第6卷 第3期 西北地震学报 Vol.6No.3
1984年9月 NORTHWESTERN SEISMOLOGICAL JOURNAL Sept., 1984

SOME SEISMICAL PRECURSORS BEFORE THE 1976 TANGSHAN EARTHQUAKE

Guo Zenggian Qin Baoyan Wang jin

(*The Seismological Institute of Lanzhou, State Seismological Bureau, Lanzhou, China*)

The Tangshan earthquake (M=7.8) of July 28, 1976 is the heaviest disaster in China this century. Many of seismologists are concerned about that whether there were some precursors before this catastrophic earthquake. For the sake of reviewing the possibity of predicting the Tangshan earthquake, a rich and varied book had been published[1]. In this paper we attempt to discuss a precursory earthquake migration and the appearance of the seismic activity zones several years before the Tangshan earthquake.

Precursory earthquake migration

Earthquake migration phenomena regarded as a precursor for predicting earthquake had been discussed by us in 1966[2, 3]. Before the Tangshan earthquake, there were three earthquake migration zones associated with this earthquake as follows.

1. Earthquake migration along the Yinshan mountains In history, there were two examples on earthquake migration from the western segment of the Yinshans to the Tangshan region, as shown by dotted line in Fig. 1. On April 6, 1976, an earthquake (M=6.2) took place in Helingeer, About

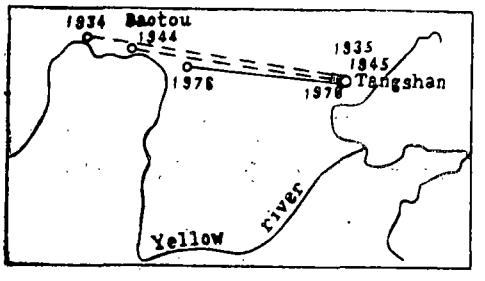

Fig. 1 Three times earthquake migration from the west to the Tangshan region.

three months later, the Tangshan earthquake occurred. This is the third migration from the west to the Tangshan region, as shown in Fig. 1 by solid line.

2. Junction towards the Tangshan region of both migrations along the Yinshan and along the Huaxia fault belt In our previous papers, a method of looking for the epicentre of a future large earthquake by junction of two earthquake migrations had been discussed in 1971*, 1980[4] and 1983[5]. The epicentral area of the Tangshan earthquake is located at the junction of the Yinshan tectonic belt with the Huaxia fault belt as shown in Fig. 2 .About three months before the Tangshan earthquake, there were two earthquakes (M=6.2, M=4.4) occurded in the Yin-shan belt and in the Huaxia belt respectively.If we make junction of extending line from the two earthquakes along the two tectonic belts, we might localize the epicentre of the Tangshan earthquake.

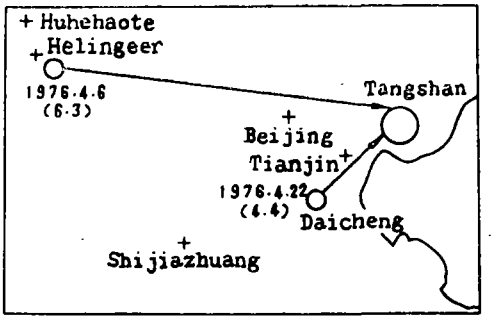

Fig. 2 Junction towards the Tangshan region of both earthquake migrations along the Yinshan belt and the Hua-xia belt before the Tangshan earthquake of 1976.

3. Earthquake migration towards Tangshan from the Liaodong peninsula

Earthquake migration from the Liaodong peninsula to the Tangshan region appeared in 1944—1945. It is interested that during 1975—1976, a similar migration repeated as shown in Fig. 3 .

