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The complexity of seismogenic faults in the northern Longitudinal Valley, Taiwan, revealed from the 2018-2022 M5.8+ Hualien earthquake sequences recorded by dense nodal arrays

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The Longitudinal Valley in eastern Taiwan, the arc-collision boundary between the Eurasian and Philippine Sea plates, is one the most seismic active areas in the world. However, its seismotectonic architecture in the upper crust is still under debate due to the narrow geometry of the valley (width 2-7 km), thick alluvium deposits (> 3 km), and sparse station distribution. We used nodal seismographs to capture aftershock sequences of four M5.8+ mainshocks, including the 2018 Mw 6.4 Hualien, 2019 Mw 6.1 Xiulin, 2021 Mw 5.8 Shoufeng, and 2022 Mw 5.9 Guanfu earthquakes. In each small aperture array with station spacing 2-5 km, we installed tens of vertical-channel GS-11D geophones with TEXAN data loggers in 2018, 3-component Fairfield Nodal Zland in 2019, and 3-component Smart Solo (IGU-16HR 3C) in 2021 and 2022. To extract the aftershock catalog, we manually processed the continuous waveform data for the 2018 and 2019 events and then applied the deep-learning-based package, SeisBlue, for the 2019-2022 events. We used FPFIT to obtain focal mechanism solution (FMS) catalogs constrained by P-wave polarities, including reliable FMS of M < 2 events. With the dense coverage of seismic rays and stations, we applied finite-difference travel-time tomography. The improved resolution at the shallow part of the crust (at depth < 10 km) provides new constraints to get detailed (with a grid spacing of 1 km) and reliable Vp, Vs, and Vp/Vs velocity models at the local scale. Combined with the high-resolution velocity models, FMS, and the spatial distribution of these more complete aftershocks, our results depict several local tectonic structures that have not been observed at the northern Longitudinal Valley, not only a suture but also a transitional area from collision to subduction.

Keywords: northern Longitudinal Valley, suture, deep learning, nodal array, blind fault