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Decline and recovery of the Aptian carbonate factory in the southern Apennine carbonate shelves (southern Italy): Climatic/oceanographic *vs.* local tectonic controls

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ABSTRACT

In interpreting the inception and demise of different carbonate depositional systems, climatic-oceanographic variations together with sea-level oscillations are commonly considered key elements. However, local tectonic controls cannot be ruled out. In attempts to discriminate among the main factors controlling the evolution of the southern Apennine mid-Cretaceous carbonate system, detailed facies analyses have been performed on Aptian–Albian carbonate successions in the Matese Group (southern Apennines). Since the mid Aptian, the analysed successions testify to a tectonically-driven topography, replacing the previous large tropical shallow-water domain with subdomains characterised by diversified sedimentological trends. Nevertheless, around the middle part of the Aptian, the studied successions register palaeoecological signals that cannot be linked exclusively with tectonic disturbance because of the coeval appearance of analogous signals at a global scale, including a significant change in biological assemblages and an outbreak of organisms indicative of stressful conditions in the water mass.

Upper Bedoulian strata clearly record open marine settings characterised by a significant richness of the benthic communities. The biota included rudists, gastropods and echinoids plus many different benthic foraminifers and green algae. Rudists considered to be typically "tropical" forms (the caprinid *Offneria nicolinae* (Mainelli) and *Offneria murgensis* Masse, the requieniid *Lovetchenia* Masse and the monopleurid *Agriopleura* Kühn) characterise thick subtidally deposited strata in which large coral colonies and mollusc shells contributed to occasional storm-related skeletal concentrations.

The analysed Gargasian strata show impoverished biota: caprinids totally disappear, both as *in situ* and storm-related layer components, and hermatypic corals are drastically reduced. Muddy lithofacies prevail in intertidal metric cycles in which cyanobacterial consortia, both in the form of dense laminae and coalescent oncoids, orbitolinids and small gastropods (cerithiids) suggest restricted, nutrient-rich water. Large oncoids of *Bacinella irregularis*/*Lithocodium aggregatum* and mollusc (mostly chondrodontids and gastropods) shell fragments significantly contribute to storm-related coarse skeletal intercalations, in which oligotrophic condition-adapted forms (e.g., hermatypic corals) are reduced or absent. This pattern suggests generalised conditions of stress in the water mass and in more marginal open areas.

During the mid-Aptian interval, characterised by the flourishing of assemblages adapted to mesotrophic–eutrophic conditions, the southern Apennines shallow-water domain shows a progressive reduction of the previous mainly aragonite-dominated chlorozoan assemblages and an increase of calcite-dominated skeletal components, including rudists with thickened calcitic outer shell layers. Cyanobacteria and polychaetes characteristically marked the first phases of recovery in the shallow-water domains, rapidly evolving into more complex and differentiated assemblages. The outbreak of nerineid and acteonid gastropods seems to be related to a flourishing of cyanobacterial mats and related microphytae and also to the presence of polychaetes tubes (*Thartarella cocumeriformis* (Wahlman)). Moreover, the grazing activity of the nerineids favoured the flourishing of oyster-like bivalves. Among the rudists, the persistence and radiation of species adapted to a wide range of temperatures, such as Requieniidae and Monopleuridae as well as the first elevator Radiolitidae suggests some kind of oceanographic change (e.g., seawater chemistry and/or temperature).

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On the basis of the features described above, we propose the existence of a complex environmental scenario in which cooler conditions, presumably coupled with meso/eutrophic and locally oligophotic conditions, related to climatic/oceanographic global changes, cooperated in modifying the carbonate factory characterisation in a tectonically controlled setting.

1. Introduction

Lower Cretaceous peri-Tethyan successions record alternating phases of vigorous development and rapid deterioration of shallow-water carbonate factories. According to prior studies, shallow-water carbonate systems reached a maximum palaeogeographic extent during the Early Bedoulian, whereas facies development became widely altered in the mid-Bedoulian in association with the well-known Oceanic Anoxic Event 1a (OAE1a) (Skelton and Gili, 2012, and references therein). Crisis episodes are locally expressed by drowning events, as well as by drastic changes in the biotic assemblages, with or without intervening subaerial exposure episodes or in relation to increased siliciclastic input (Weissert et al., 1998; Graziano, 1999; Masse et al., 1999; Wissler et al., 2003; Föllmi and Gainon, 2008 among others). Although climatic–oceanographic variations, together with sea-level oscillations, are the key elements in controlling the inception, demise and changes in the composition and geometry of different depositional systems, local tectonic controls cannot be ruled out. In recent years, a significant number of papers have been published dealing with the syn-sedimentary tectonically driven evolution of Cretaceous carbonate depositional systems (see Graziano, 2000, Tišljar et al., 2002, and Carannante et al., 2009, among others). The goal of the present study is to search for possible links between variations in carbonate system characteristics (facies stacking patterns and geometries of the sedimentary bodies) and global events in contexts where syn-sedimentary tectonics were active.

