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Co-seismic dilatational strain in the far field of great earthquakes

Yan Zhang (1), Li-Yun Fu (1), Chi-yuen Wang (2), Rui Yan (3), and Lian-feng Zhao (1)

(1) Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China (eve_041744@163.com), (2) Department of Earth and Planetary Science, University of California, Berkeley, (3) Department of earthquake prediction, China earthquake networks center

The mechanism of the coseismic dilatational strain has been a topic of active debate. Recent studies show that the co-seismic change of dilatational strain in the far field of large earthquakes is often far greater than that predicted from static strain theory, but the underlying mechanism is not understood. Here we study this mechanism by comparing the tidal responses of crustal strain and water level documented in the Fuxin well, northeastern China, before and after three great earthquakes (the 2008 Mw 7.9 Wenchuan earthquake, the 2011 Mw 9.1 Tohoku earthquake and the 2012 Mw 8.6 Sumatra earthquake). We show that, before each earthquake, the phase of water-level fluctuation lagged behind that of the dilatational strain, due to the delay of groundwater flow to the well with respect to the tidal strain. Following each earthquake, however, the phase of water-level fluctuations increased and became the same as that of the dilatational strain. In addition, we show that the predicted change in water level from the co-seismic dilatational strain has the same sign, amplitude and time history as those of the observed coseismic change in water level. The similarity between the simulated and observed coseismic water-level change, together with the similarity in phase between the tidal response of water level and that of dilatational strain after the earthquake, suggest that the dominant mechanism for the coseismic dilatational strain in the Fuxin well is the co-seismic change in pore pressure in the vicinity of the well.