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Complex fault-zone structure of the 2021 Yangbi Earthquake sequence revealed by dense array observations

Xianwei Zeng, Chunquan Yu, and Gongheng Zhang
Department of Earth and Space Sciences, Southern University of Science and Technolog, Shenzhen, China
(12231216@mail.sustech.edu.cn)

The 2021 M_S 6.4 Yangbi earthquake occurred near the southwestern boundary of the Chuandian block in the SE Tibetan Plateau. Previous studies found that the mainshock occurred to the west of the main boundary fault – the Weixi-Qiaohou-Weishan fault, but the detailed seismogenic structure of the Yangbi earthquake sequence remains unclear. Accurate spatiotemporal characteristics of aftershocks and precise fault-zone structure are crucial for a more thorough understanding of the seismogenic structure and nucleation mechanisms of the Yangbi earthquake. Five days after the mainshock, we deployed a dense array with 200 short-period nodal seismometers spaced approximately 2 to 3 km in the vicinity of the Yangbi earthquake source region. In this study, we use the three-month-long continuous recordings of the dense array to study aftershock source parameters and fault-zone structures. We first obtained an earthquake catalog containing 88934 high-resolution event locations and 625 high-quality focal mechanisms. The entire aftershock sequence has a complete magnitude of -0.2, and a b-value of 0.97, with earthquake depths concentrated between 1 and 7 km below sea level. Combining precise aftershock locations and focal mechanisms, we constructed a detailed three-dimensional fault-zone structure model for the Yangbi earthquake sequence. The results reveal significant geometric variations in both strike and dip directions of the main fault. Along the dip direction, a conspicuous flower-like structure is present in the shallow part, transitioning to a listric structure inclined to the southwest at deeper levels. Along the strike direction, a noticeable bend exists in the central part. Several conjugate or intersecting faults are also present around the main fault. One of these faults, intersecting the main fault at a depth of about 4 km and dipping to the northeast, is likely the seismogenic fault of the largest foreshock. Additionally, below the main fault, there is another listric fault which appears to connect to the known Weixi-Qiaohou-Weishan fault at the surface. Our study provides new insight into the mechanism of the 2021 Yangbi earthquake sequence. The 3D fault-zone geometry can potentially be used for dynamic source modeling to better understand the initiation and rupture process of the mainshock.