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Subaerial exposure and drowning processes in a carbonate platform during the Mesozoic Tethyan rifting: The case of the Jurassic succession of Western Sicily (central Mediterranean)

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ABSTRACT

The Liassic carbonate platform succession outcropping at Monte Maranfusa (central Western Sicily) consists of a shallowing-upward sequence of peritidal carbonates, with Jurassic to Paleogene pelagic limestone and siliciclastic Tertiary covers above. The cyclic sequences of subtidal wackestones/packstones, intertidal microcrystalline carbonates with bird's-eye pores, and supratidal bioclastic grainstones are interbedded with dark layers of the following composition: 1) dark-gray, compact, and well-cemented limestone with blackish clasts, interpreted as calcretes (a type of carbonate soil) and 2) reddish calcite laminae, deformed by elongated cavities, filled with vadose silt, interpreted as paleokarst. This succession is crossed by almost vertical faults, of the Late Liassic to Miocene, which often coincides with neptunian dykes, filled by several generations of Toarcian–Early Miocene pelagic sediments. Another system of dykes, known as neptunian sills, filled by injected Upper Lias–Dogger pelagic sediments, lies parallel to the stratification. The parallel dykes were caused by the flexure of the platform during the Jurassic and presumably by a planar slip in the carbonate rocks, whereas neptunian dykes are caused by faulting episodes. Here, we present evidence that the dark layers in the Liassic succession of Monte Maranfusa, previously described by many authors only as parallel dykes, can actually be interpreted as a) neptunian sills, b) pedogenic calcretes, and c) paleospeleothems. Therefore, we found evidence of exposure/flooding intervals in the evolution of the carbonate platform during the Liassic, linked to different pulses in both the subsidence/tectonic activity and the sea-level oscillations. At the top, Fe–Mn crusts (hardgrounds) seal the carbonate platform succession, which is in turn overlain by condensed pelagic deposits, confirming its drowning during rifting processes.

1. Introduction

During the Mesozoic, the central Mediterranean region was characterized by a wide carbonate platform flanked by large deep-water areas to the north and east (Wendt, 1963; Jenkyns, 1970; Catalano et al., 1996, 2000), growing on the stretched African continental crust (Catalano et al., 2013). Like most of the Mediterranean region, during the Jurassic, this carbonate ramp underwent a drowning process, which produced pelagic sedimentation on the submerged plateau. Within the carbonate platform, some sectors differentiated because of diachronous drowning and consequent variable thickness of the succession and pelagic facies association (Di Stefano, 2002; Martire and Pavia, 2002). Studies on Mediterranean Jurassic deposits revealed the association of changes in environment and sedimentation with tectonic and volcanic events, anoxic episodes, and mass extinction (Bernoulli and Jenkyns, 1974; Catalano and D'Argenio, 1978; Alvarez, 1990; Bertotti et al., 1993; Catalano et al., 2001).

During the Lias, in different areas of the western peri-Tethyan region, such as the Apennines in Italy (Colacicchi et al., 1975; Catalano and D'Argenio, 1982a,b; Barattolo and Bigozzi, 1996), Dinarides in Slovenia (Dozet, 1993), Baetic Cordillera and Gibraltar in Spain (Ray, 1997; Bosence et al., 2000), and Atlas in Morocco (Crevello, 1991), small-scale shallowing-upward peritidal carbonate cycles were generated by either autocyclic (progradation of tidal flat or lateral migration of tidal channels; Ginsburg, 1971; Pratt et al., 1992; Satterley, 1996) or allocyclic (tectonics, eustatic fluctuations; Hallam, 1988; Strasser, 1988) control mechanisms (Strasser, 1991). These cycles are formed by a subtidal unit of an inner platform with benthic foraminifera, gastropods, and calcareous algae that may or may not grade upward into an intertidal unit, followed by supratidal pedogenetic caps (Wright, 1994; Barattolo and Bigozzi, 1996; Sattler et al., 2005). The Lower–Middle Liassic shallow-marine carbonate succession consists of several well-developed subaerial exposure surfaces and paleosols that show remarkable vadose diagenesis and continental conditions, either on tops of

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peritidal cycles or upon subtidal deposits indicative of the relative sea-level fall (Wright, 1986; Wright et al., 1988).

