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Quaternary transpression and lacustrine sedimentation in the San Lorenzo area (Sant'Arcangelo Basin, Italy)

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ABSTRACT

Quaternary lacustrine sedimentation of the San Lorenzo Succession represents one of the more recent steps in the evolution of the northern part of the Sant'Arcangelo Basin. The latter is a large Pliocene to Pleistocene wedge-top depozone of the southern Apennines foreland-basin system that developed close to the front of the thrust belt in southern Italy.

The lower to middle Pleistocene lacustrine deposits are composed of siltstone and claystone interbedded with sandstone, carbonate and volcaniclastic beds, arranged in fining-upward sequences. The overall stratigraphical, sedimentological, and structural data collected demonstrate that the San Lorenzo lacustrine deposits formed when the northern sector of the Sant'Arcangelo Basin was undergoing tectonic deformation. In particular, new data reveal the presence of strike-slip syndepositional faults. These faults belong to positive flower-type structures, which developed in a left-lateral transpressive tectonic regime characterized by a E–W horizontal component of shear stress. The lacustrine deposits recorded the activity of these faults showing growth structures represented mainly by gentle synclines, as well as other minor folds. The tectonic activity of the main faults formed an endorheic area with at least two different depocentres accumulating lacustrine successions.

1. Introduction

Lacustrine depositional systems occur in a wide range of structural settings, and their formation is often strongly controlled by synsedimentary tectonics (e.g. Gierlowski-Kordesch and Kelts, 2000). Within the Apennines mountain chain (Italy), several satellite basins developed during Pliocene and Quaternary times, and lacustrine successions characterize intervals of their sedimentary infill, mainly recording transtensional and/or extensional tectonic regimes (e.g. Cavinato, 1993; Basilici, 1997; Cavinato and Miccadei, 2000; Cavinato et al., 2002). The aim of this paper is to show the stratigraphical and structural features of the San Lorenzo lacustrine deposits (Sabato, 1997, 2000) that developed during early and middle Pleistocene times in a small sector of a wide satellite basin, called the Sant'Arcangelo Basin, in the southern Apennines (Fig. 1A). The San Lorenzo lacustrine deposits, cropping out along very continuous natural exposures, allow us to observe and analyze the relationships between the development of depositional systems and synsedimentary tectonic deformation, and to suggest a structural framework to explain the complex evolution of the northern part of the Sant'Arcangelo Basin during the Quaternary.

2. Geological setting

The studied Quaternary lacustrine deposits crop out in the middle sector of the northern part of the Sant'Arcangelo Basin, exposed and deeply cut by rivers during late Quaternary time. The Sant'Arcangelo Basin is a large marine to continental satellite basin of the southern Apennines (a wedge-top depozone in a foreland-basin system, according to definitions of DeCelles and Giles (1996)). Its sedimentary infill records timing and style of syndepositional tectonics affecting the southern Apennines, at least from late Pliocene to middle Pleistocene times (Casero et al., 1988; Caldara et al., 1988; Roure et al., 1991; Hippolyte et al., 1991; Pieri et al., 1994, 1996; Patacca and Scandone, 2001). According to subsurface data, the Sant'Arcangelo Basin is filled by at least a three km thick sedimentary succession (Patacca and Scandone, 2001) (Fig. 1B). Several authors have proposed different formal and/or informal stratigraphical subdivisions for the exposed part of the succession (e.g. Vezzani, 1967; Lentini and Vezzani, 1974; Pieri et al., 1993, 1994; Lentini et al., 2005; Benvenuti et al., 2006). A critical review of the different stratigraphical interpretations of the Sant'Arcangelo Basin fill is outside the scope of the present work. Here we follow nomenclature proposed by Pieri et al. (1993, 1994), slightly

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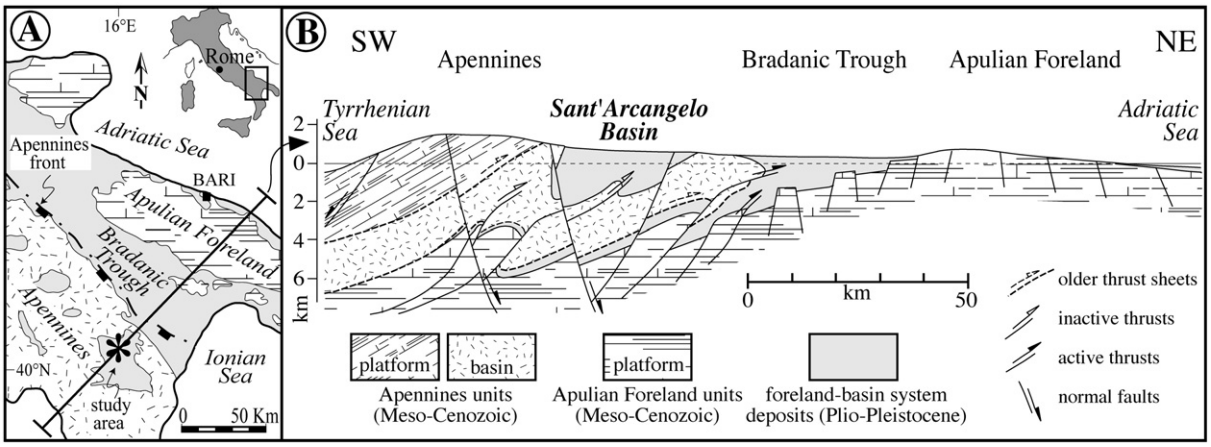

