



## Upper Pleistocene-Holocene relative sea level changes at Pianosa Island (Tuscany Archipelago): geological, geomorphological and archaeological markers

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**UPPER PLEISTOCENE-HOLOCENE RELATIVE SEA LEVEL CHANGES  
AT PIANOSA ISLAND (TUSCANY ARCHIPELAGO):  
GEOLOGICAL, GEOMORPHOLOGICAL AND ARCHAEOLOGICAL MARKERS**

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**ABSTRACT:** Foresi L.M. *et al.*, *Upper Pleistocene-Holocene relative sea level changes at Pianosa Island (Tuscany Archipelago): geological, geomorphological and archaeological markers.* (IT ISSN 0394-3356, 2011).

Based on geological, geomorphological and archaeological markers, we provide new data and interpretations on the relative sea level change occurred at Pianosa Island (Italy) since the last 125 ka. The MIS 5.5 deposits are characterized by a 2 m thick whitish fossiliferous calcarenite, cropping out at a maximum altitude of 4 m a.s.l. containing *Strombus bubonius*. Archaeological remains provide evidence of sea level change for the last 8 ka. Particularly useful are some fish tanks and a quarry cut around 2 ka BP (Roman age).

**RIASSUNTO:** Foresi L.M. *et al.*, *Variazioni relative del livello del mare nell'Isola di Pianosa (Arcipelago Toscano) nel Pleistocene superiore-Olocene: markers geologici, geomorfologici e archeologici.* (IT ISSN 0394-3356, 2011).

In base a dei markers geologici, geomorfologici ed archeologici, vengono forniti nuovi dati e interpretazioni sulle variazioni relative del livello del mare avvenute nell'Isola di Pianosa a partire dagli ultimi 125 ka. I depositi del MIS 5.5 sono caratterizzati da una calcarenite fossilifera biancastra contenente *Strombus bubonius*, affiorante fino ad un'altezza massima di 4 m s.l.m. I resti archeologici forniscono evidenze della variazione del livello del mare per gli ultimi 8 ka. Particolarmente utili a tale scopo sono alcune peschiere e una cava, entrambe realizzate intorno ai 2 ka (Età Romana).

**Key words:** relative sea level changes, geological, geomorphological and archaeological markers, Pianosa Island (Tuscany Archipelago).

**Parole chiave:** variazioni relative del livello del mare, markers geologici, geomorfologici e archeologici, Isola di Pianosa (Arcipelago Toscano).

The bedrock of the island consists of three Neogene sedimentary Formations (GRACIOTTI *et al.*, 2003). The turbiditic marly-clays facies of the Marina del Marchese Formation are Burdigalian in age (BOSSIO *et al.*, 2000; FORESI *et al.*, 2000) and show a maximum visible thickness of about 150 m. This unit is underlain by the Golfo della Botte Formation, about 300 m thick, made of marly clay with arenaceous and conglomeratic intercalations. The Golfo della Botte Formation is upper Tortonian – lower Messinian in age, and deposited in a lacustrine - lagoonal environment.

The Pianosa Formation dated as Middle Pliocene – Lower Pleistocene consists of very fossiliferous biocalcarenes and sands with a maximum thickness of 30 m, which unconformably overlies the Miocene units. In recent studies (GRACIOTTI *et al.*, 2003; FORESI *et al.*, 2007), the authors consider this formation composed of two different units separated by a reddish-brown layer consisting of well-lithified carbonates and iron

oxides and phosphates. The deposition occurred on a submarine ridge characterized by shallow water (FORESI *et al.*, 2007).

The Pianosa Formation is covered by whitish fossiliferous calcarenite, about 2 m thick, outcropping approximately 3-4 m a.s.l. The typical malacofauna was described by several authors (FORESI *et al.*, 2007 and reference therein) and it consents to refer this unit to the Last Interglacial (125 ka).

These deposits are covered by red sand with clayey matrix, locally cemented, and continental breccias with red silty-sandy matrix, this units dated as Upper Pleistocene.

