Heterozoan carbonates in oligotrophic tropical waters: the Attard member of the Lower Coralline Limestone Formation (Upper Oligocene, Malta)

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The aim of this work is to present a high resolution analysis of the Attard Member of the Lower Coralline Limestone Formation (Upper Oligocene, Malta) in order to depict the internal and external factors controlling the architecture of a typical late Oligocene platform dominated by heterozoans and subordinately by photosynthetic skeletal assemblages (Brandano et al. 2003a,b). The Attard Member is characterized by 4 members (Fig. 1): Manghiai, Attard, Xerendi and 8 Mara (Pedda, 1978).

FACIES ASSOCIATION AND DEPOSITIONAL MODEL

The depositional profile of the Attard carbonate ramp is consistent with a homoclinal ramp (Fig. 2). The inner ramp is represented by cross-stratified, pelmicritic, foraminiferal grainstones to packstones facies characterized by planar to trough cross-bedding. This facies containing well sorted and highly abraded biogenic components including nummulites and microforaminifers. It was deposited in a very shallow-water setting, as indicated by the abundance of abundant porcellaneous foraminifers and other components. These deposits pass downslope into unsorted, rillid or flute casts to rudistaceous facies, usually stilolitified and characterized by the abundance of small rudiolitids. Other components are coralline algal stromata, calcareous microforaminifers, associated coral (mainly xenia), phacelids and subclustered foraminifers. Sedimentological and compositional characters suggest a depositional environment colonized by saccoglossus and infilled with adjacent areas containing scattered corals where deposited the coralline bioherms, autecozones showed to packstones/flute casts facies. Middle ramp lithofacies consist of massive red algal foraminiferal to packstone facies composed by mocoons, red algal branches and rudista, larger foraminifers, bryozoans, and brachiopods. The middle ramp lithofacies were deposited in the oligotrophic zone. The sediments being generated from the shallower inner ramps by currents.

METHODS

Good sill exposures of the Attard Member along the southern side of the Victoria Line Fault offer the opportunity for detailed field mapping and lithostratigraphic analysis, including studies of controlling processes and facies architecture of a 20 m thick portion of the carbonate ramp succession (Fig. 3).

Field observations were complemented by petrographic examination of 28 thin sections for textural characterization and identification of several components. Ecological factors such as water depth, substrate type, and working rework were determined by using coralline algal and foraminifer assemblages.

For the paleoecological reconstruction we computed the past plate motions of the Maltese Islands using plate-motion data from Sager and Sclater (1980) assuming a negligible relative motion between the Malta-Plateau block and the North African plate over a 500 km sea time interval (approx. 10 Ma).

The reconstruction is based on rigid body rotations of Africa relative to the palaeomagnetic reference frame (Fig. 4). We focused in this study to palaeoecological framework of different characteristic times, incorporating plate movements relative to Anomaly 11, Anomaly 6, and Anomaly 5, at 53.1 Ma, 170.9 Ma, and 10.9 Ma, respectively (Sansaloni and Scotti, 2005), and current plate kinematics at time to 13.2 Ma (Debiets et al., 1994).

PONMINERAL ASSEMBLAGE

INNER RAMP

MIDDLE RAMP

Zoanthalcane and foraminiferal assemblages of the Attard Member (Burens, Archais, Periarcas, Soriotes, Lapetofield) argue against persistently high nutrients, since these foraminifers thrive in oligotrophic (Langer and Hüttinger, 2004) to possibly slightly mesotrophic (Plattner et al., 2004) waters. This is supported by the absence of low-oxygen foraminiferal assemblages (LOFAs) and the very close presence of filter-feeding organisms, such as bivalves and echinoids, that normally depend on environments with relatively abundant organic matter.

Fig. 1. North-South and east-west sections in the palaeomagnetic reference frame. Plate abbreviations: AP — Africa; E — Europe.

Fig. 2. Stratigraphic architecture of the Attard Member:

Fig. 3. Depositional model of Attard Member.

Fig. 4. Stratigraphic architecture of the Attard Member.