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Morpho-structural heterogeneity of shallow-water coralligenous in a Pleistocene marine terrace (Le Castella, Italy)

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ABSTRACT

Coralligenous is the most volumetrically significant type of autochthonous carbonate build-up in the Mediterranean, but its range of morphological variability at the macroscale, and potential link with environmental factors have not been fully documented. Well-preserved examples of coralligenous are exposed in shallow marine carbonate deposits from the Upper Pleistocene Le Castella marine terrace (Southern Italy). The coralligenous build-ups occur in the lower part of an unconformity-bounded, transgressive-regressive sequence. They show high structural and morphological heterogeneity in terms of framework type and build-up size, over a distance of several hundred meters. In northern exposures, coralligenous forms banks up to 4 m high, with a dense, coralline-dominated framework, laterally adjacent to paleo-channels devoid of build-ups and filled by coeval infra-circalittoral biogenic packstone. To the south, build-ups are smaller (up to 1.8 m high), with an open algal framework and local predominance of the coral *Cladocora caespitosa* as primary framework builder. At both locations, the most important framework-building coralline species is *Mesophyllum philippii*; *Titanoderma pustulatum* also occurs. Analysis of sedimentary structures, paleo-topographic indicators, faunal composition of associated mollusk assemblages, and predominance of *M. philippii* suggest the algal builds-ups grew within a shallow-water, possibly infralittoral setting, competing for space with other biocoenoses. Suitable substrate availability in the form of conglomerate blocks or shell accumulations was the primary factor controlling the inception and spatial distribution of coralligenous. Differences in hydrodynamism and water turbidity determined variability in size and internal composition between the northern and southern locations. To the south, abundant supply of fine suspended sediment resulted in smaller build-ups with more open framework, the growth of which was terminated abruptly by sediment burial. Eventually, relative sea level fall during regression prevented further growth of the coralligenous even in the northern area. This study contributes to a better understanding of the relationship between coralligenous morphology and environmental factors, highlighting the role of suitable substrate availability, turbidity, and sediment burial in influencing spatial and temporal variability of coralligenous assemblages.

1. Introduction

In the scheme of the benthic zonation of the Mediterranean Sea, coralligenous is a circalittoral biocoenosis consisting of a rigid biogenic framework primarily dominated by encrusting coralline algae (Pérès and Picard, 1964; Pérès, 1967, 1982; Bosence, 1985; Bellan–Santini et al., 1994; Bressan et al., 2001; EUNIS classification, Davies et al., 2004). It forms on both submarine rocky substrate, usually in caves or sub-marine cliffs, and soft substrates (Laborel, 1961). In the latter case, coralligenous is described in the literature as *coralligène de plateau*, defined as a rigid framework settled on an originally coarse bioclastic bottom (Laborel, 1961; Pérès and Picard, 1964; Pérès, 1982; Laborel, 1987; Bellan–Santini et al., 1994). Coralligenous has been described from a range of water depths (Fredj, 1964; Laborel, 1961, 1987; Sarà, 1966; Sartoretto, 1994; Ballesteros, 2006), including shallow-water infralittoral settings (Sarà, 1969; Sarà and Pulitzer-Finali, 1970; Pansini and Pronzato, 1973; Hong, 1980; Laborel, 1987; Sartoretto, 1994; Argenti et al., 1989; Chiocci et al., 2001). Therefore, the original definition of coralligenous as a strictly circalittoral biocoenosis might need further elaboration. Moreover, different facies of coralligenous have been described for the present-day Mediterranean Sea (Laborel, 1961; Pérès and Picard, 1964; Sarà, 1966; Pérès, 1982; Gili and Ros, 1985; Bellan–Santini et al., 1994; Sartoretto, 1994; Canals and Ballesteros, 1997; Di Geronimo et al., 2002; Bonacorsi et al., 2012; Bracchi et al., 2015) but the relationship between morphological and compositional variability at the macro-, meso-, and microscale and environmental factors is not always clearly resolved.

