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Deep-focus repeating earthquakes in the Tonga-Fiji-Kermadec subduction zone

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Deep-focus earthquakes in the Tonga-Fiji-Kermadec subduction zone occupy more than 66% of the global deep seismicity. The high level seismicity in this region provides an excellent opportunity to search for the potential deep-focus repeating earthquakes in the existing waveform database. Utilizing the permanent anchor of the Global Seismographic Network (GSN), we compile a vast waveform dataset for earthquakes in the Tonga-Fiji-Kermadec subduction zone recorded by the GSN in a 20-year time window of 1990-2009. Waveform cross correlation (CC) is performed to search for repeating earthquakes. A total of 7 multiple event sequences and 12 event pairs with average CC coefficient above 0.8 is found among more than 200,000 event pairs. Depth distribution of those high CC pairs is at the depth range of 550 to 650 km. The master event relocation algorithm is applied to further determine the precise relative location/depth among those high CC event pairs. Relocation results suggest that 40% of all those high CC pairs are within 8 km in both horizontal and vertical space. In particular, six high CC pairs are colocated with more than 60% overlaid faulting area, providing a compelling evidence for the repeated rupture along the same fault patch. Thermal shear instability is considered the mechanism most likely to be responsible for deep-focus repeating earthquakes. Creeping process provides a plausible thermal source to develop thermal shear instability. The year-order-of-magnitude time separation between those deep-focus repeating earthquake pairs is compatible with heat production rate from the creeping process, depending predominantly on the high covergence rate of the Pacific plate along the Tonga-Fiji-Kermadec subduction zone.