High-resolution crustal structure illuminated by ultra-dense array recordings

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As dense and ultra-dense seismic arrays become more available, not only detailed small-scale structures (e.g. crustal fault zones) but also deeper crustal structures can be obtained with high resolution. Here we show the results derived from recordings at ultra-dense arrays, which were deployed across the Chenghai fault in Yunnan, southwest China, with average station spacing of 40 meters. The arrays consisted of three-component short-period sensors (5 s) and were in the field for one month, during which 20 teleseismic and 62 local earthquakes have been recorded. Based on the analysis of across-profile delay times of P arrivals from teleseismic and local earthquakes, we clearly identified a low velocity zone (LVZ) that has a width of ~2.5 km. Travel time forward modelling suggests that the depth extent of the LVZ is less than 1 km. Ambient tomography results show that the velocity of the LVZ is only 0.4 km/s at shallow depth, 70 percent and 40 percent lower than those at the northwestern and southeastern sides of the fault zone. In addition, we derived the horizontal-vertical amplitude ratio of ambient noise and found that the stations within the fault zone show remarkably coherent signatures, corresponding to two impedance interfaces (at 50 m and 350 m in depth, respectively). Furthermore, receiver function images show unprecedented coherency in observing lower crustal layers on the ultra-dense array, demonstrating the potential of deriving a high-resolution structure of the lower crust using the small-aperture yet ultra-dense seismic network.