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Study of fossil counterparts could contribute to a better characterization of coralligenous, providing a broader stratigraphic perspective where major dynamic trends are more evident than the effects of ephemeral environmental variations. Unfortunately, very few fossil examples of Mediterranean coralligenous have been documented in the literature (Bosence and Pedley, 1982; Carannante and Simone, 1996; Rasser, 2000; Nalin et al., 2006; Basso et al., 2007, 2009; Titschack et al., 2008; Bracchi et al., 2014).

The Upper Pleistocene deposits of Le Castella marine terrace (Calabria, Southern Italy) represent a unique opportunity to explore and understand the genesis and development of spatial heterogeneity in coralligenous facies. Abundant coralline dominated build-ups are observable in shallow marine deposits raised along the present-day coastline of the Le Castella promontory. These coralligenous build-ups show evident variability over a lateral distance of few hundred meters, in terms of presence/absence, dimensions, composition, and temporal development. The aims of this study are a) to characterize compositionally and morphologically the coralline-dominated build-ups; b) to determine, through reconstruction of paleobathymetry and depositional setting, if these build-ups represent an example of shallow-water coralligenous; and c) to discuss environmental factors, including substrate type, water turbidity, and relative sea level change, that might have controlled the spatial heterogeneity of the Le Castella coralligenous.

2. Geological setting

The studied deposits belong to the uppermost part of the sedimentary infill of the Crotone basin, a segment of the Ionian fore arc basin located on the internal part of the Calabrian accretionary wedge (Cavazza et al., 1997; Bonardi et al., 2001; Minelli and Faccenna, 2010) (Fig. 1A,B). The basin developed in the context of rollback-subduction and was controlled by SE-ward migration of the Calabrian arc and the opening of the Tyrrhenian Sea from the Serravallian/Tortonian onward (Malinverno and Ryan, 1986; Faccenna et al., 2001; Milia and Torrente, 2014). The basin infill is organized in several distinct tectono-stratigraphic sequences reflecting an extensional to transtensional tectonic regime, periodically interrupted by compressional to transpressional phases (Reitz and Seeber, 2012; Zecchin et al., 2012; Massari and Prosser, 2013).

From the mid-Pleistocene, this region has been affected by significant uplift (Westaway, 1993; Westaway and Bridgland, 2007; Faccenna et al., 2011), which, in combination with glacio-eustatic sea level oscillations, resulted in the development of flights of marine terraces along the Ionian coasts of Calabria (Gliozzi, 1987; Palmentola et al., 1990; Cucci and Cinti, 1998; Santoro et al., 2009). In the Crotone peninsula, Zecchin et al. (2004) distinguished five orders of terraces that unconformably overlay a Plio-Pleistocene substrate of distal shelf to slope clays named Cutro Marly Clay Formation (Roda, 1964) (Fig. 1C).

