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Depth variations of fault friction parameter derived from dynamic modeling of GPS afterslip associated with the 2003 Mw 6.5 Chengkung earthquake in eastern Taiwan

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The Chihshang fault lies at the plate suture between the Eurasian and the Philippine Sea plates along the Longitudinal Valley in eastern Taiwan. In this study, we investigate depth variation of fault frictional parameters derived from through modeling the post-seismic slip model deformation of the 2003 Mw 6.5 Chengkung earthquake. Assuming a (steady state?) rate-strengthening friction, we implement an inverse dynamic modeling scheme to estimate the frictional parameter (a-b) and the reference friction coefficient (μ*) in depths by taking into account pre-seismic stress and coulomb stress changes associated with co- and post-seismic deformation of Chengkung earthquake. We investigate two coseismic models previously published by Hsu et al. (2009) and Thomas et al. (2014). Model parameters, including stress gradient, depth dependent a-b and μ*, are determined from fitting the transient post-seismic geodetic signal measured at 12 continuous GPS stations. In our inversion scheme, we apply a non-linear optimization algorithm, Genetic Algorithm (GA), to search for the optimum parameters. Considering the zone with velocity-strengthening frictional properties along Chihshang fault, the optimum a-b is 1.1-1.7 $\times$10-2 along the shallow part of the fault (0-10 km depth) and 1.2 $\times$ 10-2 in 22-28 km depth. Optimum values for μ* are 0.3-0.4 and 0.8 for depths of 0-10 km and 22-28 km, respectively. The inferred frictional parameters are consistent with the laboratory measurements on clay rich fault zone gouges comparable to the Lichi Melange, which is thrust over Holocene alluvial deposits across the Chihshang fault, considering the main rock composition of the Chihshang fault. Our results indicate a possibly strong influence from the surface cover of a few hundreds meter thick unconsolidated deposits (i.e. late Quaternary gravel) and the clay rich fault gouge (i.e. the Lichi Melange) on frictional properties. They also suggest that possibly there is a brittle-ductile transition zone around 20-30 km of depth in the middle-lower crust, down-dip of the co-seismic rupture asperity.