the other is the southern earthquake concentration area controlled by the northwest Taichung-Jinjiang transverse tectonic zone. The first active period of this area is from 1400 to 1700, and the second active period is after 1701 [5, 6]. Its seismic activity period is similar to that of strong earthquakes along the southeast coast (Figure 1).

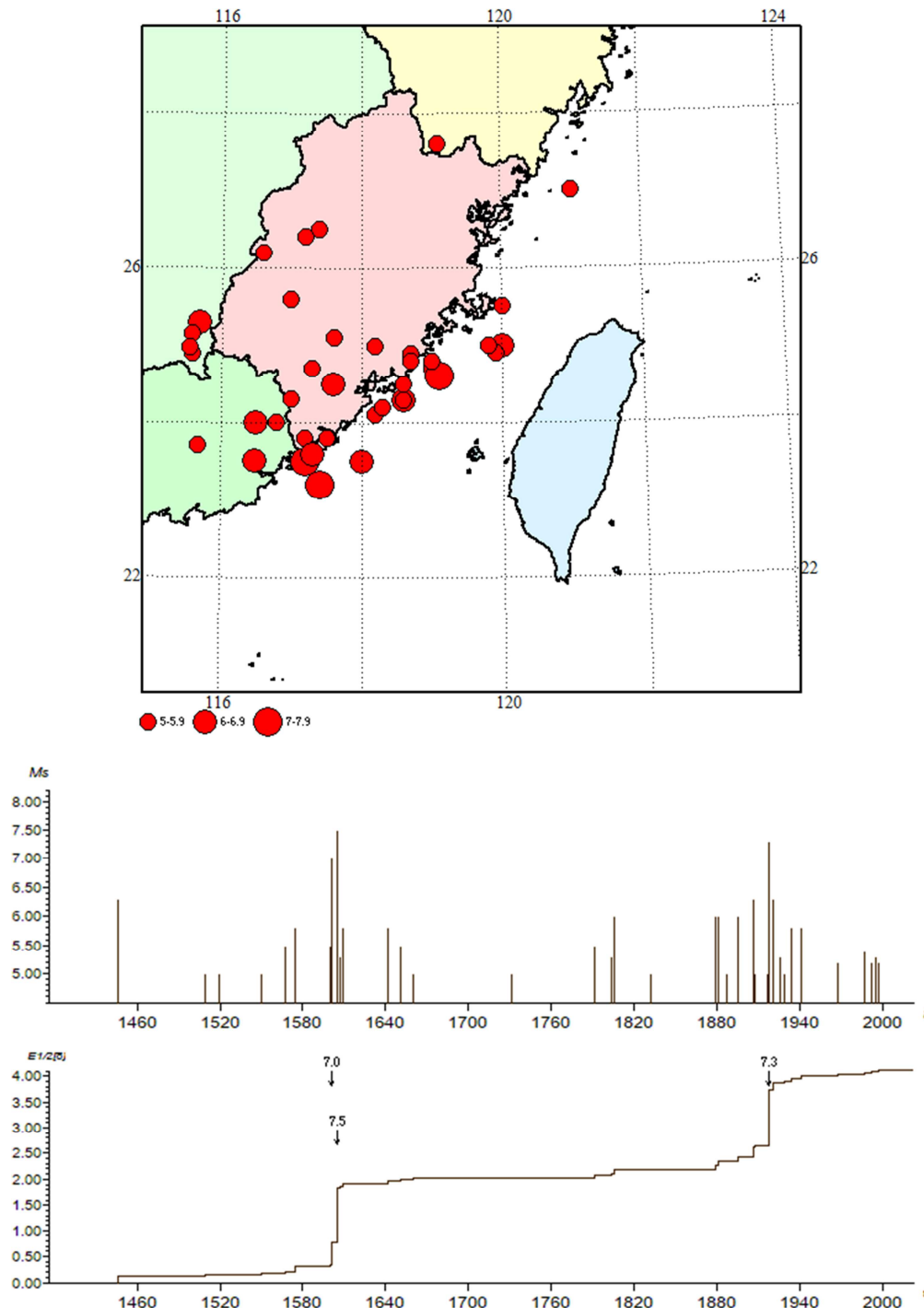


Figure 1. Epicentre distribution, M-T and creep diagram of Fujian and its adjacent areas with $M \geq 5.0$.