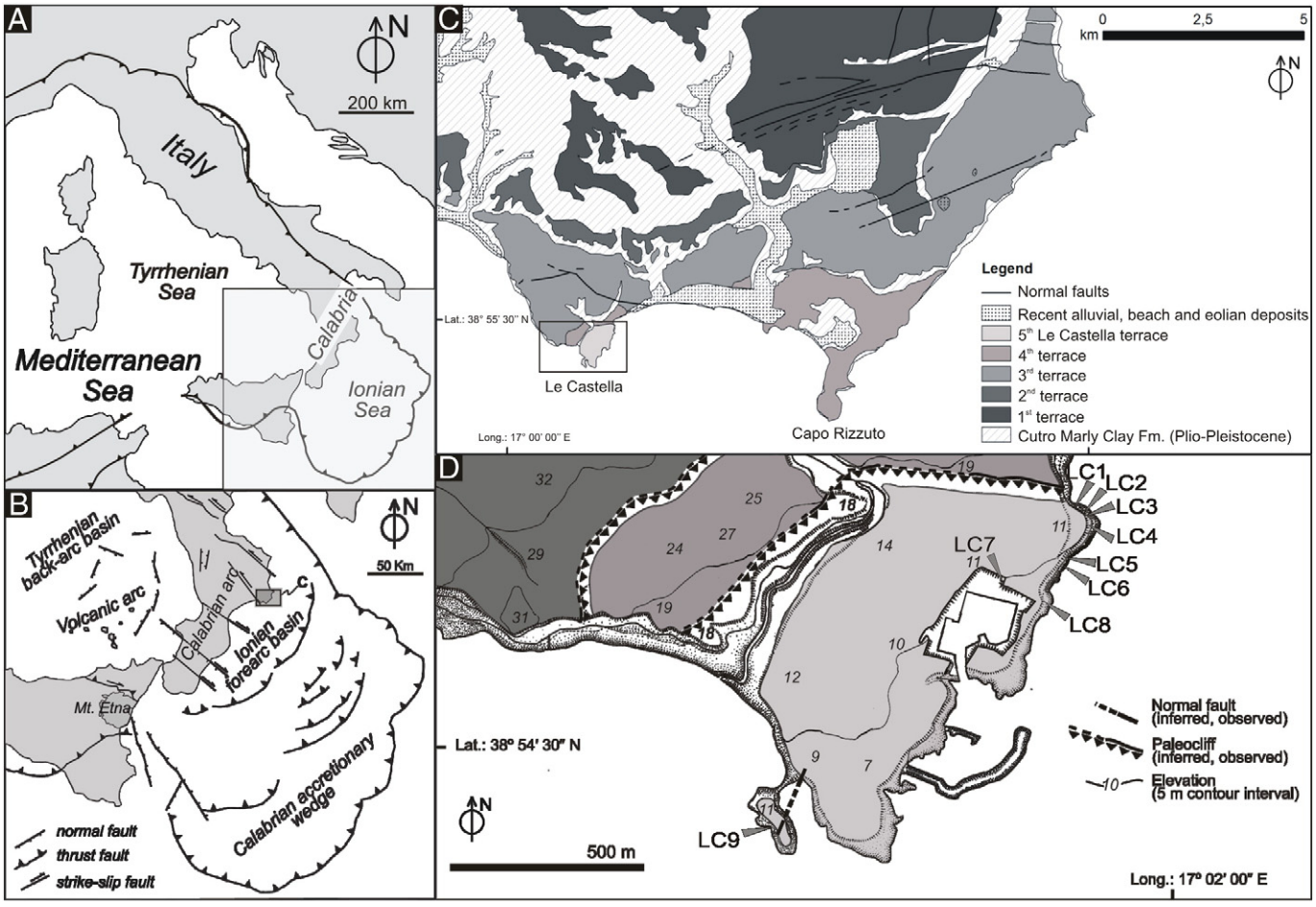

Fig. 1. Geographic and geologic settings of the Le Castella marine terrace. A): the Italian Peninsula with the regional partitions of the Central Mediterranean Sea surrounding the Calabria region (Tyrrhenian Sea and Ionian Sea). The main thrust lines of the Maghrebian–Apennine thrust belt and subduction system are also indicated (after Milia and Torrente, 2014). Bottom right square indicates area enlarged in B. B): Tectonic sketch map of the Calabrian subduction system and its main structural components (based on Van Dijk et al., 2000; Ferranti et al., 2009; Minelli and Faccenna, 2010; Polonia et al., 2011). Small shaded rectangle labeled C indicates the Crotone Peninsula, enlarged in C. C) Simplified geological map of the southern part of the Crotone peninsula, with the five orders of terraces identified by Zecchin et al. (2004). Rectangle around the Le Castella promontory indicates area enlarged in D (map modified after Zecchin et al., 2004). D) The Le Castella marine terrace, with indication of sampled sections illustrated in Fig. 2. Key for terrace colors is in C.