Continental Shelf Research 126 (2016) 36–49

Contents lists available at ScienceDirect

Continental Shelf Research

journal homepage: www.elsevier.com/locate/csr

Research papers

Foraminifera eco-biostratigraphy of the southern Evoikos outer shelf, central Aegean Sea, during MIS 5 to present

Hara Drinia *, Assimina Antonarakou, Theodora Tsourou, George Kontakiotis, Maria Psychogiou, George Anastasakis

National and Kapodistrian University of Athens, Faculty of Geology and Geoenvironment, Dept. of Hist. Geology, Palaeontology, Panepistimiopolis 157 84, Athens, Greece

ARTICLE INFO

Article history:
Received 23 October 2015
Received in revised form
12 July 2016
Accepted 14 July 2016
Available online 16 July 2016

Keywords:
Foraminifera
Marine isotope stages
Sea-level
Climate
Central Aegean

ABSTRACT

The South Evoikos Basin is a marginal basin in the Aegean Sea which receives little terrigenous supply and its sedimentation is dominated by hemipelagic processes. Late Quaternary benthic and planktonic foraminifera from core PAG-155 are investigated in order to understand their response to the glacial-interglacial cycles in this region. The quantitative analysis of planktonic foraminifera, coupled with accelerator mass spectrometry (^{14}C-AMS) radiocarbon date measurements, provide an integrated chronostratigraphic time framework over the last 90 ka (time interval between late Marine Isotopic Stages 5 and 1; MIS5-MIS1). The temporary appearance and disappearance as well as several abundance peaks in the quantitative distribution of selected climate-sensitive planktonic species allowed the identification of several eco-bioevents, useful to accurately mark the boundaries of the eco-biozones widely recognized in the Mediterranean records and used for large-scale correlations. The established bio-ecozonation scheme allows a detailed palaecological reconstruction for the late Pleistocene archive in the central Aegean, and furthermore provides a notable contribution for palaeoclimatic studies, facilitating intercorrelations between various oceanographic basins. The quantitative analyses of benthic foraminifera identify four distinct assemblages, namely Biofacies: *Elphidium* spp., *Haynesina* spp. Biofacies, characterized by neritic species, dominated during the transition from MIS 5 to MIS 4; *Cassidulina laevigata/carinata* Biofacies dominated till 42 ka (transgressive trend from MIS 4 to MIS 3); *Bulimina gibba* Biofacies dominated from 42 ka to 9.5 ka (extensive regression MIS 3,2 through lowstand and early transgression; beginning of MIS 1); *Bulimina marginata, Uvigerina* spp. Biofacies dominated from 9.5 ka to the present (late transgression through early highstand; MIS 1)., This study showed that the South Evoikos Basin which is characterized by its critical depths and connections to the open sea, and its small volume water masses that nourished foraminiferal assemblages, accurately records 5th – 4th order sea level and climatic fluctuations. Especially, the basin's limited communication with the open ocean implies that any climatic signals will be recorded in an amplified fashion, and therefore this heightened sensitivity to the effects of climate variability further underlies the prominent role of such marginal basins in the understanding of the global climatic evolution.

1. Introduction

The late Pleistocene and Holocene represent periods with the most abundant and accurate information on palaeoenvironmental and palaeoclimatic variations. This time period has been characterized by an alternation of warm and cold periods, with two major abrupt events: Last Glacial Maximum (25–19 ka; Clark et al., 2009) and Younger Dryas (~12.8–11.6 ka; Severinghaus et al., 1998; Stansell et al., 2010). In between these events, other shorter fluctuations towards cooler climatic conditions have been labeled, initially in sediments from the North Atlantic - famous as Heinrich events (Heinrich, 1988; Grousset et al., 1993; Bond et al., 1997; Hemming, 2004; Jiménez-Moreno et al., 2008). These climatic episodes were also documented in sedimentary marine cores from the Mediterranean basin (Cacho et al., 2001; Pérez-Folgado et al., 2003) and in Greenland ice cores (Dansgaard et al., 1993; Grootes et al., 1993). The warmest periods of the last ~41ka are known as Bølling-Allerød (~12.8–14.6 ka) and Holocene Climatic Optimum (7–5 ka). The Marine Isotopic Stages (MIS) are alternations of warm and cold periods of the Earth's palaeoclimate, resulting from

