

NEW ARCHAEOLOGICAL AND GEOMORPHOLOGICAL MARKERS ALONG THE ISTRIAN COASTS (CROATIA) AND THEIR RELATIONS WITH RELATIVE SEA LEVEL CHANGES

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ABSTRACT: Furlani S. *et al.*, *New archaeological and geomorphological markers along the Istrian coasts (Croatia) and their relations with relative sea level changes*. (IT ISSN 0349-3356, 2011)

New data on archeological remains and coastal morphologies have been used to refine published data on the Late-Holocene relative sea-level change along the Northeastern Adriatic coasts. Data have been compared with predicted curves, in order to detail the tectonic evolution of the studied area.

RIASSUNTO: Furlani S. *et al.*, Segnalazione di nuovi indicatori archeologici e geomorfologici lungo la costa istriana (Croazia) e correlazione con le variazioni relative di livello marino. (IT ISSN 0349-3356, 2011)

Le variazioni di livello marino tardo-oloceniche lungo le coste nordorientali dell'Adriatico sono state dedotte da una serie di nuove misure effettuate su indicatori archeologici e geomorfologici sommersi. I dati raccolti sono stati comparati con le curve predette di risalita del livello del mare.

Key words: sea level changes, late-Holocene, geoarchaeology, Istria, Northeastern Adriatic

Parole chiave: variazioni di livello marino, tardo-olocene, geoarcheologia, Istria, Adriatico nordorientale

The Gulf of Trieste and the Istrian coasts have been extensively studied during the last decade (FOUACHE *et al.*, 2000; ANTONIOLI *et al.*, 2004, 2007; FAIVRE and FOUACHE, 2003; FAIVRE *et al.*, 2011; FURLANI *et al.*, 2011). Nevertheless, many sites remain unstudied from the point of view of sea level changes.

Cited Authors reported along the limestone coasts between the Gulf of Trieste (Italy) and Istria (Croatia) the quasi-continuous occurrence of a submerged marine notch at a depth ranging between -0.5 m and -2.8 m, while Roman age archaeological remains were measured at depths usually deeper than the altitude of the notch.

We aim at detailing the late-Holocene, in particular since Roman-age, tectonic behaviour of the studied area following the methodological steps suggested first by ANTONIOLI *et al.* (2007).

1. STUDY AREA

From a geodynamical point of view, the study area belongs to the External Dinarides. It is characterized by a diffuse NW-SE orientation of the tectonic structures.

Along the Northeastern Adriatic coast crop out limestones belonging to the Adriatic Carbonate Platform and spanning in time from Lower Jurassic



Fig. 1. The study area and the surveyed sites
L'area di studio con i siti indagati

