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Lagoonal settlements and relative sea level during Bronze Age in Northern Adriatic: Geoarchaeological evidence and paleogeographic constraints

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ABSTRACT

The study of archaeological structures has been widely applied in the Mediterranean to infer the past relative sea level (RSL), but the use of Prehistoric sites was generally scarce. Pre-Classical settlements related to past marine position are quite rare and, after their occupation phase the landscape has often dramatically changed. A peculiar situation characterizes the NW Adriatic coast, along the lagoon fringe east of Venice, where several Bronze-Age settlements have been exposed after the land reclamation carried out in the 20th century. We analyzed the published information and collected new stratigraphic and geochronological data in five major sites where index points related to past sea-level are recorded. This research investigated in detail the geomorphological and geoarchaeological aspects, allowing to distinguish three different typologies of settlements: a) sites on Holocene fluvial ridges; b) sites on the alluvial plain of the Last Glacial Maximum (LGM) and along groundwater-fed rivers entering in the lagoon; c) sites in the lagoon, controlling key locations. The lagoonal environment had an extent rather comparable to the modern one already 4000–3500 years BCE, when sea level was above −4 m respect mean sea level (MSL). In the second part of the early Bronze Age, around 1800 BCE, the observed RSL was between −3.0 and −2.7 m MSL, while at the transition between recent and final Bronze Age (1250–1100 BCE) it probably was at −2.0 ± 0.6 m MSL. The analyzed settlements were abandoned during the final Bronze Age, but the data testify that sea level rose progressively. This suggests that the abandonment was probably not primarily due to RSL, but to socio-cultural reasons or other environmental causes that are not yet well understood by the archaeological community.

1. Introduction

Coastal archaeological structures are widely recognized as important markers for reconstructing past sea-level positions (e.g. Morhange and Marriner, 2015). In the Mediterranean Sea they have been largely used due to the abundance of ancient settlements along the coast and the good chronological constraints that they can provide (e.g. Pirazzoli, 1976; Flemming, 1969; Morhange et al., 2001; Anzidei et al., 2011). Most of the research focused on harbours and other docking structures from historical periods and mainly from the Classical one (e.g. Lambeck et al., 2004; Antonioli et al., 2007; Auriemma and Solinas, 2009). On the contrary, the investigations on prehistoric and protohistoric settlements and related sea level are rather rare (e.g. Galili and Nir, 1993; Antonioli et al., 1996; Brückner et al., 2006; Bailey and Flemming, 2008; Benjamin et al., 2011b; Gallou and Henderson, 2012). This is

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mainly due to the limited number of known sites that can offer direct indication of the past sea level. Moreover, considering the relative sea-level rise and the paleogeographic changes that have occurred in the last millennia, most part of the prehistoric sites that used to be coastal settlements or harbours are now submerged, largely eroded, or buried under younger deposits. This setting is generally hampering the recognition of the sites but, when buried archaeological layers are identified, they can be used as chronological *terminus ante-quem* for the layer they cover, or *terminus post-quem* for the deposits that seal them.

This work considers some of the main sites of the Bronze Age in NE Italy that supply useful information for reconstructing of the relative sea level (RSL). Here we present a review of the literature data at the light of some new stratigraphic and geochronological information. The aim of this study is to analyse the key features of the sites that developed along the Adriatic coast during Bronze Age, describing and discussing the index points related to past sea level and the paleogeographic and paleonvironmental aspects.

Table 1
Chronological phases of the Bronze Age in NE Italy according to Peroni and Vanzetti (2005) and revised by Bietti Sestieri (2010).

Cultural subdivision of Bronze Age in NE Italy			
Phase	Sub-phase	Chronological interval (years)	
		Before Common Era	Before Present
FINAL	FBA3	1000-950 BCE	2950-2900 BP
	FBA2	1100-1000 BCE	3050-2950 BP
	FBA1	1150-1100 BCE	3100-3050 BP
RECENT	RBA2-evoluted	1200-1150 BCE	3150-3100 BP
	RBA2	1250-1200 BCE	3200-3150 BP
	RBA1	1350-1250 BCE	3300-3200 BP
MEDIUM	MBA3	1450-1350 BCE	3400-3300 BP
	MBA2	1550-1450 BCE	3400-3400 BP
	MBA1	1650-1550 BCE	3600-3500 BP
EARLY	EBA2	1900-1650 BCE	3850-3600 BP
	EBA1	2200-1900 BCE	4150-3850 BP

