Investigation of the Characteristics of the 2008 Wenchuan and 2013 Lushan Earthquakes and Their Relationship

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This presentation illustrates the characteristics of the 2008 Wenchuan and 2013 Lushan earthquakes, investigates their stress interaction, and discusses the implications on regional seismicity rate changes. In 2008, we calculated that the 12 May 2008 Mw=7.9 Wenchuan earthquake has increased Coulomb failure stress on adjacent major fault systems, including the ends of the 2008 Longmen Shan rupture, Xianshuihe fault, Kunlun fault, and Min Jiang fault [*Toda, Lin, Meghraoui, and Stein,* Geophys. Res. Lett., 2008]. Our calculations showed that parts of the Xianshuihe and Kunlun left-lateral faults as well as the Min Jiang reverse/left-lateral fault were brought 0.2-0.5 bars closer to failure, roughly equivalent to a decade of tectonic stress accumulation for these faults. We also calculated that the Wenchuan earthquake could promote thrust failure beyond the ends of the 2008 Longmen Shan rupture; other independent investigations have arrived at similar results. The 20 April 2013 Mw=6.6 Lushan earthquake indeed struck one of the calculated stress increase zones.

A key argument derived from the laboratory rate/state friction laws is that a sudden stress increase might cause a sudden jump in seismicity rate that decays inversely with time and eventually recovers. In our 2008 study, we further used the Wenchuan earthquake stress changes and the observed background seismicity to forecast the regional seismicity rate during 2008-2017 [*Toda et al.,* 2008]. We used M≥3.2 shocks during 2000-2008 as the background seismicity rate of the region. The regions of calculated relatively high seismicity rate during 2008-2017 (red areas in Fig. 1) include the northwest and southeast ends of the 2008 Longmen Shan rupture, the northern Min Jiang fault (M in Fig. 1), and the 1893 rupture zone of the Xianshuihe fault (X1 in Fig. 1). The overall probability of a M≥6 shock striking somewhere in the 750 x 780 km area is estimated to be 57-71% during 2008-2017, and 8-12% for M≥7 shocks. These are up to twice the probabilities for the decade before the Wenchuan earthquake. The 2013 Lushan mainshock and its aftershock zone occurred in a region of calculated seismicity rate increase near the southeast end of the 2008 Longmen Shan rupture (Fig. 1), in qualitative agreement with the calculations of *Toda et al.* [2008] and other studies.

This presentation will discuss the key assumptions and uncertainties in the calculations of stress and seismicity rate changes. Further investigation of the regional seismicity rate changes associated with the Wenchuan and Lushan earthquakes will provide important constraints for testing hypotheses of earthquake stress interactions and for improving seismic hazard assessment.

References

Toda, S., J. Lin, M. Meghraoui, and R. S. Stein (2008), 12 May 2008 M = 7.9 Wenchuan, China, earthquake calculated to increase failure stress and seismicity rate on three major fault systems, Geophys. Res. Lett., 35, L17305, doi:10.1029/2008GL034903.

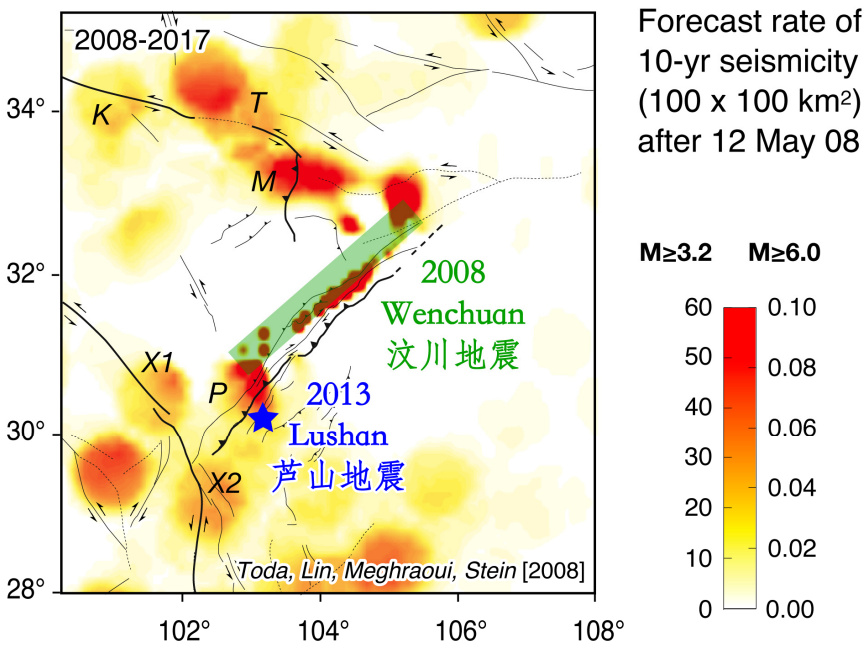

Fig. 1 Forecast of seismicity rate during 2008-2017 based on preceding seismicity and the Coulomb stress imparted by the 2008 Wenchuan rupture [*Toda et al.*, 2008]. Coulomb stress increases caused by the Wenchuan earthquake amplify the seismicity rates in areas of high backgound rate. The regions of calculated relatively high seismicity rate include K, Kunlun; T, Tazang; M, Min Jiang; X1 and X2, Xianshuihe 1893 and 1786 rupture segments; and P, Pengguan. Note that the 2003 Lushan earthquake occurred in a region of calculated sismicity rate increase