

Near-surface structure and morphology of an offset mud volcano constrain the structure and Holocene kinematics of a reverse strike-slip fault at the Gunshuiping site, Southwestern Taiwan

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Abstract

In southwestern Taiwan, geodetic observations suggest the existence of a southwest striking right-lateral fault in the Holocene Coastal Plain. This inferred fault is highlighted by a topographic scarp and the presence of the Gunshuiping mud volcano. The mud volcano displays a dome-shaped topography, 1-km in diameter, cut and offset by the inferred fault. This leads us to investigate the Holocene kinematics and geometry of this inferred fault for the purpose of seismic hazard assessment. We constrain the deformation of buried Holocene strata using 19 shallow boreholes, ¹⁴C dating, U-Th dating and Resistivity Image Profiling data for stratigraphic correlation across and along the inferred fault. The fault-perpendicular cross-sections show that the bedrock unit and Holocene strata have been uplifting on the southeast block along a fault dipping 70° SE. The cores allow to identify a distinctive sandy layer, dated 4.7 ka and that appears sub-horizontally in fault-parallel sections, in contrast to the dome-shaped topography. The cores close to the mud volcano mouths show mud dikes in this 4.7 ka layer and several mud flows within the overlying layer, which base was dated 4.1 ka. This implies that the dome-shaped topography results from accumulated mud flows at the surface that migrated through fractures caused by fault activity and/or fluid overpressure. In parallel, we use the morphology of the mud volcano to estimate the right-lateral offset accumulated since 4.1 ka or less. We estimated a minimum horizontal fault slip rate of 13.2 ± 1.6 mm/yr since 4.1 ka, which is compatible with the horizontal gradient of 15 mm/yr from GPS during 2015-2018. Using the vertical offset of distinct layers across the fault leads to a vertical fault slip rate of 4.2 ± 1.8 mm/yr since 10 ka. While GPS observations suggest that the fault is at least partially creeping, the presence of Holocene growth strata at our study area raises the possibility that earthquakes occurred during the Holocene.

Keywords: Active tectonics, fault slip rates, mud volcanoes, Gutingkeng formation.