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Fault zone structure: insights from high resolution seismological data of the 2009 MW 6.1 L'Aquila causative fault.

Luisa Valoroso (1), Lauro Chiaraluce (1), and Cristiano Collettini (2)
(1) Istituto Nazionale di Geofisica e Vulcanologia, Roma (Italy), (2) Università degli Studi di Perugia (Italy)

Fault zone structure characterization is of paramount importance for our understanding of fault zone evolution, earthquake mechanics and crustal permeability. Most of our knowledge of fault zones is achieved by field studies of ancient faults now exposed at the Earth's surface.

We use earthquake locations in order to provide a seismological image of a (high-angle normal) fault zone structure and to investigate the role of earthquakes in the fault damage zone generation and evolution.

The extraordinary dataset is composed by ∼13k aftershocks nucleated during the 2009 L'Aquila earthquake along the MW 6.1 mainshock causative fault that activated the whole upper crust, from 12 km of depth up to the surface.

We generally observe an amazing similarity in between the seismological and geological fault zone architecture. We detect horsetail structures (2x2 km) in the shallower crustal portion (<3km) of the hanging-wall block of the main fault plane. Fault bending, dilation jogs (<1 km wide) and parallel slipping planes (<1 km long) are imaged at greater depths. Small (< 0.5 km) synthetic and antithetic structures are widespread along the entire fault plane both in the hanging-wall and footwall blocks.

The total fault zone thickness as measured in terms of area interested by aftershocks activity, ranges from 0.5 to 1 km, in agreement with the observations made by field geologists. Fracture (50 to 200 m long) density decays as r*exp-n, where r is distance from the fault plane. n is in the range of 0.8-2 with variation induced by along strike and in depth fault complexities. Fracture densities seem to be related also with coseismic slip, showing with fault portions affected by larger slip and higher rupture velocity.