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A submerged monolith in the Sicilian Channel (central Mediterranean Sea): Evidence for Mesolithic human activity

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ABSTRACT

The ancient geography of the Mediterranean Basin was profoundly changed by the increase in sea level following the Last Glacial Maximum. This global event has led to the retreat of the coastlines, especially in lowland areas and shallow shelves, such as the Sicilian Channel. The NW sector of this shelf, known as Adventure Plateau, is studded by isolated shoals mostly composed of Late Miocene carbonate rocks and by some volcanic edifices. These shoals, until at least the Early Holocene, formed an archipelago of several islands separated by stretches of extremely shallow sea. One of these submerged features – the Pantelleria Vecchia Bank – located 60 km south of Sicily, has been extensively surveyed using geophysical and geological methods. It is composed of two main shoals, connected seaward by a rectilinear ridge which encloses an embayment. Here we present morphological evidence, underwater observations, and results of petrographic analysis of a man-made, 12 m long monolith resting on the sea-floor of the embayment at a water depth of 40 m. It is broken into two parts, and has three regular holes: one at its end which passes through from part to part, the others in two of its sides. The monolith is composed of calcirudites of Late Pleistocene age, as determined from radiocarbon measurements conducted on several shell fragments extracted from the rock samples. The same age and composition characterize the metre-size blocks forming the rectilinear ridge. The rest of the rocks composing the shoals are mostly Tortonian limestones–sandstones, as revealed by their fossil content. Extrapolating ages from the local sea level curve, we infer that seawater inundated the inner lands at 9350 ± 200 year B.P., the upper limit which can be reasonably taken for the site abandonment. This discovery provides evidence for a significant Mesolithic human activity in the Sicilian Channel region.

1. Introduction

An abundant number of archaeological and geological data acquired in several coastal areas of the Mediterranean Basin represent the evidence that it has undergone major changes in sea level during the glacial-interglacial cycles (e.g., Lambeck and Chappell, 2001; Lambeck and Purcell, 2005; Antonioli et al., 2009; Auriemma and Solinas, 2009). After the Last Glacial Maximum (LGM), around 19,000 year B.P., when the land area of Europe was ~40% larger than it is now, a relatively abrupt global rise in sea-level took place, estimated to be of 125 ± 5 m, as determined by correcting observed sea-level changes for glacio-hydro-isostatic contributions (e.g., Fleming et al., 1998; Mix et al., 2001; Siddall et al., 2003; Lambeck et al., 2004; Clark et al., 2009).

The Sicilian Channel is one of the shallow shelves of the central Mediterranean region where the consequences of changing sea-level were most dramatic and intense, as also occurred in part of the Aegean Sea, the northern Adriatic, and the Tunisia and Malta platforms. The Sicilian Channel is geologically part of the northern African continental shelf (Fig. 1) and lies mostly under shallow water, with the exception of three NW-trending, relatively deep troughs (the Pantelleria, Malta and Linosa grabens) produced since the Early Pliocene by rift-related processes (e.g., Reuther and Eisbacher, 1985; Boccaletti et al., 1987; Cello, 1987; Civile et al., 2010). This tectonic extension was also responsible of the formation of the two volcanic islands of Pantelleria and Linosa, and other submerged volcanic edifices lying along the eastern margin of the Adventure Plateau (Calanchi et al., 1989; Rotolo et al., 2006; Lodolo et al., 2012). It occupies the north-western sector of the Sicilian Channel, where available oil exploratory wells have shown that the sedimentary sequence ranges from Triassic to Plio-Quaternary, with various hiatuses associated with long periods of aerial exposition and/or erosion (Civile et al., 2014). The Adventure Plateau is the shallowest part of the entire Sicilian Channel, and is punctuated by several isolated banks, some of them rising up to less than 10 m below sea level (Colantoni et al., 1985). During the LGM, the Adventure Plateau was part of the former Sicily mainland, forming a peninsula (the Adventure Peninsula) bulging towards south into the Sicilian Channel, and

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separated from the North African coastline by less than 50 km. The gradual increase of the sea level caused the flooding of most of the peninsula, with the exception of some morphological highs that, until at least the Early Holocene, formed an archipelago of several islands separated by stretches of extremely shallow sea, as shown by the analysis of swath bathymetric mapping and high-resolution seismic profiles (Lodolo, 2012; Civile et al., 2015). Today, the Adventure Plateau is morphologically separated from Sicily by the Mazara del Vallo Channel (depth of about 120 m), and from Tunisia by the Pantelleria graben (depth of about 1300 m).

It is well known that the Mediterranean Sea is a unique basin from a historical and archaeological perspective, since it was an important means of communication among human communities living on its shores. These ancient civilizations have left numerous imprints along the former coasts, such as production and town structures, landing places, and ports. Some structures that are today submerged can provide fundamental information to support the reconstruction of the ancient coastlines (Auriemma and Solinas, 2009). Conversely, in shallow water areas distant from the coastline, the information on possible ancient permanent human settlements are scarce, and there are no traces to date found in the Mediterranean Basin mainly because the lack of detailed and extensive bathymetric mapping, and the presence of a variably thick sedimentary cover masking any submerged structure.

Here we present the results of high-resolution bathymetric surveys performed on the Pantelleria Vecchia Bank (PVB), a submerged shallow relief of the Adventure Plateau, located 40 km north of the volcanic island of Pantelleria, as well as underwater visual observations by divers, analyses of some rock samples collected in several locations of the bank, and radiocarbon dating. These data provide evidence for an unique and significant structure of anthropogenic origin.

