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Stratigraphic framework of the Apulian deep-water coral province, Ionian Sea

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ABSTRACT

Shallow sediment lithology and stratigraphy were investigated at selected areas off Santa Maria di Leuca (SML) on the Apulian margin between 350 and 1200 m water depth, in order to define the sea-bottom character on which coral mounds have developed. According to existing geophysical data and *in-situ* observations, deep coral growth in the SML area creates patches of colonies typically settled on hard substrates on the upper flanks and/or near the top of mound-like structures and elongated ridges.

The sedimentary stratigraphy is strongly influenced by the local topography, which is modeled by tectonic and geomorphological forcing: large-scale erosional features, slope failure and sediment mass accumulation are evident from seismic investigations. Additionally, sites of preferential sediment accumulation due to the action of bottom currents are identified. As a result, a complex sedimentary pattern characterizes this part of the Apulian margin, with strong lateral variability in sediment type and age. Although hemipelagic silty clay constitutes the main lithology, there are sites characterized by periodic accumulation of silt and fine sand and local re-deposition of coarse biogenic sand from the surrounding areas and from shallower depths. Excluding one site, where mid-Pleistocene sediments are brought very close to the bottom-surface due to wide-scale erosion, all collected sediments are late Pleistocene to Holocene in age and fall biostratigraphically within the *Emiliania huxleyi* acme nannofossil zone. Reworking, detected through nannofossil analysis, is common in most cores, excluding the ones taken from topographic highs, and is variable in extent from site to site and within the sediment column; it includes Cretaceous to Early Pleistocene species, suggesting provenance from extended successions or various stratigraphic levels, outcropping on the submerged Apulian margin or in adjacent land sections. Reworking is often associated with a high content of lithogenic particles and an increase in the coarser (silt) fraction.

Coral debris was collected at many stations, both at the sediment surface and within the stratigraphic sequence, with varying abundance in relation to proximity to the coral colonies. Radiometric dating and micropaleontological analyses at some sites allow us to propose a sequence of coral colonization phases.

1. Introduction

The living and sub-modern *Madrepora-Lophelia* coral mounds from Santa Maria di Leuca (SML) display a mosaic-like distribution across a wide sector of the Ionian margin of Apulia between 350 and 1200 m depth (Mastrototaro et al., 2001; Savini et al., 2004, Taviani et al., 2005a,b; Freiwald et al., 2009; Savini et al., 2005; Savini and Corselli, 2010; Vertino et al., 2010).

The large-scale morphology of the investigated area (Fig. 1) is related to a strong tectonic control, with elongated fault scarps that delineate a step-like topography. Superimposed on this pattern is geomorphological evidence of superficial deformation, which includes broad slope erosion, sediment sliding, block tilting and collapse. Additionally, the evolution of this sector of the Apulian margin is complicated by bottom currents, resulting in sediment remodeling and drifting (Taviani et al., 2005a; Savini and Corselli, 2010).

Deep-water corals colonize the sea bottom, forming thickets on discrete mounds and as isolated occurrences in inter-mound areas (Vertino et al., 2010). The only scant chronostratigraphic information on the area was provided by Taviani et al. (2005a) based upon

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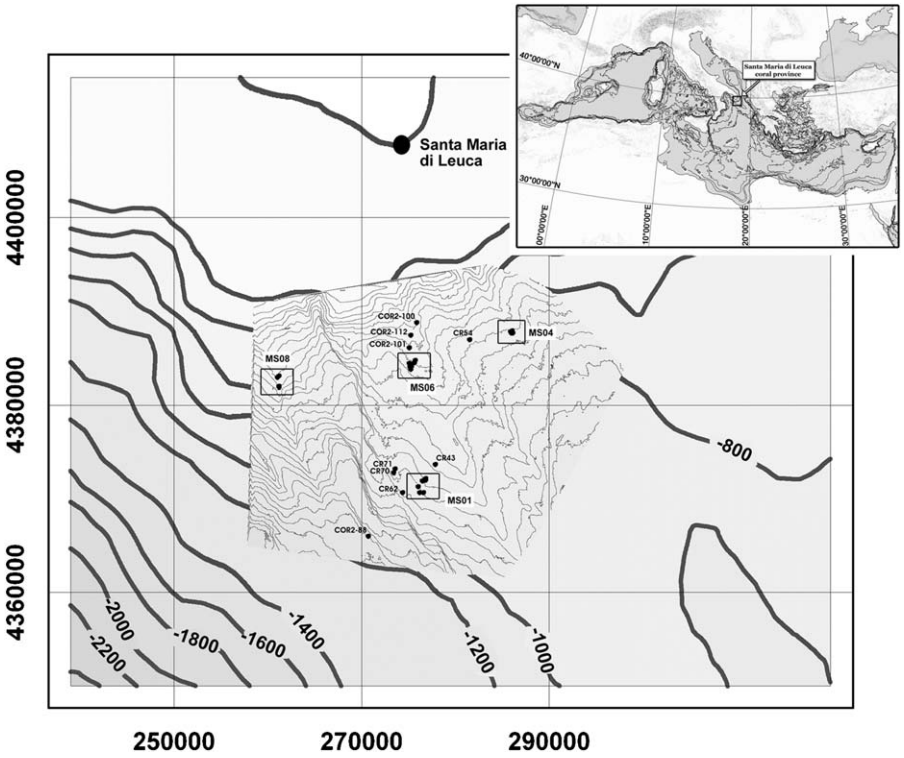