Pianosa has a characteristic flat sub-triangular shape, gently tilted east, due to the geological features. Evidence from geomorphological analysis suggest that landscape evolution is mainly related to coastal-marine and karst processes.

Coastal morphology is characterized by a series of typical landforms: cliffs, wave-cut platforms, tidal

notches, arches, and bays. Karst processes produced typical epigean (dissolution flutes, dissolution grooves, dissolution plans) and remarkable development of hypogean features. The hypogean karst of Pianosa consists in caves and conduits, with a mainly horizontal development, articulated on several levels. Numerous caves have the entrances to the current sea level. These are characterized by speleothemes. In the caves lithic artifacts of the final phase of the Upper Palaeolithic were found (LA MORGIA & SPINELLI, 1994), as well as bone breccias composed of herbivorous and carnivorous animals.

A clear difference exist between the western and eastern parts of the island. The former has steep cliffs and is characterized by a deep and wide inlet (Golfo della Botte). The latter shows less steep coasts dipping toward the east, articulated and indented due to the presence of rocky heads, small bays, and abrasion platforms. This peculiar

geomorphological context is closely related to the geological setting. Along the eastern coast the base of the cliff is formed by the highly erodible Miocene sediments, the Plio-Pleistocene Pianosa Formation which is more resistant to wave dynamics, crops out along the eastern coast.

The geomorphological evolution of the island is almost driven by eustatic and tectonic movements that affected repeatedly the Northern Tyrrhenian Sea.

Transgressive cycles are marked by wave-cut platforms. Two main orders of marine abrasion surfaces are documented at about 2÷4 m and 22÷25 m a.s.l.

The wave-cut platforms of the first order (2÷4 m) outcrops anywhere along the coast, except where outcrops marly-clayey Miocene sediments which favour the formation of steep cliffs because highly erodible.

The wave-cut platforms of the second order, which coincide with the summit topographic surface, are