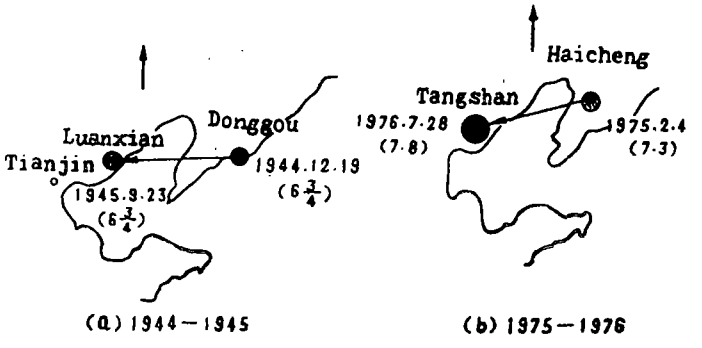

Fig. 3 Earthquake migration towards Tangshan from the Liaodong peninsula.

* 兰州地震大队，用地震资料推断近期地震危险区，地震战线，№. 8，1971.

The cause of earthquake migration had been discussed by us in previous paper (1966). The basic viewpoints are as follows.

1. The energy accumulation processes in every part of a migratory zone are similar under the action of a regional tectonic force, but the conditions for the maturation of earthquakes are somewhat different, thus occurrencs time of earthquake is in order of prioritg along the zone.

2. There are some trigger actions of an earthquake occurred in one part of a migration zone to next earthquake in the other part.

In 1971*, we further postulated that below a earthquake migration zone the substance of upper mantle is easier to flow. When an large earthquake take place in crust, it bring about motion of substance of upper mantle towards the neighbour region and trigger earthquake above the flowing substance to occur. This view is very similar to the deformation front theory proposed by Scholz in 1977.

If the starting earthquake of a migration zone is synchronized with a external factor, such as tide force, atmospheric pressure variation and magnetic storm, both the earthquake and the external factors make an influence on motion of substance of upper mantle. It is easier to form the earthquake migration.

Appearance of seimic activity zones before the Tangshan earthquake

According to reference[1], several years before the Tangshan earthquake, a seismic activity zone along the Yinshan mountain and a seismic activity zone along Huaxia fault belt appeared, as shown in Fig. 4. The former is in the direction of the east-west, the latter is in thenorth-east.

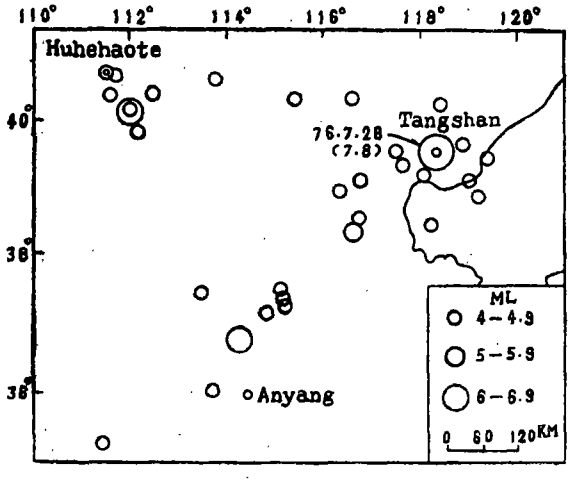

Fig. 4 Seismic activity zone appeared before the Tangshan earthquake.

A similar seismic activity pattern appeared before the 1679 earthquake (M= 8) about 200km west of Tangshan and the 1969 Bohai Bay earth-

quake(M=7.4) about 250km south-east of Tangshan, as shown in Fig. 5 ang Fig. 6.

Fig. 5 Seismic activity before the 1679 Shanhe earthquake (M= 8)

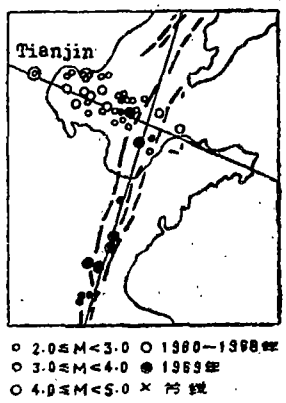

Fig. 6 Seismic activity before the Bohai earthquake of 1969.

