Long-term Temporal Regularity of Great Earthquakes (M≥8) in North China and in West America

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Abstract

Using the temporal triplet distribution with certain periodicity to fit the real temporal distribution of great earthquakes (EQs) (M≥8) in North China and in West America respectively, we found the fitness is rather good. It is therefore possible to use the fitness as reference for the prediction of future great EQs (M≥8) in these two regions. The temporal triplet distribution refers to the temporal series consisting of the periodicity, the multiplied periodicity and the golden section of such periodicities.

Key words: North China, West America, great earthquakes (M≥8), temporal regularity.

Introduction

In history many great EQs M≥8 occurred in the north China and in West America, respectively. As the great EQs M≥8 may cause serious calamity for people, it is very important to study the methods and indexes for predicting these great EQs M≥8. In this paper, we only study the regularity on the temporal distribution of great EQs M≥8. Hereafter, we generally call the great EQs with magnitude of 8 or more the great EQs. For the sake of prediction, we use the temporal triplet distribution proposed by us (Guo, et al, 1992,1999), which consist of the periodicity, multiplied periodicity and the golden section of such periodicities, to fit the real temporal distribution of the great EQs in North China and in the West of America. Theoretically, the temporal triplet distribution can be formed when great EQs are triggered by superposition of two external factors having different period and periodic ratio as 2∶3 or 3∶5. Considering the great majority of the time intervals between the great EQs occurring in China are 25 years or multiplied 25 years (Guo, et al., 2001a, 2002), we use the temporal triplet distribution with the period of 25 years to fit the real temporal distribution in north China and in the West American, respectively. We found the fitness is quite good in both these two regions. Therefore the temporal triplet distribution may be regarded as a reference for predicting future great EQs M≥8 in north China and in West America.

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1. The spatial distribution of great EQs in North China and its vicinity

We introduce 5 great EQs during the period from the 1556 Guanzhong earthquake Ms8i/4 in Shanxi province to the 1739 Yinchuan-Pinglo earthquake Ms8 in Ningxia region. Those great EQs are listed as follows:

Date	Magnitude	Location
Jan.23, 1556	Ms8 1/4	Guan Zhong, Shanxi Province
Jul.21, 1654	Ms8	Tianshui, Gansu
Jul.25, 1668	$\mathrm{Ms8}\frac{1}{2}$	Tanchung, Shangdong
Spe.2, 1679	Ms8	Shanhe-Pingu, Hebei
Jan.3, 1739	Ms8	Yinchuan-Pinglo, Ningxia

The spatial distribution of the above-mentioned 5 great EQs is shown in Fig.1.

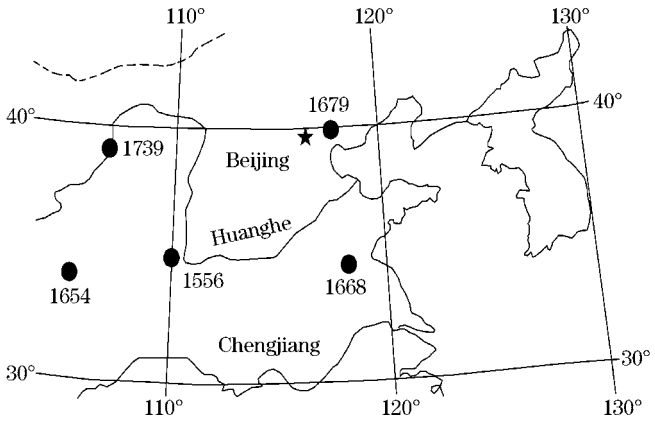

Fig.1 Spatial distribution of great EQs during period from 1556 to 1739 in North China and its west vicinity

These great EQs are approximately distributed around the north latitude circles of 35° and 40° .They coincide with the conclusion obtained by us (Guo, et al, 2001b, 2003a). The conclusion is that the great EQs M≥8 in China are almost located along latitudes of 23.5°, 30°, 35°, 40°, 45° and 50°.

