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Shallow velocity structure of the Tainan frontal thrust based on Eikonal tomography

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We deployed a dense array of 173 seismometers covering a 30 by 40 km2 area in the Tainan frontal thrust of southwestern Taiwan from February to June 2021. The seismic array with an inter-station distance of about 2 km, spanned from west to east, across four major tectonic regimes: Anping Plain, Tainan Tableland, Dawan Lowland, and Chungchou Tableland. Structurally, the Houchiali Fault separates the Tainan Tableland and Dawan Lowland, while the right-lateral Hsinhua Fault is located 5 kilometers northeast of the Houchiali Fault. For the Eikonal tomography analysis, we included data from ten BATS (Broadband Array in Taiwan for Seismology) stations, five stations from CWASN (Central Weather Administration Seismographic Network), and one station from TSMIP (Taiwan Strong Motion Instrumentation Program). These stations were strategically positioned at distances ranging from 40 to 80 kilometers away from the dense array, with azimuths between 45° to 140° and 270° to 360°. We then calculated the cross-correlation function (CCF) between 173 seismometers and these stations. These results were subsequently used by beamforming to measure the relative surface wave arrival times. To perform Eikonal tomography, we calculated the surface wave propagation of the ambient noise and the shallow velocity structure for each period between 4 and 10 seconds. Our result shows that the velocity on Tainan Tableland is almost uniform, which is probably due to the gently folded character of the underneath Tainan anticline. Meanwhile, a low-velocity zone of approximately 2.5 by 2.5 km2 with a 4s period was revealed northeast of the Houchiali Fault and southwest of the Hsinhua Fault, with a shear-wave velocity of approximately 0.5 km/s. Upon reaching the Hsinhua Fault to the northeast, the velocity increases five times to 2.5 km/s. For the 4s period, the average velocity in this region is approximately 1.5 km/s, however, the velocity distribution does not conform with the regional velocity models. This suggests the presence of potentially unexamined small-scale structures in this area. Furthermore, this area encountered strong shaking from three local or regional moderate earthquakes that occurred in 1946, 2010, and 2016 respectively. Coincidentally, the low-velocity zone aligns roughly with the soil liquefaction sites caused by these three events.