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# Late Holocene palaeogeographical evolution of Paroikia Bay (Paros Island, Greece)

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### ABSTRACT

Although there is rich evidence for human occupation of Paros' coastline, there is a dearth of data with regards to the evolution of the island's seaboard palaeoenvironments. In this paper, we use sedimentological and palaeontological proxies of late Holocene coastal deposits from lagoonal environment to reconstruct the evolution of coastal landscapes in Paroikia Bay (Paros Island, Greece). A semi-enclosed lagoon existed in the northeastern part of Paroikia from at least 2915–2551 BC, which was gradually infilled after around 780–436 BC. Although it was not possible to chronologically constrain the timing of the infill, it is most likely relatively young, indicating anthropogenic effects. A correlation of our chronostratigraphic data with archaeological remains and tidal notches in the study area suggests that the subsidence observed on Paros Island is linked to long-term subsidence in combination with vertical seismic displacements.

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## 1. Introduction

Relative sea-level fluctuations, climate change and human impacts are well recorded in the sediments of coastal marshes and wetlands (e.g., Edwards, 2007; Giraudi, 2011; Kemp et al., 2011). Coastal marshes and lagoons are particularly sensitive to local and regional palaeoenvironmental changes and have proven to be

powerful archives for studying coastal changes during the Holocene (e.g., Anthony, 2008; Clave et al., 2001; Cole and Liu, 1994; Ejarque et al., 2016; Sacchi et al., 2014; Scott and Medioli, 1978; Stanley and Warne, 1994; Vella and Provansal, 2000). Many palaeoenvironmental studies in the Aegean Sea are based on sedimentary archives extracted from coastal marshes and lagoons (e.g., Evelpidou et al., 2012a; Pavlopoulos et al., 2010; Triantaphyllou et al., 2010; Vouvalidis et al., 2010). Using a multi-proxy approach based on sedimentology, micro- and macrofauna identification and dating, it is possible to reconstruct the coastal evolution and relative sea level changes (e.g., Ghilardi et al., 2014; Marriner et al., 2014; Nixon et al., 2009; Primavera et al., 2011; Vacchi et al., 2017).

Our study area, Paros Island (Cyclades), has rich evidence for human occupation; however, there is a

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dearth of data with regards to the evolution of the island's seaboard palaeoenvironments. Palaeogeographical reconstructions are fundamental to better investigate coastal archaeological sites and to provide the basis for archaeologists regarding past human – environment interactions. In this context, the primary aim of this study is to probe the evolution of the coastal zone in Paroikia bay, Paros Island (Cyclades), and to reconstruct the palaeoshoreline changes during the late Holocene.

## 2. Study area

### 2.1. Physical setting

Paros Island is part of the Cyclades Islands complex, in the central Aegean Sea. It is the third largest island of the Cyclades (Fig. 1). The Cycladic region is presumed to be under the influence of an extensional tectonic regime behind the modern volcanic arc at the centre of the Aegean plate and possesses a relatively thin continental crust about 25–26 km in thickness (e.g., Tirel et al., 2004; Zhu et al., 2006). The central Aegean is characterized by relatively low seismicity and the absence of large earthquakes (e.g., Papazachos, 1990). According to Sakelariou and Galanidou (2016), vertical tectonic movements have been considered of minor significance for the palaeogeographical evolution of this area during the late Pleistocene-Holocene.

Several geomorphological and geoarchaeological investigations have been conducted in the Cycladic region to evaluate the RSL changes in the area (e.g., Baika, 2008; Desruelles et al., 2009; Evelpidou et al., 2012a, 2012b; Evelpidou et al., 2014; Kapsimalis et al., 2009; Karkani et al., 2017; Pavlopoulos et al., 2011; Poulos et al., 2008). For Paros Island, Evelpidou et al. (2014) have reported the presence of submerged tidal notches and suggested three palaeoshorelines at  $-35$  cm,  $-170$  cm and  $-230 \pm 20$  cm. The occurrence of tidal notches at various depths reveals the occurrence of rapid subsidence events, potentially of seismic origin (Evelpidou et al., 2014).

