INTRODUCTION

The physical processes associated with occurrence of earthquakes, such as coseismic stress changes, fluid migration, and the formation of damage zone at shallow depths, are likely to cause changes of rock properties within and around the rupture zones. Field geological investigations identified a 24-km-long surface rupture zone along the Beichuan fault (Beichuan rupture zone, thick red line) and a 72-km-long surface rupture zone along the Pengguan fault (Xiaoyaozhuang rupture zone, thick blue line) associated with the 2008 M7.9 Wenchuan earthquake. Repeating events produce nearly identical seismograms when recorded at the same station, so that temporal changes in the medium can be more easily isolated from changes in the source. Repeating earthquakes have been widely used to measure temporal velocity change associated with large earthquakes. A great number of aftershocks occurred after the M7.9 Wenchuan earthquake (Figure 1), and many of them showed very similar waveforms.

MEASURING TEMPORAL VELOCITY CHANGES USING CODE WAVE INTERFEROMETRY

All the seismograms for each pair at each station are aligned to the P arrival using the cross-correlation technique. We then measure the lag time (y) and the decorrelation index D(0) by means of computing the running cross correlation between the first seismogram and each subsequent seismogram within a 0.5-s moving time window. The fractional change of the background velocity, \( b_{\text{v}} \), equals to the negative slope of the linear trend, \( c_{\text{v}} \) (Figure 3).

RESULTS AND DISCUSSIONS

Spatial and temporal distribution of the repeating earthquakes

Figure 4. Recurrence times of all the 34 earthquakes that make up the 12 clusters. Different symbols were used to indicate different sequences. The grey symbols represent the missing members from the joint catalog. Symbol size is proportional to event magnitude.

VELOCITY CHANGES AND FAULT-ZONE HEALING ACROSS THE RUPTURE AREA

Figure 5. Map view of the repeating earthquake sequences (black stars). Stations/vyings are plotted similarly to Figure 3. The locations of four aftershocks with M>5.5 are shown in red circles. Surface ruptures are associated with the 2008 M7.9 Wenchuan earthquake. They are marked by thick red and blue lines, respectively. Inset shows the depth section view of repeating earthquake sequences along the western side of the fault in the map.

CONCLUSIONS

We employed a template matching technique to analyze the event and continuous waveform data recorded by three types of seismic networks in the 2008 Wenchuan earthquake area to identify repeating earthquakes in order to investigate the postseismic velocity changes within the rupture zone of the main shock. We identified a total of 34 repeating earthquakes spreading over 12 separated clusters from the one-year aftershock sequence of the M7.9 earthquake. We further used a grid search technique to determine the relative location of the repeating events in each sequence to ensure their rupture areas overlap each other. We applied the code wave interferometry technique to the S coda of the repeating earthquakes to estimate velocity changes between the first and subsequent events in each cluster. Our results suggest the following conclusions: (1) There is a significant difference in surface subsidence change and postseismic healing between the southwestern and northeastern parts of the rupture zone, which are characterized by thrust and strike slip motion, respectively, during the main rupture. Large velocity increases (~1–0.1–0.3%) are observed in the southwest where the main rupture was initiated, while almost no significant velocity change is found in the northeast Beichuan area. (2) The postseismic velocity healing could be temporarily interrupted by significant aftershocks, which can cause velocity drop around the source regions of the repeating sequences. (3) Short-term perturbation in velocity changes are also present from one of the cluster data, suggesting that healing of the weakened Longmen Shan thrust front in the Wenchuan area can be easily affected by various processes with different time scales, such as aftershocks, barometric pressure loading, reservoir water level changes, etc.

REFERENCES