Since 1900, Fujian and its adjacent areas have been quiet for nearly 25 years since the earthquake with magnitude 5.2 in southwest Yong'an on May 31, 1997 (Figure 2).

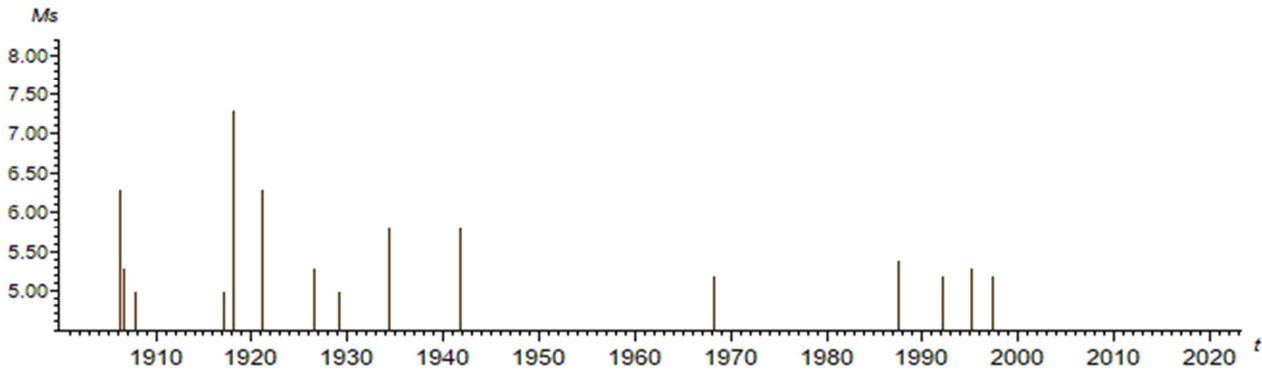


Figure 2. M-T map of earthquakes with $M \geq 5.0$ in Fujian and adjacent areas.

3. Overview of Seismic Activity in Fujian Area in the Last Half Century

According to the records of the Seismological Network of the Seismological Bureau of Fujian Province from 1971 to April 2023, there were 4165 earthquakes with $M \geq 2.0$ and 676 earthquakes with $M \geq 3.0$ and 74 earthquakes with $M \geq 4.0$ in Fujian (Table 1). The largest earthquake was the $M_{5.2}$ earthquake on May 31, 1997.

Table 1. Magnitude-frequency distribution table of earthquakes in Fujian and its adjacent areas from April 30, 1971 to April 30, 2023 ($M \geq 2.0$).

magnitude	2.0-2.9	3.0-3.9	4.0-4.9	≥ 5.0
frequency	4165	676	74	12

During this period, there were mostly small and medium-sized earthquake swarms of magnitude 2-4 on this fault zone. Since the $M_{5.1}$ earthquake occurred in the northwest of Longyan on November 26, 1992, the moderate and strong earthquakes on this fault zone became active obviously, followed by the $M_{4.8}$ earthquake swarm on May 24, 1994 and the $M_{5.2}$ earthquake swarm on May 31, 1997. It can be seen from Table 2 that 7 earthquakes with $M \geq 4.0$ occurred in this fault, all of which occurred after 1992, and the seismic activity mainly concentrated on the secondary fault zone around (25.6°N, 117.2°E) Wan'an-Shanghang Gutian in Longyan.

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Table 2. 1971-2023.4.30 Seismic activity in Fujian and its adjacent areas ($M_L \geq 4.5$).