2. The temporal triplet distribution of great EQs in north China and its west vicinity

We found, the great majority of time intervals between great EQs in China are 25 years or multiplied 25 years. Therefore, we use the temporal triplet distribution with the period of 25 years to fit the real temporal distribution of the 5 great EQs in history in North China and its west vicinity. In this case, the parameters of the temporal triplet distribution are as follows:

the period T=25 years, the multiplied periods nT=n×25, n=1, 2, 3,…， the long segment of golden section of each period is T_1=25×0.618=15 years; the short segment of the same is T_2=25×0.382=10 years. We found the real temporal distribution of great EQs in history in North China and its west vicinity is very near to the above-mentioned parameters of the temporal triplet distribution, namely:

1654-1556=98(=4×25-2)	1668-1654=14(=25×0.618+1)
1679-1668=11(=25×0.382+1)	1739-1637=60(=2×25+25×0.382)

From the numbers behind the plus minus sign in brackets, the error is not too big. It means, the real temporal distribution of the great EQs rather well fits with the temporal triplet distribution with the period of 25 years. Considering convenience for making figure too large, we only plot from the occurrence years of the four great EQs, 1654, 1668, 1679 and 1739, the temporal distribution is shown in Fig.2.

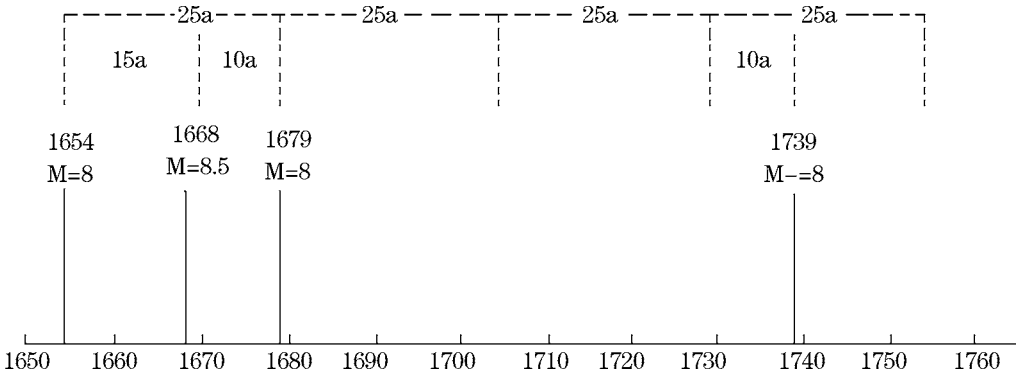

Fig.2 The temporal triplet distribution of the great EQs M≥8 in North China and its west vicinity

In Fig.2, the above dotted lines show the theoretical temporal triplet distribution, the lower vertical solid lines indicate the occurrence years of the great EQs. It is obvious, the fitness of both the theoretical and the real distribution is rather good. Rather good fitness means that the real occurrence years of the great EQs accurately or approximately coincides with some of the temporal points of the theoretical distribution. Reviewing Fig.2, from 1739 plus 15 years, the time interval satisfies one period of 25 years. Extending the end of the period for another 9×25 years, is 1979, which comparing with the 1976 Tangshan earthquake M≈8 results with an error of only 3 years, In Fig.2 if 4×25 years is calculated ahead of 1654, the 1556 Guangzhong great earthquake Ms8 1/4 in Shanxi province occurred, with a temporal error of only 2 years. After satisfying one period of 25 years from 1739, and plus 6×25 years+16 years which is near to the long segment of golden section of 25 years, the 1920 Haiyuan earthquake Ms8.5 occurred, which belong to the east-north boundary seismic belt of Tibet plateau.

There certainly are some false predictions on the temporal points determined by the temporal triplet distribution method. We do not need to consider the temporal points which have already passed, we are only interested to predicting the future temporal points on which great EQs might occur. Although the temporal triplet method can not insure that great earthquake will certainly occur on the every temporal point determined by the temporal triplet method, however, if the time approaches a temporal triplet point, the concerned hazard preventing departments should pay special attention and make necessary preparation, enhance other measures and methods to realize the prediction of such possible great EQs.

3. The temporal triplet distribution of great EQs in West America

The civilization history of American is much shorter; and accordingly there were only historical documents of three great EQs M≥8 in West America, i.e. the Jan. 9, 1857 Fort Tejon EQ Ms8.3, the March 26, 1872 Owens Valley EQ Ms8.5, and the April 18, 1906 San Francisco EQ Ms8.3. When the three great EQs occurred, long fault zones were caused by all these three great EQs, displaying their epicenter areas (Richeter, C.F, 1958). The epicentral location of the three great EQs are shown in Fig.3. We used the real temporal distribution of these three great EQs to fit the theoretical temporal triplet distribution with the periodicity of 25 years. Their fitness is also rather good as shown in Fig.4

