GNGTS

Gruppo Nazionale di Geofisica della Terra Solida

Atti del 40° Convegno Nazionale

27 - 29 GIUGNO 2022

TRIESTE - STAZIONE MARITTIMA

OGS

EAGE EUROPEAN ASSOCIATION OF GEOSCIENTISTS & ENGINEERS

SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

SEZIONE ITALIANA

21° CONVEGNO NAZIONALE

WHAT WAS THE ROLE OF FAULTS IN THE EVOLUTION OF THE MONTEREALE BASIN (CENTRAL APENNINE)? CONSIDERATIONS AND NON-EXHAUSTIVE ANSWERS

E. Chiarini[1], G. Nirta[1], A. Sciortino[2], M. Spadi[2], M. Tallini[2]

[1] Servizio Geologico d'Italia – ISPRA. Roma, Italy
[2] DICEAA - Università degli Studi dell'Aquila. Aquila, Italy

The Montereale basin is the northernmost of the intermontane basins along the Aterno River. It is located in the tectonically active axial sector of the central Apennine between the Western Fault Systems (WFS) and the eastern ones (EFS; Galadini and Galli 2000). In the last two decades, these fault systems were the source for several earthquakes with magnitude Mw ≥ 6.0. The basin is a structural depression located in a complex tectonic context, between the western limit of the E-W oriented Gran Sasso ridge and the SSW-NNE oriented Olevano-Antrodoco thrust system.

The basin is bordered to the NE by the Capitignano fault (CPF), while a second fault, the San Giovanni fault (SGF) is located in the center of the basin and seems to guide the formation of a sub-basin in the south-western sector (Fig. 1). The activity of the two faults has always aroused considerable interest because of their location between the active WFS and EFS, and for a long time represented an unsolved problem due to the lack of detailed studies on the quaternary stratigraphy of the basin. The SGF and CPF have been alternatively considered to be part of the Upper Aterno fault system in the WFS (Galadini and Galli 2000; Galadini *et al.*, 2000; Galadini and Messina, 2004), being part of the seismogenic source of the Laga Mt. fault in the EFS (Boncio *et al.*, 2004); or as a separate seismogenic source, capable of generating strong earthquakes (Lavecchia *et al.*, 2012).

Over the past decades, the basin and the surrounding areas have been studied during the national geological mapping program (sheet n. 348-Antrodoco; Chiarini *et al.*, 2014; Servizio Geologico d'Italia, 2022) and seismic microzonation studies (Tallini, 2017; Nocentini, 2018). Instead, the mapping of SGF and CPF has been carried out in detail in the in recent years (2021-2022) in the frame of the studies aimed at mapping the active and capable faults in the areas of the Montereale Basin that were affected by multiple seismic events since 24 August 2016 (Tallini *et al.*, 2021).

The analysis of the LiDAR digital terrain model allowed a more detailed mapping, in some cases substantially different from what has been published so far (Civico *et al.*, 2016). The features recognized on the digital topography were then verified on the ground and structural data were collected on the exposed fault scarps.

Thus, the fault traces were investigated by geophysical studies. A total of sixteen electrical resistivity tomographies (ERT), twelve across the CPF and four across the SGF, and two reflection seismic surveys across the CPF were performed. The results were integrated with the field data and the LiDAR analyses and allowed to choose the sites for three paleo-seismological trenches, one across the SGF and two across the CPF.

The trench across the San Giovanni fault (Fig. 1) is placed in the hangingwall of the faults detected in the paleoseismological trenches dug by Cinti *et al.* (2018). The trench exposed a sedimentary succession resting on the limestone substrate. The upper Pleistocene deposits, with an age <40,000 years, are faulted by splay faults of the main structure with decimetric offsets while the substrate is displaced by about 3 meters.

Two trenches were dug across the CPF, one at the base of the mountain front and one farther downstream (Fig. 1) to investigate a possible structure located within the Montereale basin. In the first case, the trench exposed faulted sediments, upper Pleistocene in age, while the arenaceous substrate shows a cumulative offset of about 2 m. In the second case, the upper Pleistocene sediments, that were investigated up to a depth of about 6 m, did not show clear faulting evidence.