Serial No	Earthquake occurrence time (Year-Month-Day)	Epicenter Location		Magnitude (M_L)
		Φ (°N)	Λ (°E)	
1	1974—05—17	24.4	119.7	4.5
2	1977—09—15	23.3	117.2	5
3	1980—04—07	27.42	120.73	4.7
4	1980—05—08	23.35	117.62	4.8
5	1980—07—09	23.43	118.15	4.6
6	1987—08—02	25.03	115.6	5.8
7	1987—08—03	25.03	115.6	5.3
8	1987—08—15	25.07	115.58	5.2
9	1992—02—18	25.02	119.67	5.6
10	1992—03—03	24.08	118.17	4.8
11	1992—11—26	25.48	116.95	5.1
12	1994—05—24	25.58	117.18	4.8
13	1995—02—25	24.37	118.7	5.6
14	1995—11—12	23.87	116.05	4.7
15	1997—05—31	25.58	117.18	5.6
16	1999—08—05	24.82	119.31	4.8
17	2000—05—27	23.85	118.04	4.6
18	2004—05—30	24.08	118.85	4.5
19	2006—02—09	27.68	120	4.6
20	2006—08—01	27.67	120	4.6
21	2007—03—13	26.72	117.73	5.1
22	2007—03—13	26.72	117.73	5
23	2007—08—29	25.48	117.77	4.9
24	2008—03—06	26.37	118.67	4.7
25	2008—03—06	26.37	118.67	4.8
26	2008—07—05	24.6	117.83	4.8
27	2013—08—23	25.65	118.8	4.5
28	2013—09—04	25.64	118.75	5.2
29	2013—10—30	25.6	118.8	4.7
30	2014—09—23	27.65	119.95	4.5
31	2014—10—25	27.65	120	4.6
32	2022—01—03	25.8	120.25	6.6

4. Characteristics of Earthquakes in Fujian Since 1971

Since 1971, the seismicity in Fujian has been unevenly distributed in space, and it is strong in the south and weak in the north. The seismicity in northern Fujian and northeastern Fujian, north of 26.5 degrees north latitude, is obviously less,

there are no earthquakes with $ML \geq 3.0$, and there are few earthquakes with $ML \geq 2$. However, seismicity is widespread in the area south of 26.5 degrees north latitude and coastal areas. Earthquakes with magnitude above $ML 3.0$ are mainly concentrated in Hua'an-Zhangzhou-Longyan-Yong'an area, Putian-Quanzhou overseas to Dongshan-Xiamen sea area and Gutian Shuikou reservoir area. Among them, earthquakes with magnitude of $ML 4.0$ are distributed in a grid shape according to three NE-trending seismic control zones and four NW-trending active faults. Coastal seismicity is more

developed than inland, while earthquakes with magnitude of $ML 5.0$ are distributed in Zhenghai, a NE-trending seismic control zone in Fujian Province. Hua'an-Zhangzhou-Longyan-Yong'an area is the most active area for inland earthquakes in Fujian. This area is located on the west side of the middle-south section of Zhenghe-Haifeng fault zone, and the northwest Yong'an-Jinjiang fault and Jiulongjiang fault pass through this area, with complex geological structure and frequent small earthquakes, Earthquake swarms with magnitude 3-4 are active.