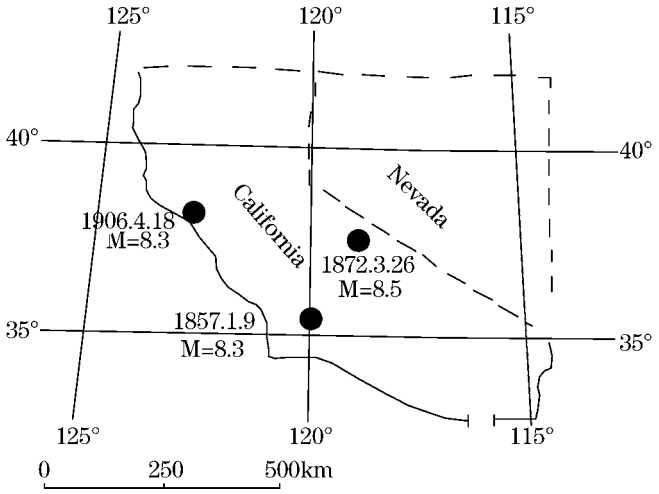

Fig.3 Three great EQs Ms≥8 in California in West America

In Fig.4, the above dotted lines indicate the theoretical distribution. The time interval from the 1857 great EQ to the 1872 great EQ is equal to 15 years, which is equal to the long segment of the golden section of the period 25 years.

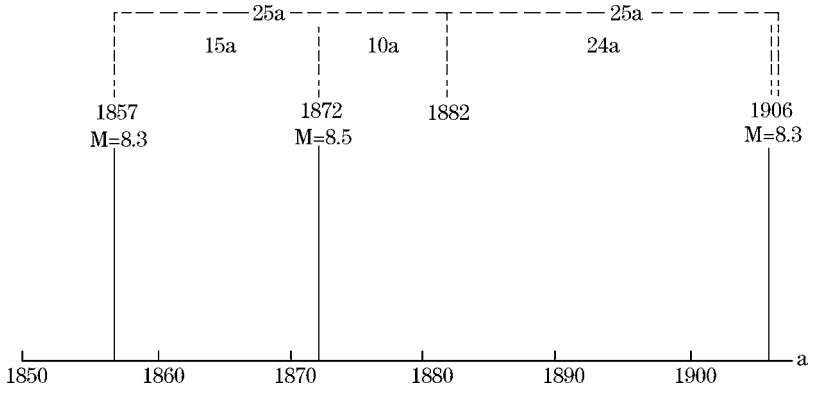

Fig.4 The temporal triplet distribution of three great EQs in California in West America

The 10 years from 1872 to 1882 equals to the short segment of the golden section of the period of 25 years, but no great EQs occurred in 1882. According to the physical mechanism of the temporal triplet distribution (Guo, et al,2003b), the real temporal distribution of the great EQs is formed by resultant triggering effect of two external factors of which the period ratio is equal to 3∶2 or 5∶3. The resultant figure of the two external factors displays a series of main periods with maximum amplitude peak values, and points of the golden section showing secondary amplitude peak values. Both the maximum and secondary amplitude peaks may trigger EQs. However, if the conditions of energy accumulation in crust are not mature for EQs to occur, no EQs will be triggered. Another following period of 25 years began since 1882. 24 years later, namely 25 years lacking only one year, the 1906 San Francisco great earthquake occurred. The above-mentioned facts means, three great EQs recorded in history in the West America rather well fit to the temporal triplet distribution with periodicity of 25 years. Therefore, we can make a preliminary prediction as follows: We do not to take into account temporal triplet points which have passed, and only need to consider the forthcoming temporal points. Accordingly, 4×25 years have passed since the occurrence of the 1906 great earthquake, indicating possible great earthquake might occur in 2006. Considering the temporal triplet distribution in Fig.4 could have an error of one year, we therefore predict, during 2005 to 2007, a great earthquake might occur again in California, in West America. As the above mentioned, this prediction can only be considered as a possibility. When the time comes, hazard-preventing departments should enhance monitoring with all available measures to achieve a more accurate and reliable prediction of possible approaching great earthquake.

4. Conclusion

We found the real temporal distribution of great EQs in North China and in West America fit rather well to the theoretical temporal triplet distribution with the periodicity of 25 years, respectively. Besides, those great EQs along the west coastline areas of Canada and along the Alaska Peninsula also fit rather well to the above-mentioned temporal triplet distribution. Furthermore, great EQs occurring in the Mediterranean-Himalayan belt also fit rather well to the temporal triplet distribution. Therefore, when one makes prediction of great EQs in North China and in West America, they may refer to the results obtained from the temporal triplet distribution in these regions.

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