Fig. 1. General map of the study area; rectangles indicate the sub-areas where sampling was performed: the detailed morphology and sampling locations in these areas are shown in Figs. 2a, 5a, 7a and 9a.

gravity-cores and in-grab mini-cores. These preliminary data showed the common occurrence of late Pleistocene (*Emiliania huxleyi* acme nannofossil zone) units, exposed at the sea bottom or covered by a thin veneer of Holocene sediment, testifying a general low recent sedimentation rate and/or significant sweep by bottom currents. Evidence from epibenthic dredge sampling (Taviani et al., 2005b; Rosso et al., 2010; Vertino et al., 2010 and present dataset) have shown the co-occurrence of living corals with firm-ground blocks or hard-grounds, often embedding fragments of older corals.

The obvious need for more regional and detailed information called for further sampling in the coral mound area. This was achieved within the Aplabes project (Apulian PLAteau Bank Ecosystem Study, 2003–2006) by sea-bottom sampling through gravity and short-push cores during two dedicated cruises. Due to the geomorphological complexity of the area, a comprehensive sedimentological study would require an even wider sampling coverage. Instead, we focused our attention on selected sub-areas where previous surveys (Mastrototaro et al., 2001; Taviani et al., 2005a; Savini et al., 2004; Vertino et al., 2010) had shown a significant presence of coral colonies.

The scope of this article is twofold. Firstly the description of the main sedimentary and chronostratigraphic context of each selected area, with particular regard to the relation between the coral colonies and the bedrock. Secondly, a documentation of the early and subsequent phases of deep coral growth, based upon coral hard-grounds and buried pre-modern biostromal deposits.

2. Material and methods

2.1. Sediment samples

The material described in the present paper (Table 1) was collected during the following oceanographic cruises: Coral2 (R/V *Urania*, 2002; sample code COR2-), Aplabes3 (R/V *Universitatis*, 2005; sample code AP-) and Corsaro (R/V *Urania*, 2006; sample code CR-). Overall, 10 gravity-cores (GC) were collected, integrated by a series of mini-cores (GR) manually extracted from undisturbed large-volume (60-L) modified Van Veen grabs. Additional information was obtained from other grab samples and through dredge samples (DR), which collected the dominant lithology present at the (sub)surface along the dredge track and a modified Ingegno (see Taviani et al., 2005a), which allowed recovery of hard-ground and mud-buried coral fragments.

Sample locations (Fig. 1) were chosen to provide a substantial spatial coverage of the area settled by corals, although most sites were located off coral mounds proper, whose hard nature prevented grab and core penetration. Sub-areas were named by Savini and Corselli (2010), based on geophysical identification of coral-rich sites, selected for visual survey through a remote-controlled deep water vehicle (Vertino et al., 2010).

Gravity and mini-cores were opened, photographed and X-rayed on-shore. Descriptions refer to sediment nature, colors (Munsell soil chart), obvious sedimentary features and speditive analyses on macrofossil content. Cores AP20, COR2-88 and AP16 were investigated in more detail for grain size on selected sub-samples.

2.2. Nannofossil biostratigraphy, micro- and macropaleontology

Speditive biostratigraphic analyses were performed on calcareous nannoplankton assemblages at closely spaced (5 cm) core samples. A total of 151 samples were analyzed from all sediment cores. Samples were prepared following the standard smear slide technique (Perch-Nielsen, 1985). For each sample, approximately 300 specimens were counted through a polarized optical microscope at 1250×. The biostratigraphic approach follows the biozonal scheme of Rio et al. (1990).