Geophysical Research Abstracts
Vol. 12, EGU2010-5793, 2010
EGU General Assembly 2010

Co and post-seismic velocity changes associated with the May 12, 2008 Mw7.9 Wenchuan earthquake

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We used continuous recordings of ambient seismic noise in Sichuan, China to track the temporal evolution of the seismic velocity at a regional scale in a 2-year period which includes the great Wenchuan earthquake. The data were recorded by a temporary network of 159 broadband seismographs ran by the China Earthquake Administration, in a 200*200 km in region that covers the southern 2/3 of the fault system activated during the Wenchuan event. We computed cross correlation functions of continuous vertical records for all pairs of stations and then a doublet analysis was performed to detect temporal velocity changes with respect to a reference correlation. The general scheme is similar to the one in Brenguier et al. (2008a,b). We carried out this analysis in different period bands.

We first considered signal between 1 and 3 s of periods. We found clear evidences that the seismic velocity drops by an average amount of about 0.05 % in the fault region after the Wenchuan earthquake while the velocity fluctuates within 0.02 % in the months before the earthquake. The co-seismic variation is therefore well above the resolution of the measurements. We compared the measurements in different sub-arrays to get a spatial distribution of the velocity change. This distribution is consistent with the stress change during the Wenchuan earthquake. Seismic velocity dropped significantly in the region where the Longmen Shan fault was activated during the earthquake. We found that the co-seismic velocity variation has an amplitude only slightly larger for station groups in the Sichuan basin than in the Longmen Shan range, indicating that the co-seismic change is not fully controlled by the non-linear response of the shallow sediments. Nevertheless, the larger drop in the Sichuan basin suggests that the sensitivity to stress drop is stronger in sedimentary layers. On average the sensitivity to stress of relative velocity change is on the order of 10^{-8} Pa^{-1} .

Subsequently, we performed the same analysis on longer period signals to investigate the process for deeper part of the crust. We considered signals between 8 and 30 s of periods. As for the short period case, we found a clear velocity decrease with an amplitude of the same order. However, this decrease does not coincide with the earthquake but occurs about 100 days later. Considering that our measurements are essentially related to the predominant Rayleigh waves, we computed the sensitivity of Rayleigh phase velocity to a change of elastic velocity at depth, at the central periods of both period bands considered (2s and 20s). Results of this analysis show that the change we measure in both period ranges concerns different part of the crust and allow us to conclude that the delayed velocity decrease observed in the band from 8 to 30 s corresponds to a deep crust signature. We discuss the possible interpretations of this observation.