* Corresponding author.
E-mail addresses: cntrinia@geol.uoa.gr (H. Drinia), aantonar@geol.uoa.gr (A. Antonarakou), ttsourou@geol.uoa.gr (T. Tsourou), gkontak@geol.uoa.gr (G. Kontakiotis), mpsychogiou@geol.uoa.gr (M. Psychogiou), anastasakis@geol.uoa.gr (G. Anastasakis).

http://dx.doi.org/10.1016/j.csr.2016.07.009
0278-4343/

changes in temperature as recorded in oxygen isotopes which have been found in deep sea cores. More than 100 MIS have been documented for the last 2 million years. As stated by Siddall et al. (2003), during the last 130 ka these climatic variations were accompanied by rather complex variations in sea level. Following Lambeck et al. (2002), several stages of sea level are labeled over the past 130 ka as follows: The interval between ~130 and 115 ka is the last interglacial highstand of MIS 5, when sea level fluctuated within 20 m more than present. The interval between ~115 and 75 ka corresponds to early regression, when sea level fluctuated between ~20 and 50 m below current sea level. The interval between ~75 and 30 ka represents late regression, when sea level was between ~30 and 84 m below present day. The MIS 4, 75–59 ka, is characterized by its greater sea level fall after MIS 4.23 of ca 84 m (Thompson and Goldstein, 2006). The MIS 4 to MIS 3 transition in sea level occurred between 57 and 60 ka BP and consisted of an initial rise to a sea level of −60 m for the first half of MIS 3 and subsequent drop to −80 m for the remainder (Siddall et al., 2008). Superimposed on are likely four sea level fluctuations of between 20 and 30 m magnitude during MIS 3 that ended at 25 ka. Eustatic sea level dropped drastically at the Last Glacial Maximum (LGM, 25–19 ka), when sea level reached ~120 m below present-day levels and never exceeded 75 m below modern sea level. The LGM is followed by a rather rapid, though punctuated, sea level transgression, which ends in the present sea level highstand by ~6 ka.

The Mediterranean marine sediments represent an excellent archive that record climate signals together with sea-level changes. Most of the studies performed on Mediterranean deep-sea successions showed that both the major climatic fluctuations and the subsequent sea level changes of the late Quaternary affected the marine environment and can be successfully detected in the marine sedimentary successions of the different Mediterranean sectors (Rohling et al., 1998; Cacho et al., 1999, 2001; Sbaffi et al., 2001, 2004; Pérez-Folgado et al., 2003, 2004; Sprovieri et al., 2003, 2006; Martrat et al., 2004; Moreno et al., 2004, 2005; Geraga et al., 2005, 2008; Sierro et al., 2005; Frigola et al., 2008; Marino et al., 2007, 2009; Sprovieri et al., 2012; Morabito et al., 2014; Kontakiotis, 2016). In this respect, micropalaeontological studies represent an important tool. Indeed, planktonic foraminiferal assemblages provided valuable information on the physical and chemical properties of the water masses and their relationships with climatic variability (Kontakiotis et al., 2011, 2016a,b; Antonarakou et al., 2015). They also allowed the definition of a detailed succession of eco-biozones for the late Quaternary (Asioli et al., 1999, 2001; Capotondi et al., 1999; Sbaffi et al., 2001, 2004; Principato et al., 2003; Sprovieri et al., 2003; Geraga et al., 2005; Budillon et al., 2009; Triantaphyllou et al., 2009; Siani et al., 2010; Kontakiotis, 2012), displaying the climatic changes. On the other hand, the composition and distribution of benthic foraminiferal assemblages is mainly controlled by the water-mass properties, mainly oxygenation and food supply (e.g. Miller and Lohmann, 1982; Corliss, 1985, 1991; Gooday, 1986; Corliss and Chen, 1988; Altenbach and Sarnthein, 1989; Van der Zwaan and Jorissen, 1991; Herguera and Berger, 1991; Barmawidjaja et al., 1992; Sen Gupta and Machain-Castillo, 1993; Jorissen et al., 1995, 1998; Bernhard, 1996; Jannink et al., 1998; Jorissen, 1999; Fontanier et al., 2002; Debenay et al., 2005).