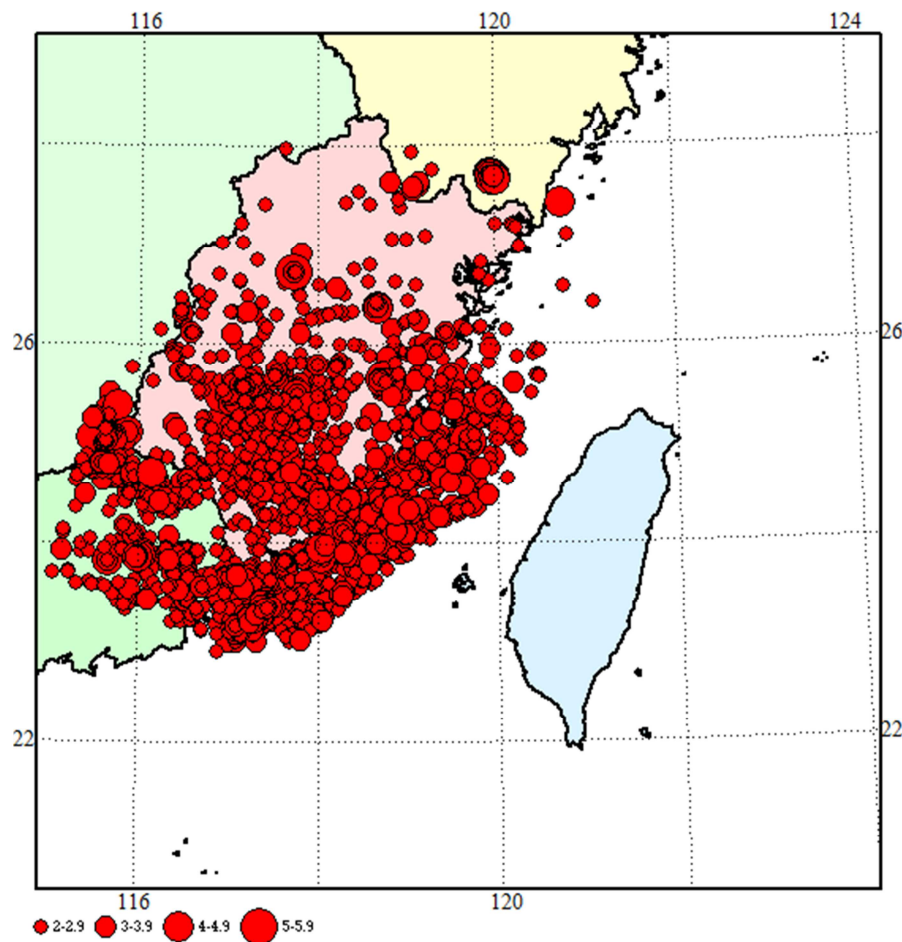


Figure 3. Distribution of earthquake epicenters in Fujian and its adjacent areas ($ML \geq 2.0$).

From Putian-Quanzhou overseas to Dongshan-Xiamen sea area, isolated small and medium earthquakes are the main activity, and moderate earthquakes with magnitude 4 or above sometimes occur. The seismic activity in Fujian coastal areas is distributed in strips along the NNE and NNE directions, which is basically consistent with the faults in the coastal fault zone. On the basis of the distribution of seismicity along the tectonic lines of large and small earthquakes in Fujian mainland, the characteristics of cluster distribution are particularly remarkable. The clustering of seismic activity in Yong'an, Liancheng and Longyan border areas is particularly prominent. Shuikou and Xianyou areas are also areas with clusters of seismic activities (Figure 3) [10-12]. In addition, according to Lin Songjian's research, the types of earthquakes

in Fujian can be divided into two regions: the eastern region (A region) and the western region (B region). The number of earthquake sequences in the two regions is similar, while the number of main aftershocks, double earthquakes and foreshocks is similar. The difference is that the isolated earthquake sequences in the A region account for the majority, but only a few in the B region. At the same time, there is no swarm earthquake sequence in Area A, but all swarm earthquakes occur in Area B. Therefore, the eastern part of Fujian (Area A) is mainly characterized by isolated or main aftershock earthquakes, while the western part (Area B) is mainly characterized by swarm or main aftershock earthquakes (Figure 4). [13-15]

