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Preface to the special issue on Lushan earthquake

Sidao Ni · Heping Sun · Xiaofei Chen · Zhonghuai Xu

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On April 20th, 2013, a strong earthquake (M_s7, China Earthquake Network Center) struck Lushan county of Sichuan province and the quake (hereafter referred to as Lushan earthquake) caused substantial loss of life and damage to infrastructure. Just as the 2008 M_s8 Wenchuan earthquake, the Lushan earthquake also occurred on the Longmenshan fault system. After the Lushan earthquake, preliminary studies of the Lushan earthquake and its possible link to the Wenchuan earthquake have been published in special issues rapidly organized in a few journals such as Seismological Research Letters, Chinese Journal of Geophysics and Science in China. Those studies have investigated many aspects of the Lushan earthquake and suggested possible link between the two earthquakes (for example, Zeng X et al. 2013; Han et al. 2013; Xie et al. 2013; Zheng et al. 2013; Shan et al. 2013; Li et al. 2013), but there are many problems of the Lushan earthquake itself which need to be studied in more details. Therefore, a special issue is organized in *Earthquake Science* to report further progress of the Lushan earthquake studies which involve both coseismic and postseismic processes as well as tentative efforts of earthquake prediction.

S. Ni (✉) · H. Sun
State Key Laboratory of Geodesy and Earth's Dynamics, Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan 430077, China
e-mail: sdni@whigg.ac.cn

X. Chen
School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China

Z. Xu
Institute of Geophysics, China Earthquake Administration, Beijing 100081, China

For a strong event such as the Lushan earthquake, waveforms on broadband seismomters in the near field are usually offscale and geodesy approaches become essential for recording the accurate ground displacement and velocity. With GPS data, Du et al. find that static displacement of a few mm is resolvable for sites hundreds of km away and is up to a couple of cm for near stations. They also find that ground velocity is up to a few cm/s for near stations. Anomalously strong ground motion is found for two stations in Sichuan basin, which could be due to the amplification of basin structure or shallow site effects.

Among the published source parameters of the Lushan earthquake, there are controversies regarding its centroid depth and moment magnitude. Chen et al. investigate factors that may influence inversion of centroid depth, and they find that source duration time and filter band have substantial effects. Exploiting the advantage of low-frequency normal modes of free oscillation in resolving seismic moment, Hu and Jiang presented studies of the Lushan earthquake moment magnitude with data recorded on the superconducting gravimeter.

As for properties of the rupturing fault, two papers present interesting results via modeling f_{max} and early aftershock seismicity. Wen and Chen proposed that f_{max} is real and not due to site effects after studying spectra of strong motion records on many stations. With f_{max} resolved, they inferred that the fault cohesive zone is about 240 m wide. Rate and state friction law describes mechanical behavior of fault plane motions, and has been broadly adopted in rupture dynamics. Via modeling early aftershock rate, Jia et al. confirm the existence of early aftershock deficiency and suggest that mainshock process is different from aftershocks processes.

After the coseismic kinetic slip model of the Lushan earthquake is resolved from waveform inversion; ground motion, ground displacement, and gravity response can be computed. Zhu et al. simulate strong motion with realistic topography and find that topography has substantial effects on ground motion. Dai et al. also find that topography is essential for explaining the very strong ground motion at station 51BXD. Wang et al. compute both coseismic and postseismic ground displacement and gravity changes due to the Lushan earthquake, and they find that the Lushan earthquake may influence the adjacent region in 10 years.

After the mainshock, dense portable seismic network was installed rapid and has recorded abundant aftershocks. These valuable dataset has led to a detailed study of crustal structure and stress field in the source region of the Lushan earthquake. Tian et al. performed joint inversion of earthquake location and seismic velocity structure, and they find a substantial high-velocity anomaly in the epicentral region which could be related to earthquake asperity. Liu et al. find that polarization vectors at most stations are consistent with regional stress field, and there are variation in time delays which could be due to stress relaxation from the mainshock.

Usually, new phenomena are observed after detailed data analysis related to strong earthquakes. Song et al. find that micro-seismicity rate increases after Rayleigh waves from the strong earthquakes traveled across the Datong volcanic region. They proposed that dynamic Coulomb stress change might be responsible for the seismicity rate increase. Ren et al. find that maximum seismic intensity of the Lushan earthquake is lower than that of the Wenchuan earthquake, though stronger ground motion is recorded for the Lushan earthquake. Via spectrum analysis, they identify a probable explanation for the consistency between macroseismic intensity and ground motion records.

There are also tentative efforts for earthquake predictions. Liang et al. study gravity changes before the Lushan earthquake and try to relate the change to occurrence of the Lushan earthquake. Jiang et al. also find ionosphere changes (VTEC changes) before the earthquake and discuss the potential for earthquake prediction.

Understandably, it is not feasible to fully understand every details of the Lushan earthquake in just a few months. The results in this special issue would better serve only as enlightening clues instead of the final conclusions. Hopefully, the studies in this special issue can be helpful for mitigation of seismic hazard by future strong aftershocks.

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