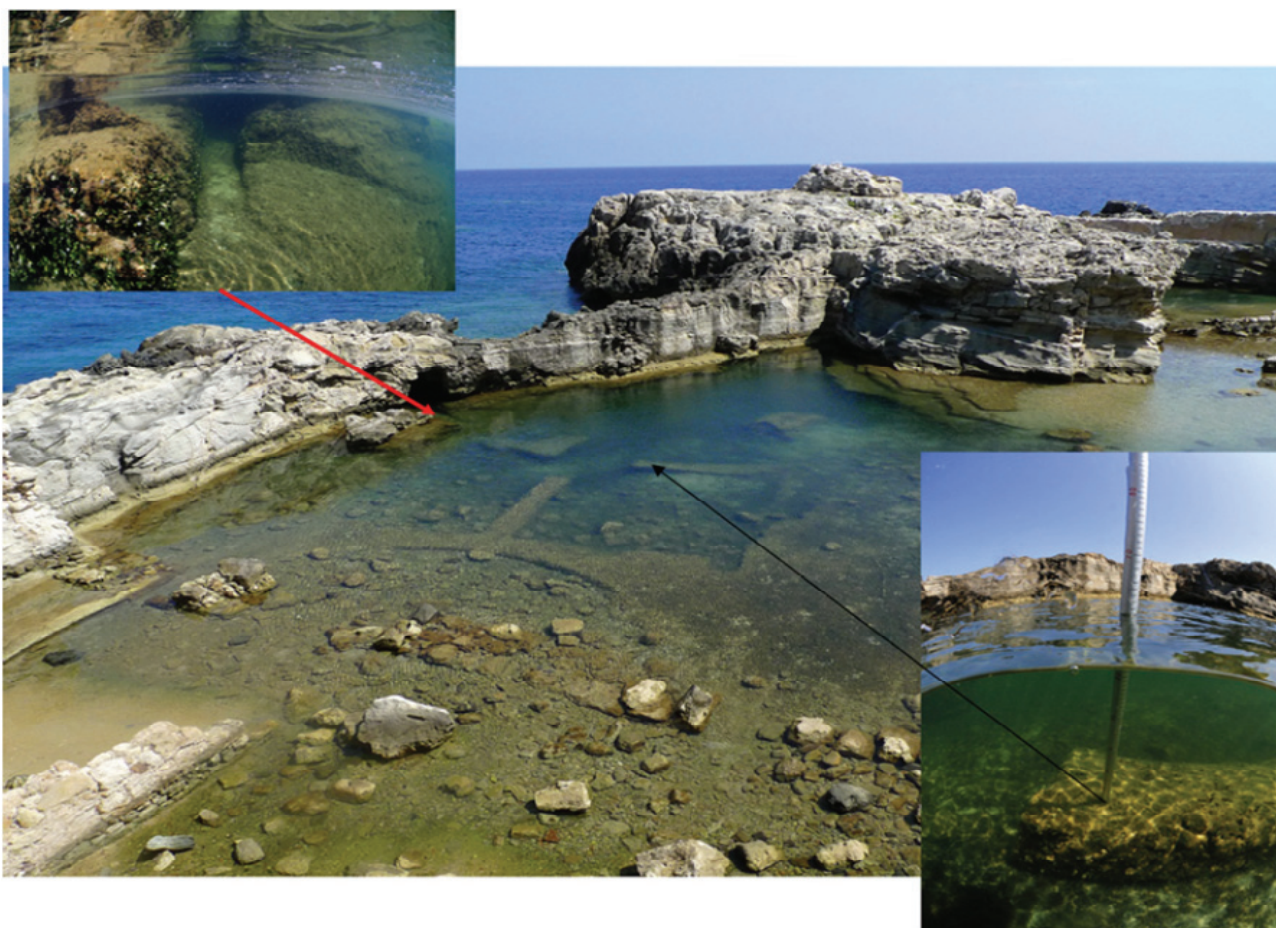


Fig. 1 - The Marzocco fishponds (Pianosa Island) during low tide. The arrow on the left indicates the hole communicating with sea in the southern wall. The arrow on the right box indicates the measurement of the top of separating pools wall.

*La peschiera del Marzocco (Isola di Pianosa) durante la bassa marea. La freccia sulla sinistra indica il foro nel muro meridionale comunicante con il mare. La freccia sul riquadro di destra indica la misura della parte superiore del muro di*

located along the western and southern coast characterized by active cliffs. Here the erosion surfaces truncates sharply clinostratified ramps of the Pianosa Formation.

A marine ingression occurred during the Last Interglacial (MIS 5.5 of the isotopic curve) when the mean sea level was higher than the present. This phase is represented by the basal erosion surface at an elevation of 2÷4 m a.s.l., by lithodome holes placed at various levels, up to 7 m a.s.l., and by backward paleoclimbs.

During uppermost Pleistocene the sea level was considerably lower than the present and induced the emersion of wide areas. This condition favoured the development of karst process, particularly during the low-stand period (about 20 ky BP), when carbonatic rocks was widely exposed, and the deposition of continental breccias.

In order to detail the decimetric vertical displacements for the last 2 ka, the Roman age archaeological remains were studied. They were drawn in 1989 and the altitude of archaeological markers was not corrected for tide, but they have been included in this research because are indispensable to understand the shape, the functionality and where take the scuba measurements. Some architectural elements (fishtanks and cetaria), were measured during the course of scuba research operation and subsequently corrected for tide and pressure. Comparing the predicted sea level curve (LAMBECK et al. 2011) with the collected data it is possible to observe that the values lie a few centimeters below the predicted sea level curve. This result was obtained using as markers both the holes in the radial walls of the Agrippa fishponds and the altitude of the uppermost walls that separate the different pools, which indicate the same altitude

(Fig. 1).

In conclusion, based on the data obtained from analysis of the MIS 5.5 age inner margin altitude and archaeological markers relating to the various types of settlements dated between 2.1 ka and 1.5 ka BP it is possible to establish that the island of Pianosa has remained tectonically stable since at least 125 ka.

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