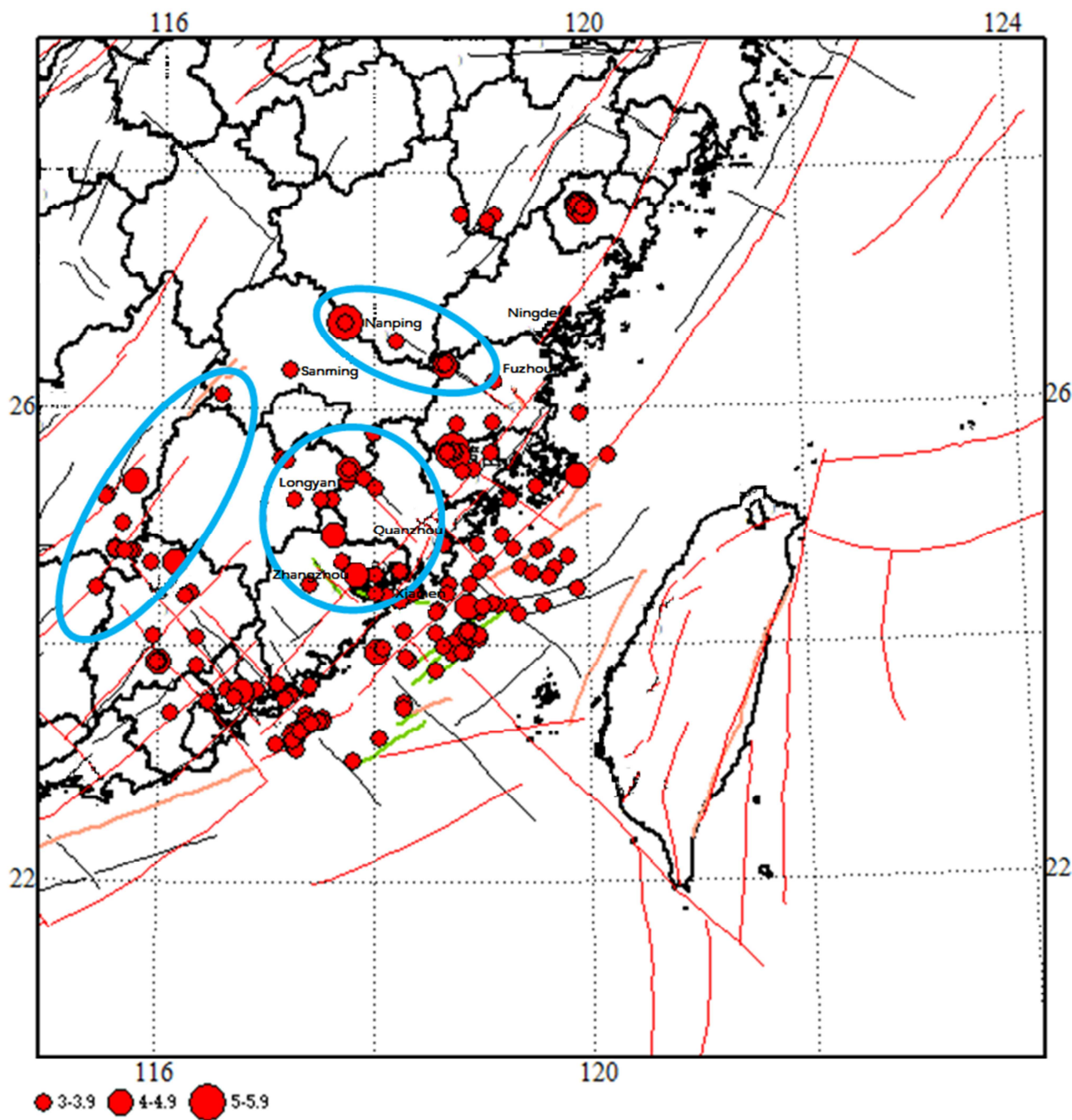


Figure 4. Distribution map of main structures and earthquake sequence types in Fujian and adjacent areas.

Since 1971, the earthquake swarm type earthquakes with $M \geq 3.0$ in Fujian are mainly distributed in the following three areas (Figure 4): Area I-Zhanghualong area (Zhangping County-Huan County-Longyan City); Area II-Fujian-Jiangxi border area; Area III-Minjiang River Basin. These three earthquake swarm earthquake-prone areas are the most frequent inland earthquakes in western Fujian District. The quietness of earthquakes with magnitude above ML4.0 in Fujian area was broken. As can be seen from Figures 5 and 6, earthquakes with magnitude above ML4.0 in Fujian area can be divided into four stages: the first stage was from 1971 to 1983, with 12 earthquakes with magnitude 4.0 to 4.9, and the largest earthquake was the ML4.8 earthquake in South

