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Seismogenesis of a crustal-scale creeping fault – the Chihshang fault of eastern Taiwan

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Creeping crustal faults often generate streaks of microearthquakes, and although less in common, they may also simultaneously produce large earthquakes that rupture the brittle upper crust. The Chihshang fault in eastern Taiwan possesses such a behavior and provides a unique natural laboratory for studying earthquake processes along a creeping fault. The Chihshang fault is the most active segment of the Longitudinal Valley fault that forms the Eurasia-Philippine Sea plate boundary in eastern Taiwan. Geodetic studies indicate that the Chihshang fault slips at the surface at an average rate of 2.2 cm/yr in a N40˚W direction, which takes up 24% of total contraction across the Taiwan collision. Field surveys in local outcrops suggest that the Chihshang fault is a narrow, shear-concentrated thrust with minor left-lateral component. With a high slip rate across such a sharply localized fault zone, the fault appeared to slip with minor earthquakes for the past one hundred years, except for two $M > 6$ events occurred in 1951 and 2003, respectively. In this research we would like to address the following questions that are crucial to the understanding of seismogenesis of a creeping fault. (1) Does the Chihshang fault produce slip-parallel microseismic lineations, as a common feature for creeping faults? (2) Does the Chihshang fault cut through the entire crust and connects to the island arc Moho detachment? (3) What is the role of fluid pressure played in the seismogenesis of the Chihshang fault? (4) Is fault instability governed solely by cyclical accumulation and release of tectonic stresses? Or, does the tectonic stress couple with crustal fluids affecting fault behavior? (5) Can we identify repeating earthquakes along the Chihshang fault, either periodic or non-periodic, to separate creeping zone from the locked zone? To obtain a high-resolution fault behavior at depth, we apply the double-difference method to relocate more than 3400 earthquakes ($1.0 < M < 6.5$) occurred in the Chihshang area during the period be-

tween 1991 and 2003. Statistical re-sampling methods are used to estimate relative location errors. Fault plane solutions for earthquakes with M $>$ 3.5 are determined by using P-wave polarities and SH/P amplitude ratio. We identified nearly 200 repeating microearthquakes with waveform cross-correlation coefficient larger than 0.95 using the 1992 – 2003 earthquake catalogue. Using the recurrence intervals of observed repeating microearthquakes, we investigate the fault behavior at depth and slip rate variations in space and time for the Chihshang fault. The repeating earthquakes were organized into 41 sequences, including 3 to 13 events, with both quasi-periodic and aperiodic types. Our study offers fine-scale fault plane geometry and style of earthquake faulting for the Chihshang fault, which are important for earthquake hazard assessment in eastern Taiwan.