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Combining seismic reflection and refraction data to investigate tectonic features of the Manila Trench offshore southern Taiwan

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Disastrous earthquakes (Mw>8) were mostly megathrust earthquakes that slipped along plate boundaries as stresses can be easily accumulated in the megathrust fault zone between two plates. Some large thrust faults, called splay faults, have been suggested to emerge from the megathrust fault to the seafloor. The splay fault may enhance tsunami generation by raising the fault plane angle from a low angle megathrust fault to a high angle splay fault, which could increase the vertical displacement of the seafloor once the fault is activated. The Luzon subduction zone has been regarded as one of the high tsunami risk zones. South of Taiwan, the Luzon subduction zone consists of four morphotectonic units from west to east: the Manila Trench, the Hengchun Ridge (accretionary wedge), the North Luzon Trough (forearc basin) and the Luzon volcanic arc. The accretionary wedge can be further divided into a lower slope domain and an upper slope domain by a splay fault. This splay fault separates a folds and thrusts dominated lower slope domain of the accretionary wedge from an intensely deformed upper slope domain. This splay fault system extends from offshore southern Taiwan to offshore southwestern Taiwan in a SSE to NNW direction, and may connect to the Chi-Shan fault onshore. It has been suggested to be a major branch of the megathrust system in the Luzon subduction zone.
In this study, we analyze several large-offset multi-channel seismic profile data collected during the TAIGER survey in 2009 across the Manila trench between 18.5°N to 21°N. Special processing procedures to attenuate multiples and to enhance deep signals on seismic reflection profile data have been performed to image tectonic features of the Luzon subduction zone. Velocity structural models from ocean bottom seismometer (OBS) data are constructed for depth conversion. Finally, we map the geometries of decollement, subducting oceanic basement, splay faults, and other structural features across the Manila trench. Our results suggest (1) the eastward dipping decollement steps down to basement at about 20 km from trench axis; and (2) there are 2 or 3 splay faults emerging from the megathrust fault zone from different branching points. The existence of these splay faults may suggest that this area has high potential of seismic and tsunami threats.