第5卷 第3期 西北地震学报 Vol.5, No.3
1983年9月 NORTHWESTERN SEISMOLOGICAL JOURNAL Sept., 1983

MEETING OF A PROPAGATING SHEAR FRACTURE WITH A STATIC FAULT

传播的剪切破裂与另一静态断层的交遇

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摘 要

本文讨论了地震发生时传播的剪切断层遇到横交的粘锁不好的静止断层时的各种情况。文中指出，传播的剪切断层端部有压应力和张应力，静止断层对压应力和张应力的反应是不同的。压应力可以通过静止断层而传入该断层的另一侧介质中（尽管有衰减），但张应力就可能把静止断层拉裂而传不到静止断层的另一侧介质中去。这样，当一个传播的剪切断层在未和静止断层相遇时，它的端部有很高的剪切应力，但越过静止断层后只剩下（或主要剩下）压力所引起的剪切应力了。此时剪切应力大大衰减，因之剪切断层的传播就停止了。当然在断层交会地区介质破碎松软，这也是断裂停止的一个原因。震前确定停止地点有助于确定孕震体的长度，由此可对未来震级大小作出估计。

In the study of physics of earthquake source, the meeting of a propagating shear fracture with a static fault is an important problem. It is related to stopping of propagation of fracture, anomalous seismic intensity and so on. This paper briefly discusses the problem.

1. Types of meeting of propagating shear fracture with static fault

According to property and spacial distribution of faults, the meetings of propagating fracture with static fault are classed into following types.

(1) The meeting of a propagating shear fracture along a stuck fault with a static fault which is not locked, as shown in Fig 1.

(2) The meeting of a propagating shear fracture in intact medium with a static fault, as shown in Fig 2. In the Fig, the static fault is not locked.

2. Stopping mechanism of a propagating shear fracture

The stopping mechanisms are various. Among them, it is possible that the propagating fault would stop when it meets the static fault. When a shear fracture is propagating, there are a pressure region and a tensile

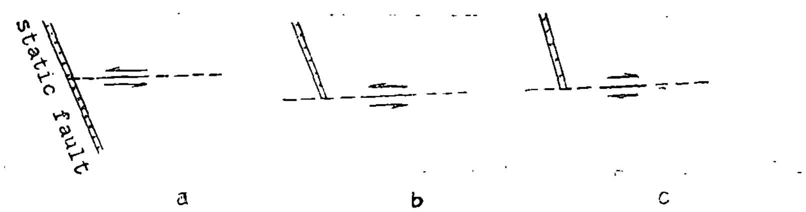

Fig. 1 Types of meeting of propagating shear fracture along stuck fault with static fault.

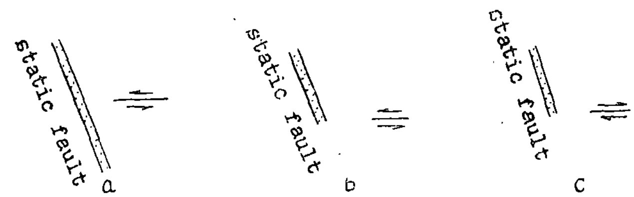

Fig. 2 Types of meeting of propagating shear fracture in intact medium with static fault.

region in the vicinity of the tip of fracture as shown in Fig3a, where P denotes pressure region, T tensile region. When the propagating shear fracture meets a static fault, the pressure stress passes through static fault, although the pressure stress has some decay, and the tensile stress can hardly pass through the static fault because it should make the fault open, as shown in Fig 3 b. In final, a pressure stress is only applied to the medium Ⅱ. Then the shear stress is much decaied. This decaying leads to the stopping of propagation of shear fracture. It should be pointed out that in Fig 1b, the pressure stress directs to the static fault, it can not make the propagating shear fracture stop. However, in Fig 1 .c, the tensile stress directs to the static fault, since the tensile stress can hardly pass through the static fault, only pressure stress is exerted apply on Ⅱ side in Fig 4 . The shear stress produced by pressure stress in Ⅱ side of Fig. 4 is much smaller than that produced by a dislocation in I side of Fig. 4.

