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Postseismic deformation of the 1999 Chi-Chi, Taiwan earthquake

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On September 21, 1999, the M_w 7.6 Chi-Chi earthquake broke the Chelungpu fault in Taiwan and generated large coseismic slip with more than 10 meters. Significant postseismic surface displacements of Chi-Chi earthquake are recorded by the GPS network in Taiwan after the first year. Previous studies suggest that afterslip is the dominant mechanism of the early and near-field postseismic deformation; while viscoelastic relaxation responds for the long-term and far-field deformation.In order to illustrate the postseismic deformation over the past 15 years or so, we analyzed GPS position time series from 1999 to 2013 after the Chi-Chi mainshock and 1993 to 1999 prior to the mainshock as the interseismic period. The interseismic velocities with respect to S01R located at the Penghu Island are about $15 \sim 20$ mm/yr in the rupture area. In contrast, postseismic horizontal displacements in the first year after the mainshock are almost five times of the interseismic horizontal velocity. Postseismic displacements rapidly decrease and the amplitude of the secular horizontal velocity near the rupture area after a decade falls in a similar range of the interseismic velocity. On the other hand, the secular velocities at the far-field stations is still fast than the interseismic velocity and suggest that the postseismic relaxation time is much longer than a decade. We constructed a 3D semi-analytic model of postseismic deformation driven by coseismic stress perturbation that afterslip and viscoelastic flow are fully coupled. The model requires rheological properties changes beneath the Taiwan orogenic belt in order to obtain a satisfactory fit to postseismic GPS data. Our model shows the viscosity of lower crust is about 10^{19} Pa s, while the middle crust below the Central Range is about 10^{18} Pa s.