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Shallow seismic velocity of central Taiwan at TCDP drill site from downhole linear array analysis

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To help better understand the rupture process and mechanism associated with the disastrous 1999 Chi-Chi, Taiwan Earthquake (Mw 7.6), the National Science Council (NSC) granted the Taiwan Chelungpu-fault Drilling Project (TCDP) funding in 2003. After finishing the core sampling down to 2 km, the National Central University (NCU) deployed 7 downhole short-period seismometers centered at a depth of 1110 m ,where the Chelungpu fault is penetrated, beneath the drill site to monitor seismicity along the fault zone. This downhole linear array has recorded tremendous high quality seismic waveform data generated from local and regional earthquakes. Due to the high attenuation effect in the shallow unconsolidated sedimentary layer, surface reflected phase is not likely to be detected. In this study, we adopt the beam forming method to enhance the amplitude of signals from direct and surface reflected body waves. To clearly identify direct and reflected seismic phases, we calculated fourth-root vespagrams for events with various back azimuths. According to the theoretic inference, the apparent slowness is proportional to cos(ic)/V, where ic is the incidence angle and V is the average velocity around the linear array. Apparent slowness of surface reflected phase is opposite in sign and almost double in value compared with the one of direct phase. Slower shallow velocity above this linear array would give a sharper (smaller) incidence angle for the reflected phases, thus a larger slowness is expected. Based on an estimate of incidence angle from particle motion, we are able to further infer the Vp and Vs around and above the fault zone.