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The investigation of blind continental earthquake sources through analogue and numerical models

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One of the most challenging topic in earthquake geology is to characterize the seismogenic sources, i.e. the potential causative faults of earthquakes. The main seismogenic layer is located in the upper brittle crust. Nevertheless it does not mean that a fault take up the whole schizosphere: i.e. from the brittle-plastic transition to the surface. Indeed, latest damaging earthquakes were generated by blind or "hidden" faults: 23 Oct. 2011, Van earthquake (Mw 7.1, Turkey); 3 Sep 2010, Darfield earthquake (Mw 7.1, New Zealand); 12 January 2010 Haiti earthquake (Mw 7.0); 6 April 2009 L'Aquila earthquake (Mw 6.3, Italy). Therefore understand how a fault grows and develops is a key question to evaluate the seismogenic potential of an area. Analogue model was used to understand kinematics and geometry of the geological structures since the beginning of the modern geology. On the other hand, numerical model develops much more during the last thirty years. Nowadays we can use these two methods working together providing mutual interactions. In the two-three most recent years we tried to use both numerical and analogue models to investigate the long-term and short-term evolution of a blind normal fault.
To do this we improved the Analogue Model Laboratory of the University of Pavia with a laser scanner, a stepper motor and other high resolution tools in order to detect the distribution of the deformation mainly induced by blind faults. The goal of this kind of approach is to mimic the effects of the faults movements in a scaled model. We selected two seismogenic source cases: the causative fault of the 1908 Messina earthquake (Mw 7.1) and that of the 2009 L'Aquila earthquake (Mw 6.3). In the first case we investigate the long term evolution of this structure using a set of analogue models and afterwards a numerical model of our sandbox allow us to investigate stress and strain partitioning. In the second case we performed only an analogue model of short-term evolution of the L'Aquila seismogenic source comparing our result with pre-existing numerical models. In both cases we obtain mutual advantages using together experimental results. We believe that the analogue modelling approach coupled with numerical modelling applied to the study of active faults can provide useful insights to investigate the seismic potential of a structure with important appliances also for the seismic risk assessment.