Several Cretaceous carbonate successions cropping out in the southern Apennines (Italy) provide good examples for this particular topic. Carannante et al. (2009) recognised in southern Italy, both from outcrop and core data, a sharp variation in the sedimentary dynamics and depositional architectures of the Aptian–Albian carbonate systems controlled by tectonics: in the mid-Aptian the uniform, shallow-lagoon, flat-topped system rapidly evolved into a more complex system in which shallow-water, rudist-dominated, carbonate production areas were patchily located in open-shelf settings closely spaced with by-pass and deeper basinal areas.

All the Cretaceous southern Apennine carbonate sequences were first interpreted as pertaining to tropical carbonate platforms (for a synthesis, see D'Argenio, 1988). More recent works have recognised a sharp change in the facies characterisation and in the biotic assemblages from the "mid-Cretaceous" time interval onwards (Carannante and Simone, 1987; Carannante et al., 1997, 2006; Simone and Carannante, 2008). The pre-Aptian central-southern Apennine shallow-water carbonate domain was characteristically occupied by chlorozoan assemblages, in which almost entirely aragonite-shelled rudists, corals, larger foraminifera and calcareous green algae co-existed with abundant nonskeletal grains. Only minor episodes of perturbation of carbonate systems are recorded in this time interval (Graziano, 1999; Simone and Carannante, 2008), but this is beyond the scope of the present work. The Aptian-Turonian limestone records significant shifts in the biotic assemblages, from chlorozoan to chlorozoan-impoverished/foramol communities, punctuated by repeated crisis episodes among the platform-dwelling biota (cyanobacterial-dominated facies) and specific mineralogical signatures concerning the skeletal aragonite/calcite ratio (Carannante et al., 2008). To discriminate, if possible, between local (tectonic) and global (climatic–oceanographic) controls on the evolutionary history of the southern Apennine carbonate depositional settings, thorough stratigraphic analyses were performed in selected outcropping areas of the Matese Group (southern Apennines, Italy, Fig. 1), focussing on the Aptian–Albian interval due to its significant peculiarities both in terms of lithofacies and biotic turnover.

2. Geological setting

The Matese Group provides significant relief in the central-southern Apenninic sector (Fig. 2), with peaks locally exceeding 2,000 m. The related geological features have been described from the late 19th century. Since the 1960s, significant studies on their general and structural aspects were performed by D'Argenio (1963), Ietto (1969), Sgrosso (1988), Patacca et al. (1990), Scrocca and Tozzi (1999), Pescatore et al. (1999), and Calabrò et al. (2003). Detailed analyses of the facies can be found in D'Argenio (1963), Carbone and Sirna (1981), Accordi and Carbone (1988), Carannante et al. (1993; 1997; 2009), Ruberti (1991; 1993a; 1993b; 1997), and Simone et al. (2003), among many others.

In the Matese, thick Mesozoic–Caenozoic carbonate successions crop out, covered by Upper Miocene flyshoid deposits (Fig. 2). The carbonate successions were exposed by deformation of a large palaeogeographic domain (the Apennine–Apulia carbonate depositional systems), pertaining to the Adria Promontory (the central-southern Tethyan belt). Since the Late Triassic, major structural elements have been repeatedly reactivated, controlling the palaeo-environmental evolution of the various subdomains, each characterised by different facies associations (D'Argenio, 1966; Iannace et al. 2005a, 2005b, Carannante et al., 2009). In particular, the mid-Cretaceous interval shows evidence for several structuring phases largely controlling the carbonate sedimentary systems. The related limestone, analysed in the Matese outcrops, compared with the coeval carbonate sediments of the subsurface Inner Apulia Carbonate Unit cored in neighbouring areas (the Benevento oilfield and the Monte Taburno 1 and Morcone 1bis wells) show that, beginning from the Late Aptian, a large carbonate domain (Inner Apulia Platform) was dismembered into a series of subdomains, which included shelf productive areas and a series of small intraplatform basins (or elongated depressions) locally affected by significant subsidence (Carannante et al., 2009). Tectonically active margins, characterised by the presence of complex channel networks, developed alongside the small intraplatform basins in which resedimented carbonate debris accumulated. Moving upward in the successions, the mid-Cretaceous depositional intervals record long-lasting subaerial exposure episodes locally characterised by stratigraphic gaps variable in age and duration, shallow or deep subsurface karst features and the occurrence of discontinuous lenses of bauxite, all considered to be mainly the product of exposure driven by tectonic uplift (see Carannante et al., 1988, 1994; Ruberti, 1992; Carannante et al., 2009). This confirms the complex post-Aptian tectonically driven palaeo-topography, with different evolution in the resulting subdomains.

Active tectonic features are clearly evident for the Late Aptian–Albian transition and in the Early to mid-Cenomanian