Fig. 1. A) Schematic geological sketch of southern Italy; the asterisk marks the study area. B) Schematic cross-section through the southern Apennines. Locally, the wedge-top depozone corresponds to the Sant'Arcangelo Basin.
Modified from Sabato, 2000.

modified by Onofrio (2008) (Fig. 2A, B). The latter, according to biostratigraphical data of Marino (1993, 1994) and Pieri et al. (1996), subdivides the basin-fill succession of the Sant'Arcangelo Basin into four late Pliocene to middle Pleistocene depositional sequences that are, from the bottom: (1) the Caliandro Sequence, late Pliocene in age; (2) the Agri Sequence, late Pliocene–early Pleistocene in age; (3) the Aliano Sequence, early Pleistocene in age; and (4) the Sauro-San Lorenzo Sequence, early–middle Pleistocene in age (Fig. 2B, C). Thickness of each sequence varies from some hundreds of metres to over one thousand metres, and each sequence is composed of both continental and marine facies (Pieri et al., 1996).

3. The Sauro-San Lorenzo Sequence

The early-middle Pleistocene Sauro-San Lorenzo Sequence (including the studied lacustrine deposits) developed only in the northern part of the Sant'Arcangelo Basin and lies on the underlying Aliano Sequence separated by a gentle angular unconformity passing eastward to a correlative conformity. The Sauro-San Lorenzo Sequence begins with sediments of an alluvial system (unit a of the San Lorenzo Succession — Fig. 3A, B and step t1 in Fig. 3C) passing basinward (eastward) to fan delta and shelf deposits (lower part of Sauro Succession — Fig. 3A, B and step t1 in Fig. 3C). When the growth of a ridge split this basin-margin area into two depositional regions (step t2 in Fig. 3C), coeval but separate depositional systems developed (Pieri et al., 1994, 1996). In the western region, lacustrine deposition (unit b of the San Lorenzo Succession — Fig. 3A, B and steps t2 and t3 in Fig. 3C) replaced alluvial sedimentation, whilst in the eastern region, marine shelf environments persisted (upper part of Sauro Succession — steps t2 and t3 in Fig. 3C).

4. The San Lorenzo Succession

4.1. Stratigraphical and sedimentological features

The San Lorenzo Succession, representing the western part of the Sauro-San Lorenzo Sequence (Fig. 3A, C), has a maximum thickness of about 250 m, and is comprised of two lithological units (units a and b in Fig. 3). The unit a, about 50 m thick, is mainly composed of conglomerates with metres thick matrix- or clast-supported beds, separated by thin layers or lenses of sandstones. Commonly the lower bed contact is erosive and exhibits channel features. The conglomerates are trough cross-bedded and clasts are rarely imbricated and mostly sub-rounded with sizes ranging from 1 to 30 cm. In the upper part of unit a, the conglomerates pass to horizontal- or trough cross-stratified sandstones. Palaeocurrents show palaeoflow direction towards the east–southeast. According to Onofrio (2008), the lower unit of the San Lorenzo Succession was deposited in alluvial fan systems (unit a in Fig. 3C).

The unit b (Fig. 3C) is mainly composed of silty claystones with a variable thickness of several tens of metres to about 200 m. This unit is developed in a NW–SE-elongated endorheic area in two different and probably not always connected depocentres. The first depocentre is located in the vicinity of the Sauro River, where deposits show mainly palustrine features, and the other depocentre is to the north of the Agri River, where deposits are lacustrine in origin (Sabato, 2000) (Fig. 2B). In both depocentre domains the deposits are gently folded into a syncline (Fig. 2B, C).

The following sedimentological study targets unit b of the San Lorenzo Succession cropping out north of the Agri River, where an early to middle Pleistocene age was determined by chronological, biostratigraphical and paleomagnetic data. In particular, the upper part of the unit was dated at 1.1 ± 0.3 Ma (Caggianelli et al., 1992) through K–Ar radiometric dating of a volcaniclastic layer (see asterisk in log 1 of Fig. 4), and was given a middle Galerian age in a biostratigraphical study of a vertebrate fossil horizon (see double asterisk in log 2 of Fig. 4) (Masini et al., 2005). Integrating these data with paleomagnetic analyses along the entire lacustrine unit, the Jaramillo, late Matuyama, and Brunhes chrons were recognized (Mattei et al., 2004; Sabato et al., 2005a) (Fig. 4).

In this lacustrine system, the facies were logged at both the depocentre (log 1) and a marginal (log 2) area (Figs. 2 and 4).

At the lake depocentre (log 1 in Fig. 4), the deposits are arranged in fining-upward sequences composed of normally graded and parallel- to ripple cross-laminated silty sandstones or sandstones passing upward to very finely laminated or bioturbated claystones, with a total thickness varying from some decimetres up to 1–2 m. The base of some sequences is composed of volcaniclastic layers; carbonate beds and rare horizons rich in organic matter are commonly interbedded. According to Moretti and Sabato (2007), these sequences represent deposition from density currents that operated in an environment normally characterized by low energy conditions and fine-grained sedimentation. These deposits also show soft-sediment deformation structures (deformed laminations, slumps, small- and large-scale load-structures, large-scale water-escape structures, and neptunian dykes) (Moretti and Sabato, 2007).

These lake centre deposits pass laterally (NW) to the marginal area of the system where approximately 30 m of claystones and silty claystones in the lower part are overlain by 20 m of sandstone–claystone beds. In these upper beds, silty and volcaniclastic layers, up to 1 m thick, also occur (log 2 in Fig. 4).