2. Methods

Detailed sea-floor surveys were conducted in November 2012 using a hull-mounted multi-beam sonar system with the R/V *OGS-Explora*. Subsequently, in December 2012, a high-resolution survey was focused on a specific area of the PVB, which was mapped with a portable multi-beam sonar system. These surveys provided a context for direct sea-floor observation made by divers, who recorded high-definition video (for a total of approximately 8 h of registration) and photos, and collected several rock samples. In addition, radiocarbon measurements were made on small, intact shells extracted from 4 different rock samples, applying the Talma and Vogel (1993) calibration method. Because the obtained ages are close to the limit for ^{14}C dating, the measurements were performed in two different laboratories in USA (Lawrence Livermore National Laboratory, and Beta Analytic Inc., Miami) to verify the goodness of the data.

These activities, carried out in various phases from August 2013 to September 2014, were supported by the Italian *Arma dei Carabinieri*, who made available their boat and a group of divers. Francesco Spaggiari and Fabio Leonardi (*Global Underwater Explorers*) contributed with rock samplings and underwater videos. More details on acquisition parameters and processing of high-resolution bathymetric data can be found in the *Supplementary Material*.

3. Results

3.1. High-resolution bathymetric maps and underwater surveys

The bathymetric map (Fig. 1) reveals that the PVB is made up of two main shoals, intersected by fractures and steep valleys, and a number of smaller isolated bathymetric highs, covering a total area of 5.2 km^2, with little or no sedimentary cover. The present depth of the two main shoals varies from 16 to 24 m, while the surrounding areas are located at depths ranging from 46 to 60 m. Here, the unconsolidated sedimentary cover of the bedrock is composed of coarse organogenic sands with thickness ranging from a few decimetres to a few metres (Stanley et al., 1975; Colantoni et al., 1985). This bank is located in a sector of the Adventure Plateau dominated by NW-trending, high-angle normal faults related to the continental rifting phase that produced the Pantelleria graben (Civile et al., 2010). Compressional structures, generated by a Late Miocene compressional phase (Argnani et al., 1986; Lentini et al., 1996), have been also recognized in this sector.

The high-resolution map focussing on the area between the two shoals (Fig. 2) shows that the most evident morphological feature is an 820 m long, rectilinear ridge connecting the two shoals and enclosing an embayment. The base of this ridge lies at water depths ranging from 43.1 to 44.4 m while its summit lies between 35.1 and 36.8 m below sea level. The ridge is characterized by a flat top and a regular slope ranging from 16° to 20°. A parallel, but less continuous, segment of ridge is located 80 m inward of the main outer one and rises about 2 m above the surrounding sea-floor. Underwater surveys were made throughout the entire length of the outer ridge and part of the inner one, in order to obtain photographs and video images, and to collect rock samples. The slopes of the ridge are devoid of sedimentation due to a relatively strong and constant bottom current with velocity varying between 2 and 3 knots. The entire ridge is composed of rock blocks generally with a rectangular shape in plain view lying in close contact to each other. Such a geometric arrangement is particularly evident in the central part of the ridge. About 100 m seawards from the southern termination of the outer ridge, an elongated rectangular flat top ridge extends 82 m towards the open sea and rises ~2 m from the surrounding sea-floor. To the north of the rectilinear ridge, other important morphological elements seen on the map are at least three concentric, semi-circular ridges, and regularly spaced by 60 m. Between the two southern ridges the almost flat sea-floor lies at 36÷38 m below sea level. The water depth of the annular areas between the northern semi-circular ridges ranges from 32 to 34 m. At ~15 m from the base of the southern semi-circular ridge, an important morphological element, easily recognizable from the bathymetric maps (Fig. 3), is an elongated monolith laying on the sea-floor, isolated from the rest of the outcrops, and broken in half, as appears from inspections carried out by divers (Fig. 4). The good match between the two adjacent parts suggests that it was originally a single block. Its length is 12 m, with a recognizable squared section of about 2 m, particularly regular in its southern half. The longitudinal axis of the monolith is oriented N50°E. A rounded hole with a diameter of about 60 cm passes right through the monolith, at 50 cm from one end. Another hole of the same diameter, but not crossing the whole monolith, is present in one of its sides. It is about 40 cm deep and is located midway in the monolith, at a right angle with respect to the first hole. Another hole, but less regular, with a diameter of about 50 cm, is found along the other side of the monolith. Also this hole is located midway in the monolith.

3.2. Macroscopic and microscopic analyses on rock samples

Here we present analyses of rock samples recovered in some locations of the PVB (Fig. 5). Samples 1, 2, 3, 1A, 2A, 4A, 5A, 6A and 7A have been grouped together because these all correspond to a bioclastic calcirudite. Samples 1, 2, 3, 4A and 6A have been taken by divers at various water depths from the blocks composing the outer rectilinear ridge, and sample 7A was taken at the top of the inner ridge. Samples 1A, 2A and 5A have been taken by divers from the monolith described above. The macroscopic analysis shows that about 95% of the clasts consist of fragments of shells, red algae and corals, with rare, well rounded lithoclasts (generally between 0.5–4 mm in size), embedded in a thin layer of calcite. A photomicrograph of a thin section (transmitted light) shows that the coarse-grained, rounded bioclasts (red algae) are surrounded by an isopachous fringe of calcite, indicative of precipitation in marine phreatic zones where all pores are filled with water (typical feature of low-intertidal and sub-tidal cements). In this case, bridging