Preliminary study of anomalous pre-seismic baseline variations from the continuous GPS observations in Taiwan

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Taiwan is situated in an active tectonic region characterized by an on-going collision between the Luzon arc and Chinese continental margin. The rapid crustal deformation and frequent earthquakes imply the large seismogenic potential in the Taiwan area. In the recent decades, the Global Positioning System (GPS) has become an efficient tool for studying active tectonics and geodynamics. After the 1999 Chi-Chi earthquake (Mw = 7.6) more than 150 new continuous GPS (cGPS) stations have been established in Taiwan. Since 1994 these cGPS stations have been operated by various agencies, including the Central Weather Bureau (CWB), Institute of Earth Sciences, Academia Sinica (IESAS), Central Geological Survey (CGS) and the Ministry of the Interior (MOI). A dense network comprised of more than 500 cGPS stations currently monitors the Taiwan area. In this study, we present some suspected precursor signals obtained from cGPS observations. Using baseline variations of high-quality continuous GPS data, we characterize the possible pre-seismic precursor signal of the two recent earthquakes in Taiwan. A significant decrease in extension rate was observed about 5 months before the M_L = 6.4 Rueisuei earthquake (31 October 2013), occurred near the Longitudinal Fault in the eastern Taiwan. A significant increase in soil-gas concentrations was also recorded 2 months before the Rueisuei earthquake. Furthermore, the pre-seismic baseline variation of cGPS was observed in 8 baselines near the epicenter of the M_w 6.4 Meinong earthquake (6 February 2016) in the fold-and-thrust belt of SW Taiwan. In this case, we found clearly anomalous signal in the time series of 8 baselines with length variations showing that the deformation rate slowed down and decreased to near zero before the Meinong earthquake. The duration of the anomalies varied from about 9 months to 2 years in relation to the location of the baseline. The duration time of the anomalies shows obvious correlation with the distances between the baseline location and the epicenter. The dilatancy–diffusion model suggested that the pre-slip strain anomaly can be observed in the following three major stages: elastic strain buildup (stage I), dilatancy dominant (stage II) and influx water dominant (stage III). Seismic slip may nucleate on fault patches due to the frictional drops with increasing slip or sliding speed, and earthquake may occur on along-strike or downdip extension while aseismic deformation rates accelerate. However, according to the dilatancy–diffusion model, the observed baseline length rate variation anomalies seem to show a “slow-down” of deformation rate and probably resulted from the closure of preexisting cracks before the nucleation of the Meinong earthquake. Therefore, we can assess the seismic potential or possible precursor signal by this method.

Keywords: GPS , Pre-seismic anomalous, baseline variation

