Abstract ID : **7**

Probabilistic evaluation of the fault source of coseismic mass-transport deposits: the example of Aysén fjord, Chile

Content

Contemporaneous mass transport deposits (MTDs) recorded in high-resolution sediment archives provide evidence of past seismic shaking. However, because they usually cannot be linked directly to a fault rupture, assessment of the earthquake source (location and magnitude or specific fault) based on this type of indirect paleoseismological evidence remains difficult. Based on observations of coseismic mass wasting and associated seismic intensities, previous studies have assigned minimum shaking levels required to trigger them. Attempts to infer the most likely earthquake source mostly relied on methods originally developed to estimate the location and magnitude of historical earthquakes using intensity prediction equations (IPEs), but considered these minimum intensities as actual intensity values. Here, we develop a probabilistic method to infer the most likely earthquake source from the spatial distribution of positive and negative MTD evidence. This approach simultaneously allows the triggering intensity to be higher (or lower) than the assumed threshold and takes into account IPE uncertainties, two shortcomings of existing methods. The method is extended by considering known active faults rather than a grid of possible epicenters. We apply this method to Aysén Fjord (southern Chile), which is intersected by strike-slip faults of the Liquiñe-Ofqui Fault Zone (LOFZ). In 2007, an MW=6.2 earthquake hit the fjord with intensities of VIII+, causing major landslides entering the fjord. Seismic reflection profiles show that its sedimentary fill contains a record of nine prehistoric MTDs, which are mainly attributed to crustal earthquakes on the LOFZ. First, we conduct a sensitivity analysis to evaluate the potential of the fjord to distinguish between different possible fault ruptures and to determine which IPE performs best. Application to the MTD record allows identifying the most likely fault sections and magnitude range for most of the events. Compared to methods currently in use, the probabilistic method performs at least as good, and in several cases significantly better. We conclude that the method has great potential to constrain the size and location of paleoearthquakes for which only shaking evidence is available.

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Contribution Type : Oral Preference

Status: SUBMITTED

Submitted by **Dr. VANNESTE, Kris** on **Tuesday 22 May 2018**