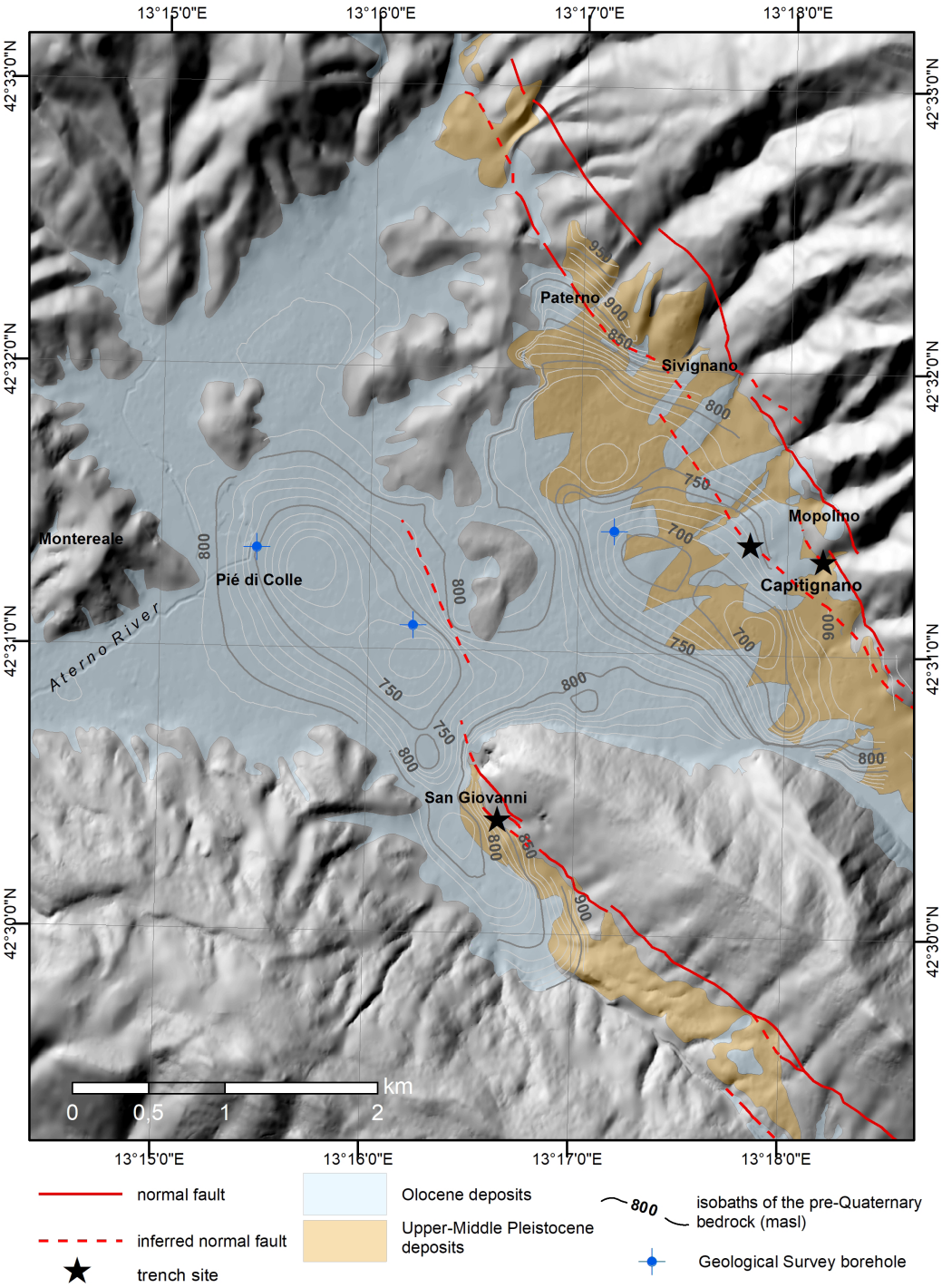

Fig. 1 - Geological sketch of the Quaternary infill of the Montereale intermontane basin. Isobaths of the pre-Quaternary substrate (masl) modified after Chiarini *et al.,* 2014.

Despite the Montereale basin is substantially undissected and therefore with scarce exposure of the Quaternary deposits, the reconstruction of the stratigraphic evolution was possible by integrating the field mapping with geophysical studies, core drillings, paleomagnetic analyzes and, ^{14}C and $^{39}Ar/^{40}Ar$ dating.

In the Montereale basin two different depocenters characterized by significantly different thickness of the Quaternary deposits can be recognized (Fig. 1), higher for the Capitignano depocenter, in the hangingwall of the CPF, and smaller in the depocenter of Piedicolle, at the northwestern tip of the SGF. Obtained data suggest that in the first phase of the sedimentary evolution of the basin, the fault-related subsidence exceeded the sedimentation rate, allowing the persistence of lacustrine sedimentation. Subsequently, between the early Pleistocene and middle Pleistocene, a slowdown in the activity of the CPF allowed the threshold between the two depocenters to be overcome and a drainage pattern similar to the current one to be established. Thus, the Montereale basin has followed the same evolutionary pattern recognized for other intermontane basins in the Central Apennines; it has been rather early captured by the Aterno hydrographic system, because of its position along the Apennine watershed and of the low tectonic subsidence (D'Agostino *et al.*, 2001). Geurts *et al.* (2020), argue that the integration of the intermontane basins in the hydrographic system of the Aterno network is part of the natural evolution of the hydrographic network rather than strictly related to the tectonic and climatic factors.

Between the late middle Pleistocene and the present, alternating aggradation and erosive episodes, suggest that the activity of the CPF was no longer able to compensate the sedimentary rates and therefore the evolution of the basin was essentially controlled by external factors (e.g. lowering of base level). However, the persistence of a modest tectonic activity is testified by the dislocation of the deposits of the upper Pleistocene along the CPF and SGF.

In addition to the clear societal impacts, this study aims to investigate a complex area where faults such as those studied, albeit of small extension, about 7 km that of San Giovanni and about 10 that of Capitignano, show clear evidence of having controlled the Quaternary sedimentation. Furthermore, the study of these "small" structures is important as it can provide information on the relationships and possible interactions with the "large" structures located in the most eastern (Laga and Gran Sasso) and western (Alto Aterno) fault systems.

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