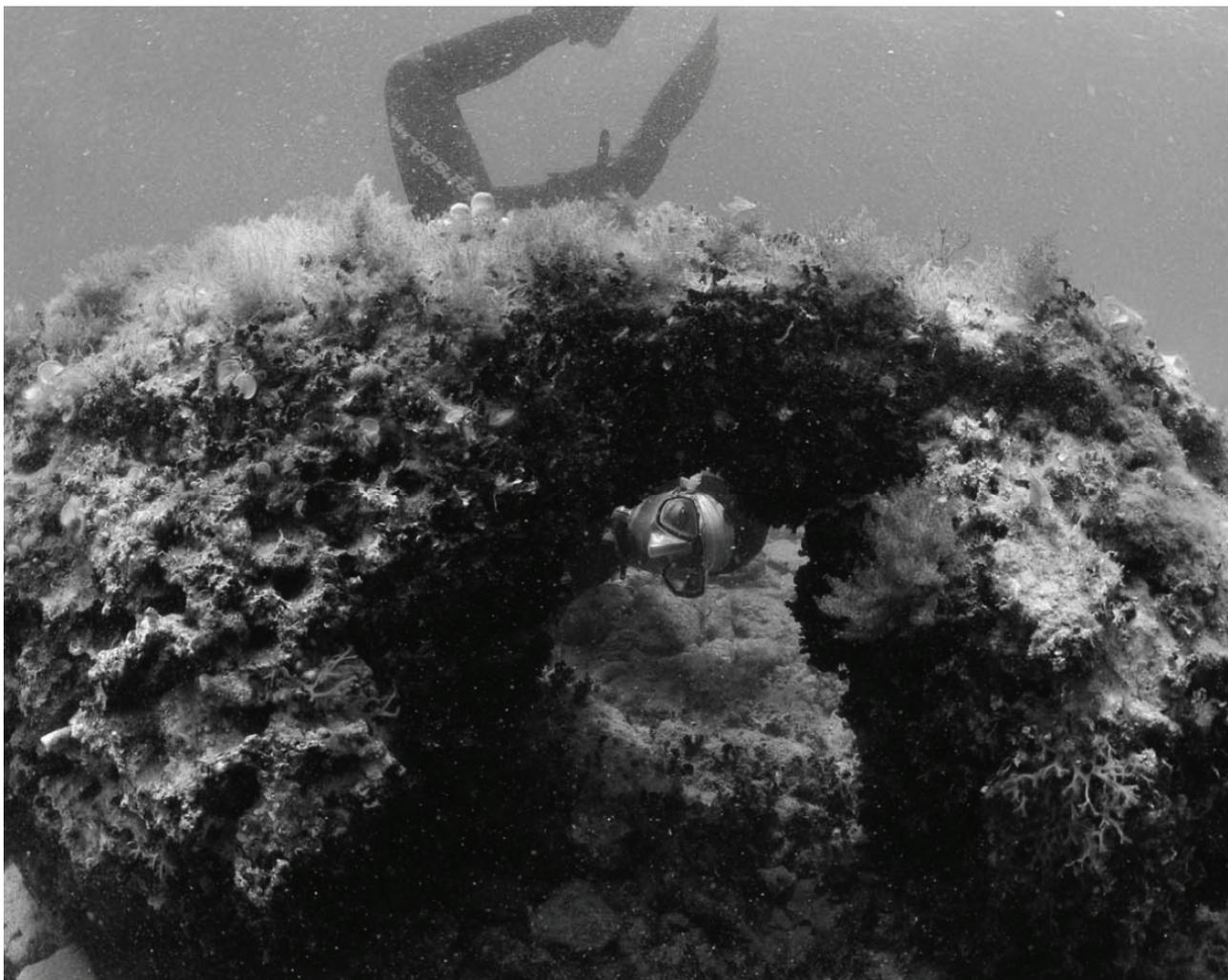


Fig. 2. Submerged dock at Barbariga
Il molo sommerso di Barbariga

(Toarcian) to Eocene (VLAHOVIĆ *et al.*, 2005). Previous works recognized the occurrence in the NE Adriatic sector of a NW tilting along different geological time scales: pendulum data (BRAITENBERG *et al.*, 2005), geomorphological markers (ANTONIOLI *et al.*, 2004, 2007), archeological markers (DEGRASSI *et al.*, 2008) are evidence of recent tilting, while geophysical data (BUSETTI *et al.*, 2010), structural data (CARULLI *et al.*, 1980) and gravity modeling (COREN *et al.*, 2006), indicate that the tilting is regional and long lasting. Moreover, the dataset suggests that the southern side of the gulf has subsided, at least since Roman time (about 0.6 mm/y), while the northern side has subsided during the Holocene, probably faster than the southern side (up to 1.99 mm/y, even if probably this value is mainly due to high sedimentation rates), following the aforementioned tilting (FURLANI *et al.*, 2011).

2. THE INVESTIGATED SITES AND THEIR SIGNIFICANCE ON LOCAL TECTONICS

Six new submerged archaeological and geomorphological markers have been surveyed, one in Italy and the remnants in Istria (Croatia). In particular:

- 1) submerged structure at Sistiana (Trieste, Italy). The functionality of the structure is not completely understood yet, since it is inclined toward the sea. Since the presence of quarries, which are active since Roman age, located just near the site, it could be a "slide" to charge limestone blocks on the ships. Its altitude ranges between -1.0 m and -5.0 m;
- 2) coastal quarry at Palud (Pula, Croatia). The structure shows the proofs of human quarrying on limestone blocks. The base level of the quarry is covered by cementitium (maybe used to level off the pavement) and it is at about -0.2/-0.3 m m.s.l.

Offshore there is another human-made basement;
 3) submerged "path" at Kolone (Bale, Croatia). A submerged path, at about -1.5 m m.s.l., connects the coast to a small island. It is about 100 m long;
 4) submerged dock at Barbariga (Croatia). The state of conservation is bad. The altitude of the structure is about -1.5 m;
 5) submerged beachrock at Brijuni. Its depth ranges between about -5.0 and about -1.5 m. Its morphology suggests that the structure is a beachrock;
 6) coastal quarry at Sekovac (Premantura, Croatia). The structure evidences the proofs of human quarrying on limestone blocks. The altitude is similar to the quarry located at Palud.

The comparison between published and these new data refines the knowledge on late Holocene sea level change in Istria.

The large number of structures already surveyed in the area allows to usefully integrate the available data, despite the bad state of conservation of the studied markers and the large uncertainty on their functionality.

The most useful sea level marker is the roman dock at Barbariga. The mean values of the tide and pressure-corrected archaeological measurements suggest a depth of -1.6 ± 0.5 m for the 2 ky Bp sea level (Roman age – I sec. A.D.). Considering the recent position of the submerged road at Bale, the same relative sea level rise rate seems to affect even the area located toward North. The altitude of the quarries represents an upper limit for the Roman Age sea level, however values agree with the other considerations.

Comparison between the position of the submerged markers and the predicted values of sea level rise for the Northern Adriatic Sea details data collected by previous Authors and confirms the negative tectonic rate ($-0.7/-0.8$ mm/yr) for the whole studied area.

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