

HDS004-P01

Room:Convention Hall

Time:May 27 09:00-10:45

Paleoseismic studies along the Philippine fault zone, eastern Mindanao, Philippines

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The Philippine fault zone (PFZ) is one of the major strike-slip faults of the world that transects the entire length of the Philippine archipelago for more than 1,200 km from northwestern Luzon Island in the north to eastern Mindanao Island in the south. Consists of several segments, this arc-parallel, NW-SE trending, left-lateral fault zone is related to oblique subduction of the Philippine Sea plate beneath the Philippine island arc. This fault zone has been seismically active for the past 100 years with more than 10 earthquakes greater than M7. The most recent devastating earthquake was the 1990 Mw 7.7 Luzon earthquake that produced more than 120-km-long surface rupture along the Digdig fault with maximum horizontal slip of about 6m.

In Mindanao Island, the PFZ traverses its eastern portion for about 320km. It is characterized by fault parallel ridges, systematic deflection of stream and fluvial terraces, sag ponds and fresh tectonic scarps related to historical surface rupture. Historical documents also show possible surface-rupturing earthquakes such as the 1879 Ms 6.9 Surigao earthquake, 1891 Ms 7.2 Davao earthquake, and 1893 Ms 7.3 Monkayo earthquake. The fault trace in this island contains numerous geometric discontinuities such as en echelon steps and branching that may be used for segmentation of the fault zone. However, the timing of most recent earthquakes and recurrence intervals for these faults were poorly constrained. In order to reveal its paleoseismic activities, we have excavated multiple trenches across the different segments of the PFZ in Mindanao Island for the past two years.

Two sites were excavated across the Surigao fault located in the northern part of the island. Near vertical faults were identified on both sites and revealed evidence for at least two and probably three surface-rupturing earthquakes during the past 1,300 years that includes the 1879 Ms 6.9 Surigao earthquake. Prior analysis of aerial photographs and field observation along this segment also revealed fresh tectonic scarps and offset river terraces related to the surface rupture of the 1879 Surigao earthquake. In central part of eastern Mindanao, trench exposure in Compostela Valley across an east facing scarp that cuts an alluvial plain in an inter-valley mountain, exposed near vertical faults and contained evidence for at least two probably three or more surface-rupturing earthquakes for the 1,700 years that may include the 1893 Ms 7.3 Monkayo earthquake. Near the southern end of PFZ in Mindanao Island, trenching studies conducted north of Mati City showed a longer recurrence interval (> 1,000 years) compared to the other segments in this island. No historical earthquake (>M6) was documented in this area for the past 400 years.

Trench investigation conducted in this island revealed systematic variation of recurrence interval from 500-600 years in the northern part (Surigao segment), 500-1000 years in the central part (Compostela Valley) to > 1000 years along the southern end of the PFZ. This variation may be correlated to the southward decrease on slip rate along PFZ in this island from 24 mm/yr in the northern part (Surigao) to about 10 mm/yr in the south (Davao) derived from campaign type GPS survey (Aurelio, 2000, Island Arc).

Keywords: Philippine fault, paleoseismology, active tectonics, recurrence interval