The controlling factors of an Upper Oligocene carbonate ramp (Attard Member, Lower Coralline Limestone Formation, Malta): from facies to paleolatitude

M. BRANDANO (*), V. FREZZA (**), L. TOMASSETTI (***), M. PEDLEY (****), M. CUFFARO (*****), R. MATTEucci******

(*) Dipartimento di Scienze della Terra, Università di Roma “La Sapienza”, P. Aldo Moro 5, I-00185, Italy and IGAG-CNR, P. Aldo Moro 5, I-00185, Roma, Italy
(**) Dipartimento di Scienze della Terra, Università di Roma “La Sapienza”, P. Aldo Moro 5, I-00185, Italy
(****) Department of Geography University of Hull, Cottingham Road Hull HU6 7RX, UK
(*****!) IGAG-CNR, P. Aldo Moro 5, I-00185, Roma, Italy and ISMAR-CNR, Via Gobetti 101, I-40129, Bologna, Italy

Corresponding author: E-mail: marco.brandano@uniroma1.it

The Oligocene represents a key-interval during which coralline algae became dominant on carbonate ramps and luxuriant coral reefs emerged on a global scale. Few works have considered the impact that these early reefs had on ramp development and the role of paleoceanographic and paleogeographic settings. We present a high-resolution analysis of the Attard Member of the Lower Coralline Limestone Formation (Upper Oligocene, Malta) and a paleolatitudinal reconstructions of the Maltese Islands from Oligocene to late Miocene times in order to decipher the internal and external factors controlling the architecture of a typical Upper Oligocene platform. For the paleolatitudinal reconstruction we computed Maltese Islands past plate motion using results obtained by SCHETTINO & SCOTISE (2005) in the paleomagnetic reference frame. We assessed a negligible relative motion between Hyblean–Malta Plateau block and North Africa plate, so that our reconstruction is based on Africa rigid body rotations with respect to stable Eurasia during a time interval Δt=33.1 Ma, from Present up to most of the Oligocene. We focused on Malta past geographical position at different times, using current plate angular velocities at time t=3.2 Ma (DE METS et alli, 1994), and with respect to Anomaly 5, Anomaly 6, and Anomaly 13, at t=10.9 Ma, t=20.1 Ma, and t=33.1 Ma respectively (SCHETTINO & SCOTISE, 2005), also combining angular vectors obtained by ROWLEY & LOTTES (1988) at t=25.2 Ma. Results show that over most of the Oligocene (t=33.1 Ma), the Maltese Islands largely lies below 30°N (fig. 1).

The Attard Member carbonates were deposited as a homoclinal carbonate ramp (fig. 2). The inner ramp was characterized by very high energy shallow-water setting influenced by tide and wave processes. These passed downwind into a depositional environment colonized by sea-grass. In the deepest environment of the inner ramp seagrass meadows interdigitated with adjacent unconsolidated areas characterized by scattered corals. The Middle ramp lithofacies were deposited in the oligophotic zone, the sediments being generated from the combined accumulation of *in situ* production and sediments swept from the shallower inner ramp by waves and currents. The outer ramp facies are represented by Il Mara Member carbonates. Here coralline algae are absent and the low angle clinoform fine grained wackestone beds are dominated by large, thin *Lepidocyclina* and erect bryozoan colonies (PEDLEY, 1975, 1978).

The biota assemblages of the Attard Member suggest that carbonate sedimentation took place in tropical waters and oligotrophic to slightly mesotrophic conditions in a paleolatitude position analogous to the present-day North Red Sea. To understand why the oligotrophic carbonate factory (chlorozoon) did not expand, factors including CO₂ concentration and Mg/Ca ratios were analysed but only the paleoecology of the zooxanthellate corals seems to play a fundamental role in the development of the ramp. Corals, until the late Miocene, lived in the middle-lower part of the photic zone (POMMAR & HALLOCK, 2007). Consequently, the low capacity of corals to thrive in high-light conditions and form wave-resistant reef structures must have been a significant factor affecting substrate stability at this time. Because of the lack of reef frameworks at the time mid-ramp areas appear to have been more exposed to wave and storm activity thereby promoting the development of rhodalgal assemblages dominated by coralline algae and subordinately by LBF.

REFERENCES


Fig. 1 – North Africa plate (AF) motion with respect to stable Eurasia (EU) Δt = 0.0 – 33.1 Ma.

Fig. 2 – Depositional model of the Attard Member