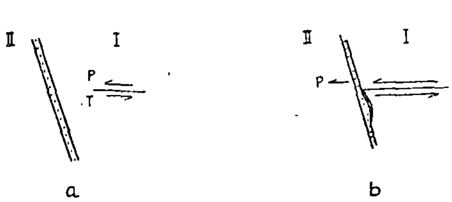

Fig. 3 Difference between the pressure and tensile transmissons.

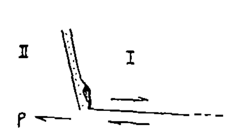

Fig. 4 Pressure stress transmission and tensile stress decay

Therefore, when the propagating shear fracture meets the static fault, the propagating shear fracture would stop. If S denotes the shear stress produced by dislocation in Ⅰ side, then the shear stress produced by pressure in Ⅱ side is

$$S' = \frac{s}{2} - f(h) \qquad (1)$$

where h is thickness of static fault. f(h) denots attenuation of pressure stress in h.

3. Estimating the seismic intensity based on meeting of a propagating shear fracture with a static fault

If a static fault is wide and the materials filled in fault zone are weak and soft, an image force appears which acts on the propagating shear fault. Then the inertia force of of the fault block increases and releases more seismic wave energy. This effect will increase the seismic intensity in the junction region of propagating fracture with a static fault. It is necessary to study this problem further.

4. Discussion

In our country, there were many examples on the jounction of propagating shear fracture with static fault.

(1) The 1975 Haicheng (海城) earthquake (M=7.3).

This earthquake showed that a propagating shear fracture, the earthquake source fracture, met Lower Liao He(下辽河) fault zone[1] and stoped, as shown in Fig. 5.

(2) The 1920 Haiyuan (海原) earthquake (M=8.5)

The seismic fracture zone of the Haiyuan earthquake stoped in that place where it met a static fault which has a north-south strike in the Guyuan region (固原)[2] as shown in Fig. 6.

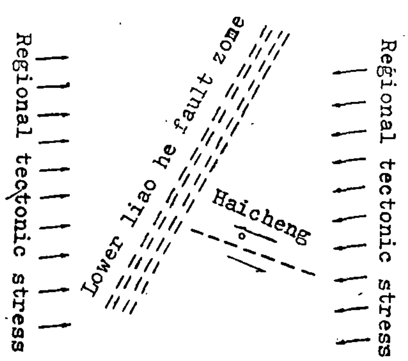

Fig.5 Meeting of source fracture of the 1975 Haicheng earthquake with Lower-Liao-he fault zone.

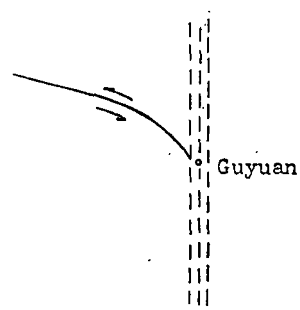

Fig. 6 Seismic fracture stoped in Guyuan region where the seismic fracture met a static fault.

(3) The 1668 Tancheng (郯城) earthquake (M=8.5)

For this earthquake, the mezoseismal zone and tectonic background are shown in Fig 7.[8]

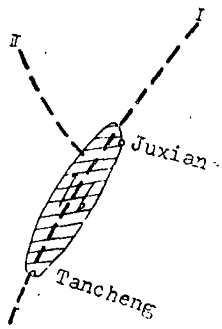

Fig. 7 seismic fracture starting from Tancheng region and pass through branch fault.

The 1668 Tancheng earthquake is a historical one, we have not enough data to discuss its propagation in detail, but we infer that the mechanism of the 1668 earthquake is similar to Fig 1.b.The initial breacking point is located in Tancheng region, pressure stress of dislocation directs to branch fault Ⅱ, therefore the branch does not resist the propagation of dislocation.

It should be pointed out that the stopping due to junction of faults is useful to predicting earthquake magnitude, because the length of propagating shear fracture is responsible for the magnitude of earthquake[4, 5].

$$M_S = 3.3 + 2.1\log L\ (Km) \qquad (2)$$

Where L is the length of propagation fracture, which is equivalent to the length of accumulating element in the combination model of earthquake preparation.If we can determine the length by geophysical and geological data before earthquake occurrence, we may predict magnitude and location of earthquake.

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