Geophysical Research Abstracts
Vol. 19, EGU2017-3870, 2017
EGU General Assembly 2017

Distribution of the August 24, 2016 Amatrice (Central Italy) earthquake-induced slope movements pointing out the existence of hanging wall/footwall effects in near-fault regions

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On August 24, 2016 an Mw 6.0 earthquake struck Central Italy resulting in 299 fatalities, 388 injuries and about 3000 homeless and many earthquake environmental effects. Based on mapping of the 2016 Amatrice earthquake-induced slope movements, it is clearly shown that their distribution in the hanging wall (HW) and the footwall (FW) of the seismic fault are quite different resulting in an asymmetric distribution around the causative fault and the observed coseismic surface ruptures and accompanied structures. These differences refer to the observed number, concentration and scale of recorded slope movements in the HW and FW of Mt. Vettore and Laga Mts. faults.

Slope movements in the FW were observed in seven localities within the Pretare and Arcuata del Tronto areas and in a site east of Amatrice town. Slope movements north of Pretare affected Lias to Miocene pelagic deposits and Upper Tortonian-Lower Messinian turbidite deposits, while those in Arcuata del Tronto area and east of Amatrice affected only Upper Tortonian-Lower Messinian turbidite deposits. Their distance from the aforementioned faults was short, ranging from 1.5 to 3 km. They were of low concentration and of small scale resulting in negligible to slight damage to road network.

In contrast, slope movements in the HW were much more (98 localities) than those in the FW. They affected Lias to Miocene pelagic deposits and Upper Tortonian-Lower Messinian turbidite deposits along slopes in the road leading from Pescara del Tronto village to Norcia town and Upper Tortonian-Lower Messinian turbidite deposits within the Amatrice basin and more specifically in Amatrice and Accumoli areas. Their distance from the aforementioned faults was larger, ranging from 0 to 15 km. They were comparatively of higher concentration and of larger scale causing severe damage to buildings and infrastructures and increasing human fatalities in Amatrice, Accumoli and Pescara del Tronto villages founded on top of flat hills.

In conclusion, the distribution of the 2016 Amatrice earthquake-induced slope movements show marked HW/FW effects manifested by higher concentration, wider distribution and larger scale in the HW of the seismic fault in contrast to the lower concentration, limited distribution and smaller scale in the FW.

Similar spatial distribution of slope movements attributed to HW/FW effects has been previously observed after the 2008 Mw 7.9 Wenchuan (China) earthquake. In order to further support these field observations, the phenomenon of rupture directivity in the near field region is investigated and its association with the HW/FW effect is evaluated. More specifically, sixty records in the near field region, with peak ground acceleration larger than 0.03 g, are analyzed and identified as either pulse-like or non pulse-like. The distribution of the pulse-like records indicates the orientation of rupture directivity and the periods of the extricated pulses appear to be closely related to the rise time of the corresponding fault asperities. Finally, the distribution of peak ground accelerations in the near field is evaluated in order to account for the HW/FW effect on ground motion intensity.