Seismotectonics and Seismogeological Disaster in Sichuan Province, China

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1 Introduction

An earthquake (Ms=7.0) occurred on April 20th, 2013 in Lushan County of Ya’an City, Sichuan Province, China. The epicenter is (N30.3º, E103.0º), and the focal depth is 13km. The epicentral intensity is XI degree in Chinese seismic intensity scale. The quake caused 196 deaths, 21 persons missing, 11,470 injuries, and 383,000 people were affected. Hardest hit areas included Lushan County, Baoxing county and Tianquan county.

The earthquake occurred in Sichuan Ya’an, which is one of the rainiest areas in China. The region is bounded by Longmenshan fault zone. In the west is a serious EW thrusts in Songpan-Ganzi fold belt, which were formed in the mid-late Triassic. In the east is the open and wide gentle synclinal basins, forni, minor anticlines which were formed during Yanshannia movement. Longmenshan Fault zone in the east boundary of Tibetan Plateau is formed during Himalayan movement. The Lushan earthquake which occurred on 20th April 2013 nearly 5 years after the Wuchuan earthquake, is thought by some Chinese seismologists as a big after shock of Wenchuan earthquake.

2 The characteristics of geo-disaster of Lushan earthquake

2.1 earthquake surface rupture

The focal mechanic solution indicates that the source fault of Lushan earthquake is a low angle thrust fault with dip angle 35°. The profile of aftershocks demonstrates that this fault did not rupture to the surface during Lushan earthquake. The surface deformation we investigated is coordinate with the focal mechanism of this quake.

No earthquake fault was found on the surface after Lushan earthquake. Only some earthquake fissures with the length around 100m scatter along the Daxi-Suanquan fault which is a branch of the south segment of Longmenshan fault zone. For example, in South of Jingkou Village and Shuangshi township, the road was offset about 10–20cm.(Photo1). In the same place the bended cement board of the road’s shoulder indicates the crust shortening of the upper wall of the seismogenic fault even though it did not rupture to the surface. These crust shortening deformation phenomenon, in the forms of small offset, tiny thrust faults and curved road, were found in a profile of 1 km section in this site with the total shortening amount over 20cm. This data might be a small part of the crust shortening, the bigger rest might not be observed in the field.

In Shuangshi township a 10-20cm offset of the road and a lot of fissures on the yard were found. These fissures are consistent with the direction and location with the existing fault even though it was not the seismogenic fault of the Lushan earthquake. The crust shortening deformation seems concentrated along the weak fault and broke some segment.

2.2 earthquake collapse

Lushan earthquake occurred in the mountain area of the eastern margin of Tibetan Plateau. A large number of rockfall was induced by the quake, mainly in the area of intensity degree IX and VIII. The formation of earthquake rockfall was controlled by the magnitude of ground motion and structure of rocks. The distribution of the rockfalls formed in this quake is in two dominant directions. One direction is along the long axis of intensity zone of IX and VIII and parallel to Longmenshan fault zone. Another...
direction is along the big river, where the heavy rockfall area concentrated along the steep slope located in the hard rock and deep valley, especially the very deep artificial cut slope along the highway.

2.3 Earthquake Landslide
Apparently, the disaster of landslides is not as heavy as that of rockfalls. We investigated two big landslides in the quaked area. First one is in the Caojiacun of Baoxin County, which has basic features of typical landslide with the sliding area of 5000m$^2$ and volume of 20000m$^3$, which formed during the earthquake with a slide distance of 50m. It is not stable after the quake, further siding might occur in future. Another one is in Boxing County City which was a re-slide of an old landslide. Most of the landslides induced by Lushan earthquake is of Quaternary loose debris. There was a big number of potential landslides induced by the earthquake.

2.4 Sand Liquefaction and sandblasting
We observed the sand liquefaction and blasting in Shaungshi Township. The diameter of the cones is 20~50cm and that of sandblasting mouths is around 5cm. The sandblasting reached to 40cm high. The fine and silt were blasted. The cones distribute closely along the fissures. They formed on the low terrace of a stream. The fissures with sandblasting distribute in line with the direction parallel to the regional fault.

3 The seismotectonics of Lushan Ms 7.0 Earthquake
In the epicenter of the Lushan (Ms7.0) earthquake there are several imbricate active reverse faults lying from northwest to southeast, namely the Gengda-Longdong, Yanjing-Wulong, Shuangshi-Dachuan and Dayi faults. No apparent earthquake surface rupture zones were located along these active faults or their adjacent areas. The Lushan earthquake is classified as a typical blind reverse-fault earthquake, and it is advised that the relevant departments should pay great attention to other historically un-ruptured segments along the Longmenshan thrust belt and throughout its adjacent areas.

4. Conclusion and discussion
Lushan Ms7.0 earthquake is a slip of the southern segment of Longmashan fault zone. The slipping is a low angle thrusting. The rupture did not reach to the surface. No continuous earthquake fault was found. There are intermittent surface deformations indicating the crust shortening and tiny rupture of secondary faults. These deformation and ruptures might cause the rocks to be fractured and unstable, which enlarge the possibility of the geo-disaster as landslide and rockfall.

The landslides, rockfalls and earthquake fissures, as well as the sand liquefaction and blasting were found in the intensity area of VIII and IX. Besides the coseismic landslides and rockfalls, shock and deformation made the rock loose and unstable. The geo-disaster acts as the main threat to the quacked area after the shock.

Lushan earthquake occurred in the rainy mountain area. The secondary geo-disaster enlarged the magnitude and duration of the disaster. We should pay more attention to this and similar phenomenon.