

Non-volcanic tremor characteristics in Taiwan and their stress interaction with local earthquakes

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Recent findings of tremor in Taiwan have shown it to be an ideal region in which we can study the relationship between tremor and earthquakes. Although several studies (Chao et al., GJI, 2012; Chao et al., SSA Meeting, 2011) have identified triggered and ambient tremor beneath the southern Central Range of Taiwan, a number of fundamental characteristics of tremor in Taiwan remain unclear. In this study, we auto-detected eight-year (2004~2011) continuous seismic waveforms and obtained tremor episodes under the southern Central Range using the Waveform Envelope Correlation and Clustering (WECC) method and a spatio-temporal clustering criterion. We also quantified tremor activity before and after the local 4 March 2010, Mw6.3 Jiashian earthquake, the hypocenter of which is located about 30 km away from active tremor sources, and the 2010 Mw8.8 Chilean earthquake, which occurred six days before the Jiashian mainshock. This special dataset provides a means of studying the relationships among ambient tremor, triggered tremor, and local and regional earthquakes.

Analysis of the data shows that ambient tremor in the southern Central Range of Taiwan is characterized by frequent recurrence of short duration (5~24 min. per day); however, unlike other subduction environments, the Nankai tremor zone exhibits a continuous occurrence of tremor episodes from a period of hours to days. The analysis also shows that ambient tremor in Taiwan surrounds an active triggered tremor source and that its spectrum is similar to that of triggered tremor, but with lower amplitude, which confirms the theory that triggered tremor is a sped-up result of ambient tremor. We found that background noise in this region during the local daytime period exhibits larger amplitude than that of ambient tremor, implying that if we employ borehole seismometers in the study region, we should be able to detect more tremor episodes. Our findings also show that maximum tremor activity occurred within ten days after the Jiashian mainshock, indicating a static stress interaction between the tremor rate and locally occurring earthquakes, and that tremor rate gradually returned to its previous status six months after the mainshock. Although the dynamic stress from the Chilean earthquake exceeded the tremor-triggering threshold of 8-9 kPa in Taiwan, it neither triggered tremor nor influenced local seismicity. The study found no evidence that significant change in tremor activity correlated with that of the Chilean earthquake or local seismicity. Finally, we examined potential slow slip events in nearby regions with geodetic observations from GPS data and found no direct evidence of a connection between the GPS observations and tremor episodes. Our investigation of ambient tremor in Taiwan can lead to more thorough understanding of tremor-generated zones and geological structures in this region.

Keywords: non-volcanic tremor, dynamics and static triggering, Taiwan, tectonic tremor