INTRODUCTION

The Miocene carbonate platform successions of the Mediterranean area are characterized by phosphate and carbonate hardgrounds (Zalaffi, 1963; Carannante, 1982, Pedley and Bennett, 1985; Carbone et al., 1987; Corda 1990; Mutti and Bernoulili, 2003; Föllmi et al., 2008). These hardgrounds offer excellent insight into the environmental and oceanographic evolution of the western Mediterranean realm during the Miocene. Hardgrounds are interpreted as representing from non- or low-sedimentation conditions and condensed sedimentation on the shelf and deeper areas (Purser, 1969; Wilson, 1975; Mutti and Bernoulili, 2003). Due to their genetic relationship with reduced sedimentation rates, hardgrounds are commonly related to sea level rise (Loutit et al. 1988; Mutti and Bernoulili, 2003). However, not all reduced sedimentation events result in the formation of marine hardgrounds and, locally, favourable marine environmental conditions in subtidal to intertidal environments may promote selective early lithification of the sea floor (Nicolaides, 1995; Mutti and Bernoulili, 2003). Mutti and Bernoulili (2003) showed that hardground formation in the Lower Miocene succession of the Maiella ramp is linked to upwelling flux, which may be triggered by regional changes in water circulation and modulated by sea level changes and increased biological production. Recently, Föllmi et al. (2008) show that the phases of phosphogenesis in the Lower Miocene carbonates of Malta (Globigerina Limestone Formation) correlate well with other important phases of phosphogenesis outside of the Mediterranean area. Maxima in overall phosphorus burial rates in the oceanic domain indicate that the palaeo-oceanographic evolution of the Mediterranean water masses was in phase with that of other ocean basins.

In this work we analyse three locations related to a single Upper Miocene hardground development located in the Latium-Abruzzi succession (central Appennines, Italy). The central Apennine hardgrounds all lie on top of the Latium-Abruzzi carbonate ramp succession and in each case are overlain by hemipelagic Orbulina marls; these marls are linked to plate flexure-related to drowning and coeval input of terrigenous sediments. The hardground age ranges from Tortonian to Early Messinian. Phosphate precipitation in the investigated hardgrounds was confined to a thin layer (up to 15 cm) close to the sediment-water interface. Here oxic to suboxic conditions prevailed, resulting in early-diagenetic iron cycling and subsequent phosphogenesis in oxygenated bottom-waters. Glaucony only occurs in the planktonic-rich marls that overlie and infill the phosphatized hardground level in the Latium-Abruzzi succession.

An upwelling flux triggered phosphogenesis, promoting the early lithification of the sea floor on the platforms. After upwelling event neritic carbonate production could not be re-established on the Latium-Abruzzi platform because of the persisting eutrophic conditions and the high rates of tectonic subsidence and terrigenous input linked to Appennine orogenesis.

The Latium-Abruzzi phosphorites are coeval with the Tortonian phosphogenic phase reported in the Mediterranean. Despite being a global event, regional and local factors played a major role in the hardground deposition at each site.

Key Words: Hardground, phosphate, glaucony, trophism, Miocene

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