Geophysical Research Abstracts
Vol. 15, EGU2013-2153, 2013
EGU General Assembly 2013

Continuous Record of Permeability inside the Wenchuan Earthquake Fault Zone

Lian Xue (1), Haibing Li (2), and Emily Brodsky (1)

(1) Dep. of Earth and Planetary Science. UC, Santa Cruz. United States (lxue3@ucsc.edu), (2) Key Laboratory for Continental Dynamics, MLR, Institute of Geology, Chinese Academy of Geological Sciences, China (lihaibing06@yahoo.com.cn)

Faults are complex hydrogeological structures which include a highly permeable damage zone with fracture-dominated permeability. Since fractures are generated by earthquakes, we would expect that in the aftermath of a large earthquake, the permeability would be transiently high in a fault zone. Over time, the permeability may recover due to a combination of chemical and mechanical processes. However, the in situ fault zone hydrological properties are difficult to measure and have never been directly constrained on a fault zone immediately after a large earthquake. In this work, we use water level response to solid Earth tides to constrain the hydraulic properties inside the Wenchuan Earthquake Fault Zone. The transmissivity and storage determine the phase and amplitude response of the water level to the tidal loading. By measuring phase and amplitude response, we can constrain the average hydraulic properties of the damage zone at 800-1200 m below the surface ($\sim$200-600 m from the principal slip zone). We use Markov chain Monte Carlo methods to evaluate the phase and amplitude responses and the corresponding errors for the largest semidiurnal Earth tide M2 in the time domain. The average phase lag is $\sim 30^o$, and the average amplitude response is 6×10^{-7} strain/m. Assuming an isotropic, homogenous and laterally extensive aquifer, the average storage coefficient S is 2×10^{-4} and the average transmissivity T is 6×10^{-7} m^2 using the measured phase and the amplitude response. Calculation for the hydraulic diffusivity D with D=T/S, yields the reported value of D is 3×10^{-3} m^2/s, which is two orders of magnitude larger than pump test values on the Chelungpu Fault which is the site of the Mw 7.6 Chi-Chi earthquake. If the value is representative of the fault zone, then this means the hydrology processes should have an effect on the earthquake rupture process. This measurement is done through continuous monitoring and we could track the evolution for hydraulic properties after Wenchuan earthquake. We observed the permeability decreases 35% per year. For the purpose of comparison, we convert the permeability measurements to into equivalent seismic velocity. The possible range of seismic wave velocity increase is 0.03%$\sim$ 0.8% per year. Our results are comparable to the results of the previous hydraulic and seismic studies after earthquakes. This temporal decrease of permeability may reflect the healing process after Wenchuan Earthquake.