

The 2018 edifice collapse event of Anak Krakatau, Indonesia: Landslide movement history estimated from seismic waveforms

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On December 22, 2018, a huge Tsunami occurred at the Sunda strait in Indonesia, and more than 400 people were killed. There was no large earthquake at that time and the tsunami was associated with the volcanic eruption and edifice collapse in Anak Krakatau island.

The seismic signals due to this event are recorded by the broadband seismic network in Indonesia. There are about 170 broadband stations all over Indonesia, with a spacing 50-100 km. We performed the seismic waveform inversion using long-period component (20-100 s) at the near-field distance (60-200 km), assuming a single force mechanism. We also performed a grid search with 10 km spacing to estimate the location of the source.

Our result shows that the onset of the event was about 14:55:50 (UTC), December 22, 2018. The duration of the source time function is about 1 min with a large amplitude, followed by a smaller signal about a few min. The particle motion of the source time function suggests the event was occurred from northeast to southwest direction with very low dipping angle (about 10 degree). The location of the event was estimated at the Anak Krakatau.

This seismic event was most likely caused by the edifice collapse of the Anak Krakatau. The satellite image shows that the southwest half of the island was subsided after the collapse, and there is a oceanic basin at the depth of 200 m in the southwest of the island, which was the old crater created by the eruption in 1883. These geometries are consistent with the movement history estimated by the seismic waveform inversion.

Based on the scaling relationship between single force amplitude vs mass of the landslide (Ekström and Sterk, 2013), the mass was estimated as $0.2-0.4 * 10^{12}$ kg. This number is consistent with the volume estimated by the tsunami waveform simulation (Maeno and Kaneko 2019; Watada et al., 2019). We think that the edifice collapse was very low-dipping and moved like a landslide, and the mass sliding into the ocean caused the huge tsunami.

The relationship between this landslide and volcanic eruption is still debating, but Center for Volcanology and Geological Disaster Mitigation in Indonesia officially reported the timing of the eruption was 15:03 (UTC). Since the occurrence of the landslide was estimated as 14:55:50, the eruption may be triggered by the landslide, such as the 1980 eruption of Mount St. Helens triggered by the massive landslide.

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