Deep Structure Beneath the Southwestern Section of the Longmenshan Faults and Lushan Ms7.0 Earthquake on 20 April 2013

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The Wenchuan Mw 7.9 earthquake on 12 May 2008 occurred at the central section of the Longmen Shan faults zone, locates at eastern margin of the Tibetan plateau. Almost five years later, a magnitude Ms 7.0 earthquake happened at the southwestern section of this faults zone. The focal depth of the Wenchuan event is 14-19km, with the main rupture on the Beichuan fault near Yingxiu, which propagated to the Pengguan fault. The maximum vertical and horizontal co-seismic displacements reached 6.5m and 4.9m [1,2], and surface rupture belts are 240-300km and 90km along the Beichuan and Pengguan faults [3-5], respectively. Neither rupture nor aftershocks of the 2008 Wenchuan main shock left any trace south to its epicenter - the southwestern segment of the Longmen Shan fault zone. However, the Lushan quake of 2013 just took place at this gap.

Magnetotelluric (MT) observations have been carried out on two profiles (L1 and L4) across the central and southwestern section of the Longmen Shan fault belt from 2009 to 2011 after 2008 Wenchuan Mw 7.9 earthquake. The former profile (L1) crossed the central section and Wenchuan epicenter and the later one (L4) crossed the southwestern section and 2013 Lushan Ms7.0 earthquake epicenter (Fig.1). The advanced techniques are used in data processing and interpretation including phase tensor and two-dimensional inversion methods [9-11] in order to obtain the acceptable 2-D electric structure.

From two image profiles of deep electric structure (Fig.2), this work achieved the following geological results. High-conductivity layers (HCL) are observed in the middle and lower crust of the Songpan-Ganzi massif west of the central and southwestern section of the Longmen Shan fault zone, which are present at depth ~20km west off the central section, and 10-odd depth west of the southwestern section, respectively. High resistivity bodies (HRB) exist from the near surface down to upper mantle beneath both central and southwestern sections of Longmen Shan. The HRB extends westward horizontally to 25km at the central section, and southeastward at depth to merge with the high-resistivity basement of the Sichuan Basin. Nearby the source of the 2008 Wenchuan event, there is a local area of decreasing resistivity. While in the high-resistivity southwestern section of the Longmen Shan fault zone, no HCL is found to connect the HCL in the crust to the west, and local low-resistivity is also not detected there. Note that this is the measurement result at four years before the 2013 Lushan earthquake, and the current data do not allow us to expect whether decreased resistivity could appear around the source of the Lushan event after its occurrence. From MT observations, the two earthquakes occurred definitely at different places. The source of Wenchuan event is located nearby the core of a high-resistivity body, with seismogenic structure as the central fault (Beichuan fault); while the Lushan shock’s source lies between a high-resistivity body and a relatively low-resistivity zone in the east.

In combination with geological and other geophysical data, the HCL in the crust of the Songpan-Ganzi massive is interpreted to be a easy to deform or flow layer, also called “channel flow”[12-21]. The HCL is easy to generate shear and inflation, thus leading to detachment between upper and lower crust or crustal thickening. The deformation of the HCL is one of the possible reasons for steep topography between the Longmen Shan range and Sichuan Basin[12]. The southwestward motion of the Songpan-Ganzi massive with HCL is blocked by the rigid NE-trending Longemn Shan range with high resistivity and the Sichuan Basin in the southeast, forming a “T”-shaped pattern. Before the earthquakes, the Longmen Shan fault zone appeared as a stable structure, with a very small displacement rate [22,23], and long-term seismic quiescence [24,25]. When the accumulated stress in the
fault reached its limit of rock fracture, great earthquakes were generated suddenly.

The common mechanism for the Lushan and Wenchuan earthquakes is the interaction between the Songpan-Ganzi massive and Longmen Shan fault zone. And the difference in their generation processes is associated with different tectonic settings and deep structures of their sources, as well as the variable interactions between fault sections and the massive in the northwest. For these two events, different source locations and physical properties of the media around the sources can account for their varied surface expressions.

Key Words: Longmenshan fault belt, Lushan earthquake, deep structure, crustal high conductivity layer, development environment of the earthquake

References
[2] Pei-zhen Zhang, Xue-ze Wen, Jiu-hui Chen. Oblique high-


Fig.2 Two-dimensional electric structure along MT profile L1 (upper) and L4 (lower) HCL-high conductivity layer, HRB-high resistivity body.
Notations of faults are same as Fig.1