In the Apennines, Alps, and other segments of the Mediterranean chain, the Mesozoic pelagic sequences overlay dismembered remnants of the Triassic–Lower Jurassic carbonate platform that were submerged during the rifting processes (Bernoulli and Jenkyns, 1974). Abrupt lithological changes, reflective of varying environments and sedimentation, occur largely in the Triassic–Jurassic carbonate platforms to drowning-platform successions (Catalano and D'Argenio, 1982a,b; Di Stefano et al., 2002; Basilone et al., 2010; Basilone, 2011). The drowning of carbonate platforms can be controlled by many factors, due to their inability to balance the rate of relative sea-level rise. These factors include rapid eustatic sea-level rise, subsidence, ecological stress, water temperature, upwelling of cold deep water, and the rate of sediment

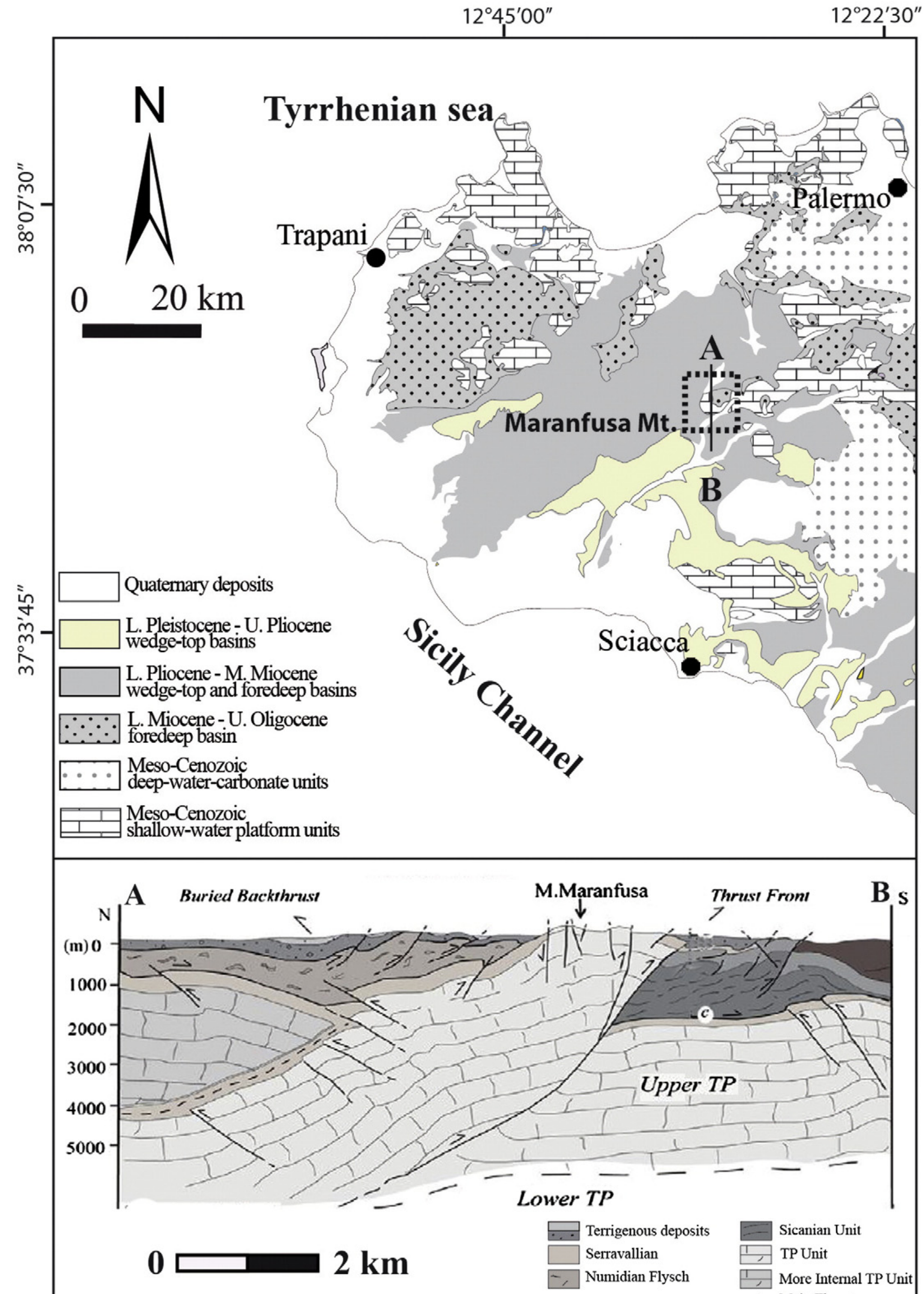

Fig. 1. Structural map of Western Sicily with location of the study area (modified from Catalano et al., 2000) and geological section (below), showing the tectonic setting of shallow-water (Trapanese) and deep-water (Sicanian) carbonates (from Albanese and Sulli, 2012).