Australia sea area on September 15, 1977; The second stage was from 1988 to 2000, with 12 earthquakes of magnitude 4.0 ~ 4.9 and 4 earthquakes of magnitude 5.0 ~ 5.9, the largest of which was the overseas ML5.8 earthquake in Jinjiang on February 25, 1995. The third stage was from 2003 to 2016, with 17 earthquakes of magnitude 4.0 ~ 4.9 and one earthquake of magnitude 5.0 ~ 5.9. The largest earthquake was the ML5.0 earthquake in Xianyou, Fujian Province on September 4, 2013. After 2014, the ML4.0 in Fujian and its adjacent areas entered a quiet period. After the ML4.0 earthquake in Zhangpu, Fujian on June 18, 2016, it reached the ML4.0 in Jinjiang, Fujian on February 8, 2021. Since 1971, there have been eight calms of ML4.0 in Fujian and its

adjacent areas for more than two years, with the longest time being 5.4a years and the shortest time being 2.8a years.

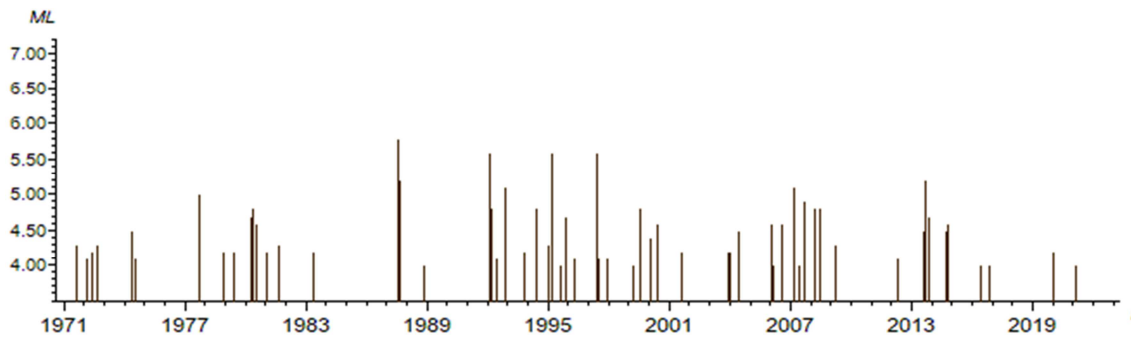


Figure 5. M-T diagram of $ML \geq 4.0$ earthquake in Fujian area.

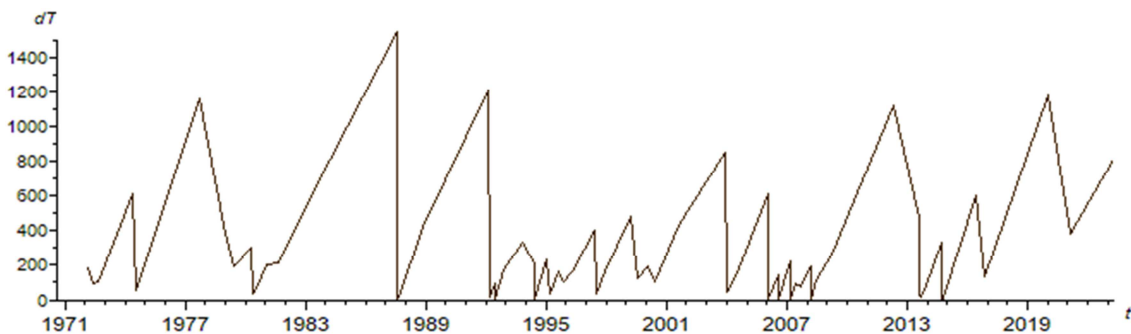
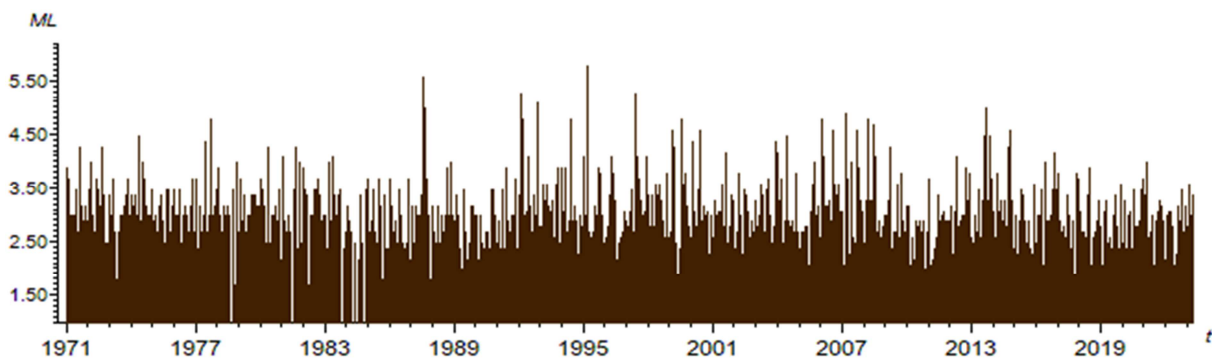