As for the 1975 Haicheng earthquake (M=7.3) about 400km north-east of Tangshan, the preceding seismic activity pattern is different from that above mentioned. Its pattern is two roughly parallel seismic activity zones, as shown in Fig. 7.

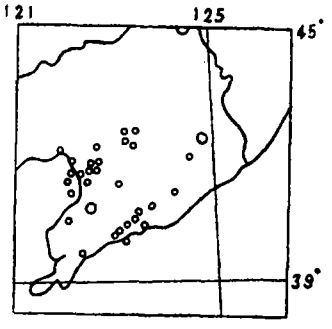

Fig. 7 seismic activity of Haicheng region during 1972.1 to 1974.2

We are interested in discussion of the relation between the seimic activity pattern and the main shock.

In Fig. 5, 6, 7, every seismic activity zone is along a tectonic fault belt. We consider, appearance of episode of a seismic activity zone along a tectonic belt means that:

1. Many of stick slip and creep slip appeared in the tectonic belt. In this case the cohesive force within the tectonic belt may decrease.

2. Due to the seismic activity, fluid confined within crust may flow out.

These effect above mentioned could play a considerable part in the earthquake occurrence on the junction of two fault belts.

For the sake of explaination, we may simplify Fig. 5, 6, as shown in Fig. 8. In the Figure, ABC and EDB indicate seismic activity zone, which coincide with fault belt, dotted line denote a large earthquake source region.

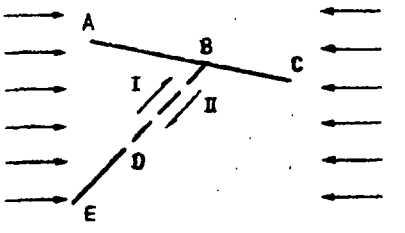

Fig. 8

When a seismic activity episode appeared along a whole fault belt, the decrease of cohesive force may be favorable to motion of fault block Ⅱ, thereby favorable to earthquake occurrence. In the other hand, if some fluid flow out of the fault belt, it is favorable to motion of fault block Ⅰ, thereby favorable to earthquake occurrence. If fluid flow out only in segment AB. it is also favorable to motion of fault block Ⅰ. When a seismic activity episode appeared along ED, the final synthetic result is concentration of stress on the point D. It is favorable to earthquake occurrence.

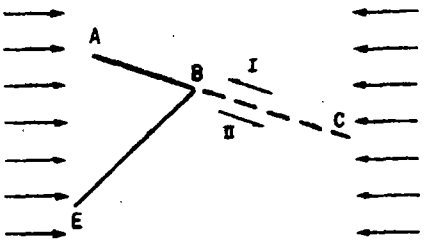

Fig. 9

In Fig. 9, the potential large earthquake source region is located in the other segment.

Based on a similar reason, when a seismic activity episode appeared along AB and BE, it is favorable to earthquake occurrence.

According to the above mentioned, we concluded that the juncton of two seismic activity zone in the same period is a precursor of large earthquake.

But the appearance of seismic activity zone before the Haicheng earthquake is different from the Tangshan earthquake. Its pattern is shown in Fig. 7. With the aim of discussing the relation between the seismic activity zones and the main shock, we simplify Fig 7 as shown in Fig. 10. Based

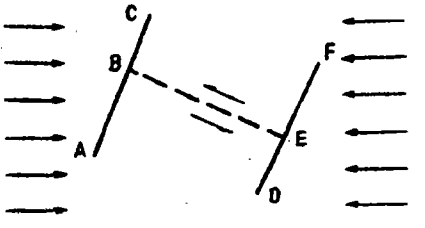

Fig. 10

on the above mentioned, it is not difficult to understand why seismic activity episode appeared along ABC and DEF before the 1975 Haicheng earthquake (M=7.3).

