Source kinematics of the 2021 Mw6.2 Petrolia earthquakes improved by deep learning: rupture propagates from the Mendocino transform to the inland strike-slip faults

Qibin Shi[1], Marine Denolle[1]
[1] Department of Earth and Space Sciences, University of Washington

On 2021 December 20th, a Mw6.2 earthquake occurred near the Mendocino triple junction with early aftershocks clustered at both the Mendocino fault and the inland fault system. To better understand the complex initiation and propagation of the coseismic rupture, we perform a multiple-point-source inversion for the mainshock. Due to the geographic setting of the source area, the regional seismological observations only cover a narrow azimuthal range. The seaward teleseismic waveforms provide excellent complement to the landward stations but suffering from low signal-to-noise ratios. Therefore, we apply a teleseismic denoiser (DenoTe) to separate the teleseismic body waves from the ambient noises. The denoiser is developed based on the two-branch encoder-decoder neural network and trained using global broadband teleseismic waveforms of earthquakes that occurred during 2000-2021. The joint inversion of denoised teleseismic body waves and local strong-motion data greatly reduces the uncertainties of source parameters of the subevents. Our result reveals a unilateral rupture of the 2021 Mw6.2 Petrolia earthquake that can be decomposed into three subevents. The first subevent (Mw5.7) initiates on the Mendocino transform about 40 km offshore and 26 km under the seafloor. The second subevent (Mw5.8) is about 20 km to the east of the first subevent and at a similar depth (24 km). The locations and focal mechanisms (strike = 90° and 98°) of the first two subevents are well aligned with the aftershock seismicity near the Mendocino transform. Then the rupture further propagates toward the inland fault system. The third subevent (Mw5.9) is located inland and at the depth of 26 km, consistent with the distribution of inland aftershocks and its pure strike-slip focal mechanism (128°/84°/179°) is in good agreement with the mapped inland faults. Our kinematic source model derived from the denoised teleseismic and local waveform indicates that the inland Petrolia fault system might have been in a critical states that was sensitive to the stress perturbation induced by the coseismic rupture of the offshore Mendocino transform fault.