Figure 6. Time interval diagram of $ML \geq 4.0$ earthquake in Fujian area.

5. Release Model Based on G-R Relationship and Analysis of Periodic Characteristics of Seismic Activity

By calculating and fitting the G-R relationship of seismic activity with $ML \geq 1.5$ in Fujian, it can be seen that the accumulation and release of seismic strain energy in Fujian has a certain periodicity. [16] It can be seen from (Figure 7) that since 1971, the strain energy accumulation has been in a state of continuous accumulation, and by 1991, the strain energy accumulation was at the highest level since 1971. During this period, medium and small earthquakes were the main ones, and the largest earthquake occurred with the

magnitude of $ML 4.8$. Since 1992, moderate and strong earthquakes have dominated Fujian, with earthquakes of magnitude 5.3 on February 18, 1992, magnitude 5.1 on November 26, magnitude 5.8 on February 25, 1995 and magnitude 5.3 on May 31, 1997, resulting in effective release of strain energy and low strain energy accumulation. From 2001 to 2006, it was in a state of stress accumulation. In 2007, the Shunchang earthquakes of magnitude 4.9, 4.7 and 4.6 effectively released strain energy, and the strain energy accumulation was at a low value. From 2008 to 2013, strain accumulation began again [17]. On September 4, 2013, the Xianyou earthquake of magnitude 5.0 in Putian effectively released strain energy accumulation, and then it was at a low value, and it is now in a state of stress accumulation. [18]



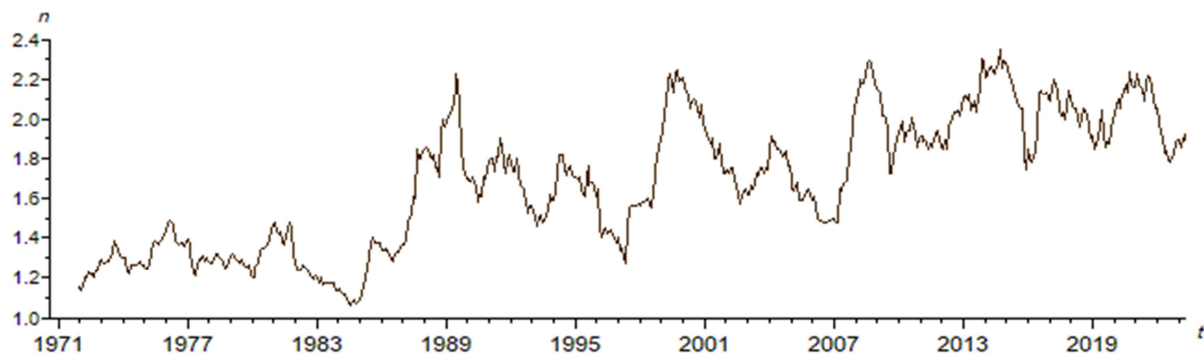


Figure 7. Strain release curve of G-R relationship of $ML \geq 1.5$ earthquakes in Fujian and its adjacent areas.