Discussion

1.We may classify precursors into two sorts.The first is "the active precursor".This kind of precursor may influence on earthquake occurrence. The second is"the passive precursor" .It is a result of the processes of source. The seismic activities appeared along the Yinshan mountain and the Huaxia fault belt belong to the active precursor.

2.Earthquake migrations are very obvious.they belong to the active precursor, too.We should pay a special attention to these phenomena.

3.The surface fault formed by Tangshan earthquake is too short, only to be 8 km.While according to our formula between the length of earthquake source and magnitude, the Tangshan earthquake having magnitude of 7.8 should has 140 km in lengh.However the length of aftershock zone of the Tangshan is the same as that determined by our formula

$$M=3.3+2.1\log L\ (km)$$

4.In the mainland of China, earthquakes almost take place in upper crust, the granitic layer.Appearance of seismicity zone which elongate very much can be classified causally into two kinds.The first is directly caused by a long active fault belt, which may be visible on the ground, the second is caused by the influence of potential active faults in the basaltic layer and the upper mantle on the granitic layer. The mechanical characteristic of the basalt layer and the upper mantle is ductile and that of granite is brittle.On the basis of the plasticity theory and experiment, we consider, in basaltic layer and upper mantle, there are a number of straight and long faults. When these faults creep, they have an influence on the granitic layer and trgger a lot of earthquake, which distribute along a long line, and possibily pass across various tectonic units.

When one or more seismicity zone have appeared, there will be large earthquake to occur in the zone or in the junction area of two seismicity zones.

REFERENCES

〔1〕梅世蓉，一九七六年唐山地震，地震出版社，1982.

〔2〕Kuo Tseng-chien and Chen Bao-Yan, The Migration of earthquake in Kansu Province, Ke Xue Tong Bao, Vol.17, №8, 1966.

〔3〕郭增建、秦保燕，甘肃省的震中迁移现象,地球物理学报，Vol.15,№2，1966.

〔4〕郭增建、秦保燕，1927年古浪8级大地震，一九二〇年海原大地震，地震出版社，1980
〔5〕郭增建、秦保燕，地震迁移问题，国际地震动态，№1，1983。

唐山地震前的某些地震前兆

郭增建　秦保燕　汪　进
（国家地震局兰州地震研究所）

本文论述了唐山地震前的某些地震前兆现象，并对它们产生的原因进行了讨论。论述的第一种地震前兆现象是唐山地震前的震中迁移。在震前共显示了三条迁移路线，即从阴山西段向唐山的迁移，从辽东向唐山的迁移和沿华夏系构造向唐山的迁移。其迁移路线的交汇区在唐山地区。第二种是唐山大震前沿阴山构造带和华夏系构造带中小地震的成带活动，这两个中小地震活动带的交汇区在唐山地区。

文中对震中迁移的原因和大震前中小地震成带状分布的原因以及带状分布的交汇区易于发生大震的原因进行了讨论。文中指出，中小地震的成带活动意味着这些带内地壳中一些地段上断层盘间的粘结力减弱或有流体逸出地表，这对交汇区震源的发震将有促进作用。例如在震源断层盘欲前进的方向上，地壳内如有流体逸出，则有利于断层盘向流体逸出地区前进，从而促使地震发生，在震源断层欲离开的部位上，如岩石粘结力减弱，也有利于断层错动而发震。据此我们把地震前兆分为主动前兆和被动前兆两类，主动前兆是它对震源发震有影响的前兆；被动前兆则仅是震源各组成部分运动的一种后果表现。

文中对中国大陆于某些大震前出现的很长的地震成带活动进行了成因分类，一类是地表可见的大断裂带引起的中小地震活动；另一类是玄武岩层和上地幔中大断裂蠕滑对上部花岗岩层中地震的触发。由于玄武岩层和上地幔物质的力学性质近于塑性且相对均匀，所以其内的大断裂较长较直，这可能就是中国大陆内某些地震沿直线分布很长、其间可跨越不同的地质构造单元的原因。