THE CAMPOTOSTO SEISMIC GAP IN BETWEEN THE 2009 AND 2016–2017
SEISMIC SEQUENCES OF CENTRAL ITALY AND THE ROLE OF INHERITED
LITHOSPHERIC FAULTS IN REGIONAL SEISMOTECTONIC SETTINGS
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The 2016-2017 seismic sequence, in central Italy, was caused by the activation of the Mt. Vettore-Mt. Bove active fault and of the Amatrice fault, which generated three mainshocks on 24 August, 26 October and 30 October 2016, the latter being the largest one (Mw 6.5; Chiaraluce et al., 2017). On 18 January 2017, four Mw 5-5.5 seismic events nucleated south of the Mt. Vettore-Mt. Bove fault, where the Campotosto active fault is located. This structure is considered as potentially responsible for M ~6.6 seismic events and a major seismic gap of the central Apennines (Galadini and Galli, 2003). The fault was also responsible for some moderate seismic events during the 2009 L’Aquila seismic sequence, the largest of which of Mw 5.2 on 9 April 2009 (Valoroso et al., 2013).

In the present study, we investigated the January 2017 events through GPS and DInSAR coseismic data. We defined that they occurred along the Campotosto fault, with a slip distribution on the fault plane that roughly spans 3-9 km depth (Fig. 1A). The retrieved 3D fault
Fig. 1 - A) Three-dimensional scheme of the Campotosto seismogenic source. Curved geometry of the fault plane is derived from the seismicity (black dots) distribution on the fault during the 2009 seismic sequence (inset) (from Valoroso et al., 2013). The modelled fault plane is planar and projection of the coseismic slip on a listric fault geometry is for illustrative purpose only. CF = Campotosto fault trace; B) Present seismotectonic and structural 3D scheme of the area under investigation, showing the relationship between the Campotosto fault, Amatrice fault and Mt. Vettore-Mt. Bove fault, with the Ancona-Anzio Fault; the structural scheme of the Mt. Vettore-Mt. Bove seismogenic source is shown in cross-section in inset.

geometry matches the Campotosto fault at surface, defined by means of geological observations (e.g. Galadini and Messina, 2001), and fits the causative fault geometry defined by Cheloni et al. (2014) for the 2009 events in this area. This confirmed that the 2009 and 2017 sequences occurred along the same seismogenic structure.
Then, in order to make inferences about the possible residual seismic moment still stored by the Campotosto seismogenic source, we combined new geological/geomorphological field data with 1945 aerial photographs interpretation and seismological data of the 2009-2017 seismic sequences, to define a three-dimensional picture of the Campotosto fault. This permitted to estimate the credible maximum expected magnitude (in terms of seismic moment), by using the regressions of Wells and Coppersmith (1994) and Galli et al. (2008), of an earthquake generated by the fault, from which we subtracted the seismic moment released by the fault during historical seismicity, and during the 2009-2017 seismic sequences. We infer that the fault can still release seismic moment equal to a Mw 6.4-6.6 earthquake.

To define the 3D geometry of the Campotosto seismogenic structure, we had to investigate its relation with the nearby faults, especially with the Amatrice fault, which aligns with the Campotosto fault, to the south, and with the Mt. Vettore-Mt. Bove fault, to the north. The Amatrice fault ruptured during the 24 August 2016 seismic event, together with the southern portion of the Mt. Vettore-Mt. Bove fault. Geological and geomorphological observations, coupled with the analysis of the 2016 aftershocks sequence, confirmed that, as hypothesised by Galadini and Messina (2001), the Amatrice and Campotosto faults are structurally and kinematically separated from one another, and they experienced completely different Quaternary slip history, being therefore related to independent seismogenic sources. Our analyses allowed us to infer that separation of the Amatrice fault from the Campotosto fault likely coincides with a tranverse structure that acts as segment boundary.

Hence, to distinguish the seismic potential of the Amatrice fault, with respect to the Campotosto fault, we investigated also the northern boundary of the Amatrice fault. Seismological and geodetic evidence related to the 2016-2017 seismic sequence and a deep analysis of the geological knowledge of this area suggested that the separation between the Amatrice and the Mt. Vettore-Mt. Bove faults is represented by the regional NNE-SSW trending tectonic structure known as Ancona-Anzio Fault; this is a complex lithospheric tectonic feature whose activity began as extensional fault during the Mesozoic, experienced strike-slip kinematics during the Oligocene, then it has been positively inverted during the Pliocene, acting as the commonly known Sibillini-Olevano-Antrodoco thrust front (e.g. Castellarin et al., 1978; Tavarnelli et al., 2004).

In this scenario, the presence of such a complex shear zone may have played a fundamental role in the 24 August 2016 event, allowing a “jump” of the coseismic rupture from one fault (the Amatrice fault) to the adjacent fault (the Mt. Vettore-Mt. Bove fault), consistently with the model proposed by Lyakhovsky et al. (2016). This model, in fact, may explain the presence of two distinguished rupture patches of the 24 August event, separated by a zone of almost absence of slip (Tinti et al., 2016), whose width may represent the Ancona-Anzio Fault zone.

The definition of fault geometry and segmentation of the Campotosto, Amatrice and Mt. Vettore-Mt. Bove active faults (Fig. 1B) permitted us to test the robustness of our inference about the residual seismic moment on the Campotosto fault. Indeed, defining our preferred 3D geometry of the Mt. Vettore-Mt. Bove allowed us to define the maximum seismic moment potentially stored by the fault prior to the 2016 seismic sequence. Then, by subtracting the seismic moment released during the 24 August and 26 October 2016 events, the residual seismic moment on the fault would have been corresponding to an about Mw 6.5-6.6 seismic event. And that is was occurred with the Mw 6.5 30 October 2016 mainshock. Hence, this allows to consider our approach at least plausible in terms of definition of the residual seismic moment for the Campotosto fault.

Acknowledgments. The complete research has been published on the journal Tectonics, as: Falcucci E., Gori S., Bignami C., Pietrananto G., Melini D., Moro M., Saroli M. and Galadini F.; 2018: The Campotosto seismic gap in between the 2009 and 2016–2017 seismic sequences of Central Italy and the role of inherited lithospheric faults in regional seismotectonic settings. Tectonics, 37, 2425–2445. https://doi.org/10.1029/2017TC004844. The authors acknowledge Daniele Cheloni and Massimo Cocco for the fruitful discussion, especially on seismotectonic
issues and fault rupture models. Federica Riguzzi provided us with the coseismic GPS offsets of the 18 January 2017 seismic events. We thank all the agencies and institutions that have made the GPS observations available for this study. We thank the European Space Agency for providing Sentinel-1 SAR images (freely available at https://scihub.copernicus.eu/dhus/). GPS station TER 2 was installed by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) and we acknowledge Dr Piera Gambino and Dr Stefano Calcaterra for providing us the related GPS data. This research has been partly founded by INGV-FISR Project 2016 Centro di Studio e Monitoraggio dei Rischi Naturali dell’Italia Centrale.

References