6. Conclusion

- (1) It has the characteristics of pre-main-aftershock type and earthquake swarm type in Fujian and its adjacent areas, which is of certain significance for future post-earthquake tracking and prediction.
- (2) Earthquakes in Fujian and its adjacent areas mainly occurred in the Changle-Zhaoan fault zone and the south of the NW Yong'an-Jinjiang fault zone.
- (3) The strain energy accumulation in Fujian and its adjacent areas is at a low value after being effectively released, and it is now in a state of stress accumulation. Attention should be paid to the possibility of earthquakes with $M \geq 5.0$ in Fujian and its adjacent areas in the next 1-3 years.

References

- [1] Gu Gongxu et al, Chinese earthquake catalogue [M], Peking: Science press, 1983.63-65.
- [2] Ding Xianghuang et al, the southeast of Fujian follows the sea activity to split with the earthquake [M]. Fuzhou: Science technique publisher of Fujian, 1999.164-172.
- [3] Wu Weican et al, M8.0 earthquakes of the Quanzhou of Fujian in 1604. "Chinese heavy earthquake research (a)", Peking: Science press, 1988.182-191.
- [4] Xu Shaoxie. Correlation and tectonic characteristics of great earthquake group in Quanzhou-Qiongsan at beginning of seventeenth century [J], Journal of geodesy and geodynamics, 2005, 25 (1): 1—5.
- [5] Chen Chen. Study on special distribution characteristics of seismic activity and active fault in fujian area [J]. Earthquake, 2005, 25 (3): 104-106.
- [6] Wei Bailin et al, the southeast shakes the movable characteristic along with Haiti [M]. Peking: The seismological press, 2001.115-118.
- [7] Peng Meifeng, Lin Shiming and Lin Songjian, Reservoir earthquake of Shuikou and its activity characteristic [J]. South China Journal of seismology. 1997, 17 (2): 84-88.
- [8] Ding Yuanzhang et al, The reservoir induced earthquake [M], Beijing: Seismological press, 1989.
- [9] Chen Wenming, Yang Gui and Chen Xiangxiong. The relationship between the Sep. 24, 1999 Fuzhou earthquake swarm activity and seismic structure [J]. Seismological and geomagnetic Observation and research. 2006, 27 (4): 28-32.
- [10] Hu Ping, Chen Xiancheng and Hu YULiang. Induced seismicity in Dongjiang reservoir, HuNan province [J].
- [11] Hu Yuliang, Chen Xianchen, Zhang Zhonglian et al. Induced seismicity at Hunanzhen reservoir, Zhejiang province [J]. 1986, 8 (4): 1-15.
- [12] Ding Boyang, Yao Lixun, et al. The property of reservoir earthquake in the east & the south of Zhejiang province [J]. Journal of Zhejiang Guniversity of Technology. 2005, 33 (1): 4-7.
- [13] Guo Fengying, Liu Feng, Huang Shengming, et al. Crustal deformation observation and induced earthquake of the Shuikou reservoir [J]. Crustal Deformation and Earthquake, 1999, 19 (supp): 170-174.
- [14] Liu Feng. Environmental conditions of induced earthquake and features of vertical deformation in Shuikou Reservoir region [J]. South China Journal of seismology. 1999, 19 (4): 77-81.
- [15] Xu Zhendong and Chen Chuanchang. Study of earthquake in Shuikou reservoir of Fujian province [J]. Journal of Geodesy and Geodynamics [J]. 2004, 24 (2): 58-63.
- [16] Zheng Xiaojing, Lin Yingyao and Lin Hua. Relationship between the water level and seismic activity of Shuikou reservoir [J]. Crustal Deformation and earthquake, 1999, 19 (supp): 179-181.
- [17] Xu Zhendong. The prediction of the maximum magnitude of induced earthquake in the Shuikou reservoir of Fujian province [J]. Seismological and geomagnetic Observation and research. 2004, 25 (3): 58-62.
- [18] Zhou Zhenrong, Lin Shu, Lin Shimin. Analysis for the Fuzhou swarm of earthquake (M3.8) and the seismicity in Fuzhou area [J]. Seismological Research of Northeast China. 2000, 16 (1): 28-32.

Biography

Xu Zhendong (April 1965~), male, Dehua, Fujian, graduate student, senior engineer, mainly engaged in earthquake monitoring.