This coastal sector presents a peculiar setting, where the reclamation of vast wetlands accomplished in the 20th century led to the emersion of wide areas (Antonioli et al., 2016). These are currently below present sea level, up to −2 and −3 m in respect to mean sea level (MSL), but had been occupied by humans before their drowning and still preserve numerous archaeological traces (Ammerman and McClennen, 2001; Bondesan et al., 2004; Bondesan and Meneghel, 2004; Fontana, 2006). The oldest evidence of permanent settlements related to the lagoonal environment dates back to ancient Neolithic (5500–4800 BCE), when the first farmers built villages along the fringes of Venice and Grado-Marano lagoons and exploited the brackish environment for fishing, hunting and shell gathering (Fontana and Pessina, 2011). In Northern Italy the Bronze Age (2200–950 BCE) is the first archaeological period that allows a well defined and robust differentiation of chrono-typological phases, with an accuracy of 20–100 years, based on assemblages of pottery and metal artefacts, as well as on dendrochronology and radiocarbon dating (Peroni and Vanzetti, 2005). In particular, the middle and recent Bronze Age (Table 1) corresponds to a phase of major increase of population, with flourishing of complex and widespread settlement systems (Peroni, 1989; Bernabò Brea et al., 1997). The main evidence of this period is documented in the central portion of the Po Plain, where the Terramare Culture developed (Fig. 1) and detailed investigations started since the second half of the 19th century (Vanzetti, 2013 and references therein). Despite the long tradition of studies considering this culture, the coastal landscape of that time is still almost completely unknown due to the dramatic progradation of the Po Delta that sealed the Bronze-Age surface with several meters of deposits. A rather different situation is documented along the coastal plain east of Venice, where the Holocene lagoonal environment has been transgressing over the late-Pleistocene alluvial

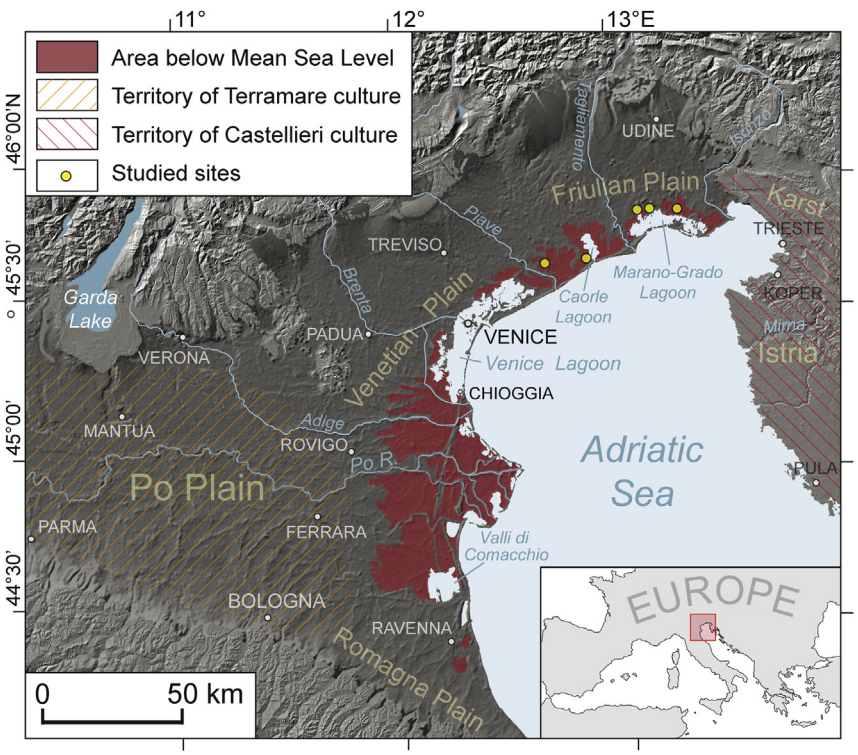

Fig. 1. Location of the study area with indication of the studied sites and of the main archaeological groups documented in Northern Adriatic area during the Bronze Age.

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