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Biotic changes and their control on Oligocene-Miocene reefs: A case study from the Apulia Platform margin (southern Italy)

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Abstract

The Oligocene-Miocene represents, for the Cenozoic, a period of extensive reef development and is characterized by a number of important changes influencing both carbonate-producing biota and architecture of reefs and carbonate platforms. The Mediterranean region, in particular, was characterized during this time by a complex palaeogeographic and climatic history with stepwise transition towards cooler conditions, biotic turnovers and the complete disappearance of zooxanthellate corals and reefs at the very end of the Miocene.

A comparative study of two reef complexes that in different times (Chattian and Messinian) grew in the same physiographic and depositional setting, i.e. the stable, undeformed eastern margin of the Apulia Platform (eastern coast of the Salento Peninsula, southern Italy), highlights evolutionary, ecological and climatic changes that differentiate Oligocene and Late Miocene reef biota of the region. In particular, the study illustrates how different reef biotic assemblages can produce different reef types, frameworks and growth fabrics along reef tracts and reef slopes.

The Chattian reef is characterized by a homogeneous reef-building biota, being largely dominated by a high diversity and abundant coral fauna associated with a moderate presence of coralline algae, and thus forming a single reef type. In contrast, the Messinian reef shows a very low coral diversity but several other reef-building components with abundant and varied secondary reef builders (coralline algae, *Halimeda*, encrusting foraminifera, bryozoans, serpulids and microbial associations). The reef, therefore, is characterized by a heterogeneous reef-building biota that forms different frameworks and growth fabrics.

The feedback to the environment of this different biotic composition is very evident in the two reefs and especially in the slope. During the Chattian a slope, mainly consisting of gravity-displaced debris, resulted from the abundant production of reef rubble, associated with a relatively poor framebuilding capacity. Conversely, during the Messinian, a biologically stabilized slope resulted from proliferation of a variety of binding organisms that strongly colonized the substrate.

The climatic cooling which occurred during the Miocene may be considered the main controlling factor of the diversity turnovers and changes that affected the coral fauna, but other environmental factors, such as changes in nutrient regimes and in hydrodynamic conditions of the sea associated with the emerging Apennine chain, may have played a role in determining differences in the reef biota and in the reef facies.

Keywords: Reefs; Reef biota; Reef slope; Oligocene; Miocene; Italy

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1. Introduction

The Oligocene and Miocene represent, for the Cenozoic, a period of extensive reef development and are characterized by a number of important changes influencing carbonate-producing biota and the architecture of reefs and carbonate platforms (for a review see Perrin, 2002).

The Mediterranean region in particular was characterized, during this time, by a complex palaeogeographic and climatic history with stepwise transition towards cooler climates, biotic turnovers and the almost complete disappearance of zooxanthellate corals and reefs at the very end of the Miocene (Chevalier, 1962; Esteban, 1996; Rosen, 1999; Perrin, 2002). Mediterranean Oligocene-Miocene reef ecosystems were well developed and most buildups, cropping out in many localities with excellent exposures and occurring in a wide variety of structural and depositional settings, represent a crucial record for elucidating the complex dynamics of interactions and feedbacks of abiotic and biotic factors in carbonate depositional systems.

There has been a recent increase in studies that highlight the close relationship between the biotic system and dynamics of sedimentary processes and many of these deal with Miocene carbonates of the Mediterranean (Pomar, 2001; Pomar et al., 2004). In these studies it is argued that changes in environmental conditions may trigger strong modifications in platform geometry and facies dynamics if they affect the carbonate-producing biota. Together with temperature, other factors such as nutrient supply, water energy, turbidity, salinity, light penetration, oxygen and CO_2 concentrations etc. are considered, and a lively debate has been generated in terms of how much the effects of temperature changes versus availability of nutrients or other environmental changes can be differentiated (Mutti and Hallock, 2003; Pomar et al., 2004).

Within this context, the present report presents a synthetic review with comparison and discussion of data and results from studies started more than 10 years ago on the Cenozoic reefs of the Salento Peninsula, in southern Italy (F.R. Bosellini and Russo, 1992; A. Bosellini et al., 1999a; F.R. Bosellini et al., 2001, 2002).

These reefs are represented by the Late Oligocene (early Chattian) Castro Limestone and the Late Miocene (early Messinian) Novaglie Formation. Both have been interpreted as fringing reefs and are characterized by depositional facies ranging from a narrow back reef towards a relatively deep fore-reef (F.R. Bosellini and Russo, 1992; A. Bosellini et al., 1999a; F.R. Bosellini et al., 2001, 2002). Their growth occurred in a depositional setting (i.e. the eastern margin of the Apulia Platform) which remained stable from the Late Cretaceous until the Late Miocene and it is assumed that, on the basis of field evidence and stratigraphic setting, their general morphology was almost the same.

The aim of this paper is to highlight and analyze differences of these two reefs on the basis of several significant features and to underline the importance of biotic control on reef architecture and internal structure. In fact, in the light of the specific setting of the two investigated reefs (they grew at different times in the same depositional setting, i.e. along the stable margin of a single platform), this study provides the opportunity to focus preferentially on ecological and climatic changes that differentiate the Oligocene and Late Miocene reef biota of the Apulia Platform and to illustrate how different reef biotic assemblages can produce different reef types, frameworks and growth fabrics along reef tracts and reef slopes.

2. Geological and depositional setting

The reefs examined and compared in this paper are part of the complex Cretaceous to Quaternary succession cropping out along the present-day eastern coast of the Salento Peninsula (from Capo d'Otranto to Capo S. Maria di Leuca) (Fig. 1a). According to Bosellini A. and Parente (1994), this coastal strip roughly corresponds to the eastern margin of the Apulia Platform, a major palaeogeographic element of the southern margin of the Mesozoic Tethys Ocean. The Apulia Platform extended from the southeastern Abruzzi region across Apulia and probably across the Strait of Otranto to the Greek islands of Cephalonia and Zante (A. Bosellini, 2002). The eastern part of the Apulia Platform represents the foreland of the Apennine thrust chain and is therefore only mildly deformed. The western part instead is downfaulted and buried underneath the foredeep and the adjacent Apennine chain. The Cretaceous margin of the platform and its transition to the adjacent Ionian basin outcrops in the Gargano Promontory (A. Bosellini et al., 1999b), whereas the Tertiary margin occurs on the eastern coast of the Salento Peninsula.

The stratigraphic succession of the Salento eastern coast has been recently thoroughly examined and reinterpreted by A. Bosellini et al. (1999a), providing new descriptions of the various lithostratigraphic units and a new geological map. This paper provides a detailed description and interpretation of the entire stratigraphic succession and a complete list of references concerning local geological contributions.

The above mentioned review clearly points out that the margin and slope of the platform are characterized