In this paper we present data on benthic and planktonic foraminiferal faunas from a late Quaternary sediment core (PAG 155) of the central Aegean Sea to determine the impact of sea-level changes together with climatic changes on abundance, species composition, and diversity of the fauna. Core PAG 155 (Fig. 1a, b) is a continuous and almost undisturbed marine record spanning the last 90 ka cored from the central Aegean Sea Basin. The study of the foraminiferal fauna will exhibit the longest record ever obtained on the shelf in this region, extending well below MIS 4. Consequently, core PAG-155 provides a very good opportunity to analyze the benthic ecosystem changes of the last glacial-interglacial cycle in the Aegean, a key area for the oceanographic setting of the entire Mediterranean. Comparison with other Mediterranean records (e.g. Debenay et al., 2005; Piva et al., 2008a, 2008b; Naeher et al., 2012) will provide information for the recognition of possible local effects.

2. Geological setting

The South Evoikos Gulf (Fig. 1a) is an elongate, WNW-ESE trending, over 60 km long and up to 25 km wide graben system that essentially hosts two sub-basins: a northern shallow one and a southern deeper basin that forms at its exit into the Aegean Sea

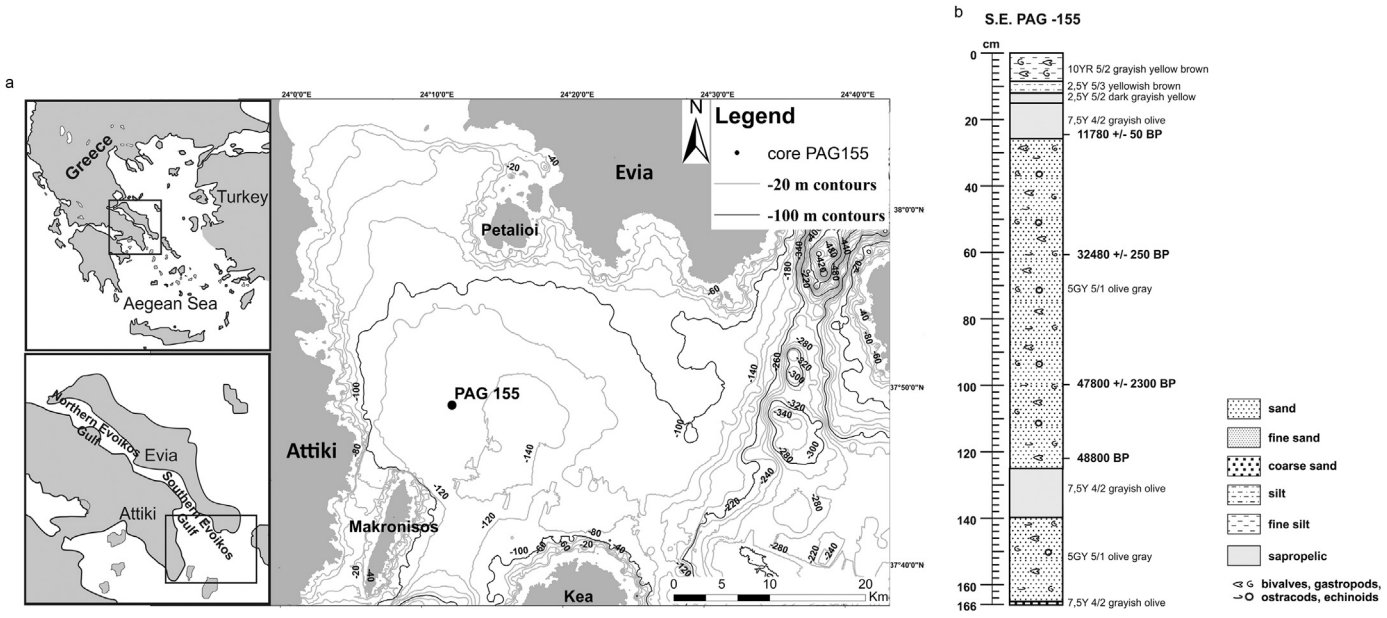

Fig. 1. a Bathymetric map of South Evoikos Basin showing the location of the studied core PAG-155. **b:** Lithology of the studied core.