Lithologically, Paros Island is characterized by a variety of metamorphic rocks (with the dominance of

marble, gneiss, and schists) along with some Neogene and Quaternary formations covering only a small part of its coastal zone. The coastal zone of Paros mainly consists of Quaternary deposits, marbles, gneiss schists, and some minor outcrops of igneous rocks. It is mainly rocky and steep, particularly in the north-eastern and northwestern part, and the beaches form a smaller part. The studied site, Livadia, is located in the northwestern part of Paros Island, at an alluvial plain bounded by two faults of NNE–SSW and east–west direction, respectively (Figs. 1 and 2).

### 2.2. Archaeological context

Paros Island is of great geoarchaeological back to the 5th millennium BC (Schilardi, 2002), while the nearby island of Saliagos has yielded a Neolithic settlement (Evans and Renfrew, 1968). In antiquity, Paros had two renowned harbours, one of which according to Scylax (Periplus 58: "... Πάρος λιμένας ἴσχυουσα δύο, ἓν τὸν ἄνα κλειστόν") was 'closed', i.e. situated within the city walls (Papathanassopoulos and Schilardi, 1981). Due to its sheltered harbours and the island's position in the Aegean, along with the marble trade, Paros became a rich maritime power.

The submerged antiquities of Paros include cemeteries of various time periods, harbour installations and buildings. The bay of Paroikia, in particular, is characterized by the presence of coastal and submerged archaeological remains (Fig. 1c), some of which remain undated (Papathanassopoulos and Schilardi, 1981). In particular, remains of a submerged Roman building have been reported by Rubensohn (1901, 1949) and later by Papathanassopoulos and Schilardi (1981). During an underwater survey by Papathanassopoulos and Schilardi (1981), an ancient mole was found between  $-2$  and  $-3$  m, with a length of  $\sim 100$  m. However, no chronological indices were found. The ancient cemetery in the bay of Paroikia was in use from the end of the 8th c. BC until the 3rd–4th c. AD (Zapheirou, 2000). Although the island has been the object of geomorphological and archaeological research, no late Holocene palaeogeographical reconstructions have been undertaken.

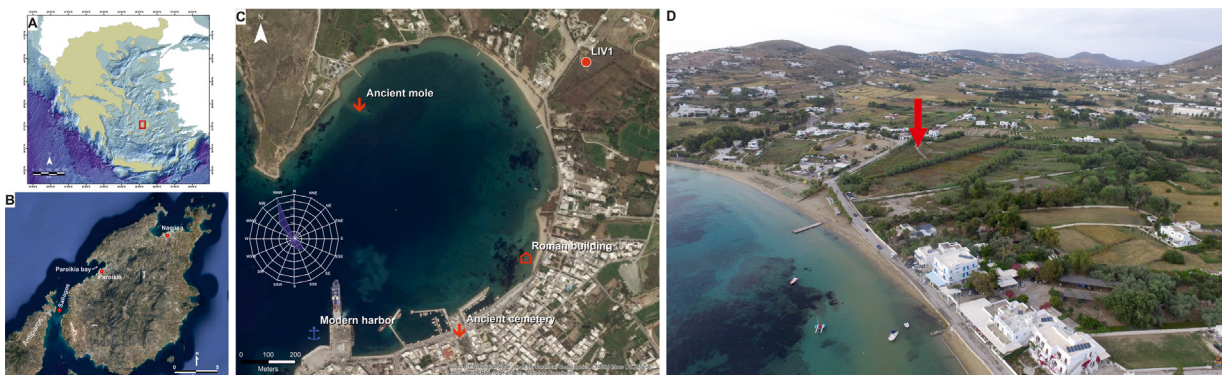


Fig. 1. Location of the study area and drilling site: a) Location of Paros Island within the Aegean; b) aerial photograph of Paros Island (Google Earth); c) location of the core along with the main submerged archaeological remains in Paroikia Bay (wind rose from windfinder.com, Image Google Earth); d) aerial view of the coring site in Livadia (the red arrow shows the coring location).

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