In the last 20 years, three seismic sequences (Colfiorito 1997; L’Aquila 2009 and Amatrice-Norcia-Visso 2016-2017) occurred in between the northern and central Apennines of Italy, activating a NW-trending and 130 km long, contiguous normal fault system composed by a set of 12-18 km long fault segments rupturing the first 10 km of the upper crust. We will exploit this exceptional opportunity to explore the processes driving such complex earthquake sequences at high spatial resolution and displaying relevant similarities as well as fundamental differences in their preparatory phase, seismicity pattern and fault complexity.

Indeed, the anatomy of these fault systems shows heterogeneity of rupture histories and complexity of activated fault segments raising questions on our understanding of long term segmentation, strain partitioning and dynamic control of coseismic ruptures.

We will interpret the imaged rupture histories during moderate magnitude earthquakes and seismicity evolution to discuss the similarities between seismological observations (faults generating earthquakes and recognised by aftershocks distribution) and Quaternary geological fault structures (faults mapped at the surface) pointing out their geometric and kinematic correspondence. In addition to this, thanks to the high resolution achieved in reconstructing the faults anatomy by locations of small magnitude earthquakes (local magnitude > 0.5), we can now investigate and characterize the fault zone structure and its evolution, an essential factor for better understanding earthquake mechanics and rupture evolution. We have observed that the seismological fault zone thickness (0.5-1.0 km; computed by means of earthquakes distribution) is comparable with values derived from geological observations made on fault outcrops. Aftershocks distribution also shows how toward the surface conjugate sets of faults are connected with the main fault plane, which with depth shows bending and dilational jogs. These strong similarities between seismological and geological images of fault structure indicate that earthquakes have a key role in the evolution of fault architecture.

We will also discuss the differences between *native* normal faults composed by planar segments rupturing the whole seismogenic layer and normal faults rupturing (and inverting) inherited thrusts with the tendency of flattening at depth along sub-horizontal horizons.

Segmentation controlled by crustal heterogeneities and intersecting structures inherited from past tectonics seems to be very efficient. These older structures, often separating diverse geological domains, affect the evolution of seismicity and control dynamic rupture propagation and coseismic slip distribution. Also the persisting *seismic gaps* along the whole fault system highlighted by the lack of seismic activity, may be related to the presence of specific geological
domains. However, observations and inferred rupture histories raise concern on the concept of maximum expected magnitude.

Two sequences experienced foreshocks activity located along structural discontinuities between the main faults (1997 Colfiorito) and along the main fault plane (2009 L’Aquila). These sequences lasting for months, marked the onset of large variations in elastic properties of the crustal volumes modelled in terms of dilatancy and diffusion processes, corroborating the hypothesis that fluids play a key role in the nucleation process of extensional faults and seismicity pattern evolution as testified by main fault planes sometimes activated before the occurrence of the largest event on the fault plane itself. Differently the still on-going 2016-2017 seismic sequence did not show any *standard* foreshocks activity, while it seems to be loaded by strain partitioning affected by a mid-crustal layer characterized by seismic activity showing changes in the rate of earthquake production during the months before the sequence onset and during the aftershock sequence.

Main shocks nucleate close to the base of the seismogenic layer and nearby intersections between the normal faults and the preexisting compressional-transpressional structures. These lateral geometrical and lithological heterogeneities also control the coseismic slip distribution as imaged by seismological and geodetic data.

We will approach the comparison between these three seismic sequences believing on the relevance to reconsider *a posteriori* our understanding of the role played by the three-dimensional geological structures and the mechanical properties of fault zones to accommodate the deformation and cause fault activation with the aim of contributing to the understanding of the beginning and evolution of the seismic sequences.

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