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Sedimentological, mineralogical and geochemical characteristics of the ooids in Cleopatra (Sedir Island, Gökova Bay, SW Turkey) and Alexandria (NW Egypt) Beach sediments: A comparison and reality of myth of the love

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ABSTRACT

According to the myth, ooid-rich sediments in Cleopatra Beach (Sedir Island, Turkey) were brought by ships from Alexandria Beach (Egypt) by the Roman leader, Marcus Antonius, for his lover Cleopatra. Ooids of both beaches have been compared in terms of sedimentology, mineralogy and geochemistry to determine reality of the myth of love. Sieve analyses exhibit that sediments of Cleopatra Beach are slightly better sorted than Alexandria Beach sediments, and have relatively smaller sized ooids, interpreted to represent a relatively less agitated environment. All ooids are composed mainly of aragonite characterized by high Sr contents (>8600 mg/kg). Hierarchical Cluster Analysis, the cross-plot of $\delta^{18}O_{aragonite}$ versus $\delta^{13}C_{aragonite}$ values of ooids, and the presence of detrital grains such as gneiss and schist hint on two distinct groups of samples that correspond to the Cleopatra and Alexandria Beach ooids. These results suggest that the myth may not be realistic, and the ooids on the shore of Sedir Island were formed in-situ, e.g., during the Late Holocene.

1. Introduction

Sedir Island in Gökova Bay (Marmaris, Muğla), southwestern Turkey, is famous with Cleopatra Beach and its distinctive white sands, consisting mainly of ooids. These ooid-rich sediments are called myth of the love. According to the myth, these white ooid-rich sediments were shipped from the Alexandria Beach in Egypt by the Roman leader, Marcus Antonius (83 BC–30 BC) to create a beach on Sedir Island for his lover Cleopatra VII (69 BC–30 BC) (El-Sammak and Tucker, 2002; Fig. 1).

There are several studies on the Sedir Island ooids and some of them compare the Sedir Island ooids with the Alexandria Beach sediments. Eseller (1990) and El-Sammak and Tucker (2002) examine ooids of Cleopatra Beach and compares them with ooids of the northwestern coast of Egypt, both support the reality of the myth based on the micro-morphological and mineralogical similarities and lack of dynamic conditions for ooid formation in Cleopatra Beach. This view is also supported by Özhan (1990), Öztürk et al. (1998) and Öztürk (2004) also considering presence of some exogenic grains in the ooid nucleus such as gneiss and granite. However, Üsenmez et al. (1993) presents an opposite view, unlike the previous researchers, based on the presence of micro nodules and tablet-shaped crust on the ooids of Cleopatra Beach in scanning electron microscopy (SEM) images. These features indicate microbially induced ooid formation that does not require the high-energy conditions. Later, this view was also supported by Altun et al. (2009) based on petrography, X-ray diffractometry (XRD), scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM-EDX) and Amino Acid Racemization (AAR) analyses.

Despite all previous studies, the reality of the myth is still unclear. Therefore, this contribution tests the validity of this myth, comparing and contrasting sedimentological, mineralogical and geochemical characteristics of the ooids from both Cleopatra and Alexandria Beaches.

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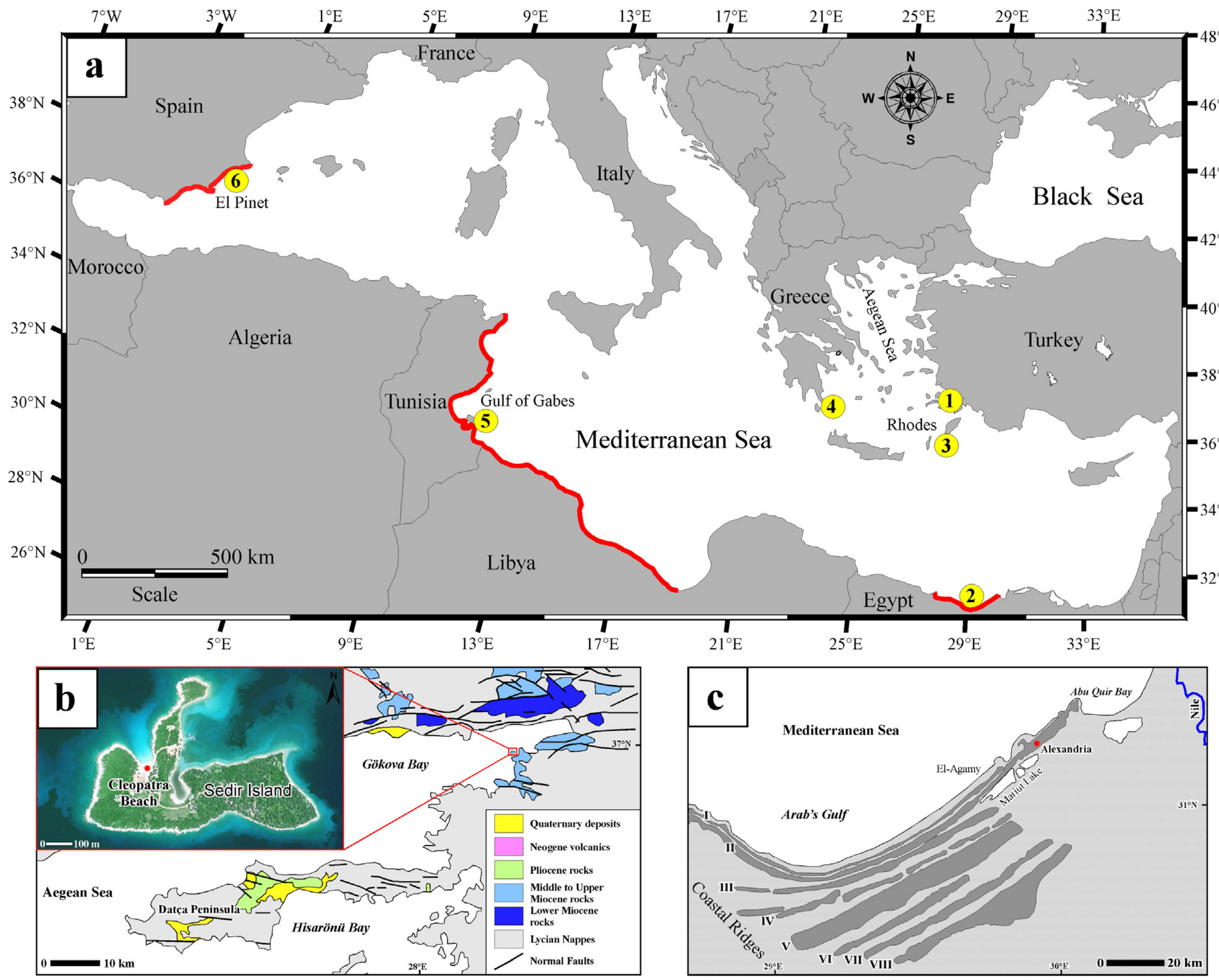

Fig. 1. (a) Quaternary ooid occurrences along the Mediterranean Sea coast: (1) Cleopatra Beach, Sedir Island, Gökova Bay, Turkey (Üsenmez et al., 1993; El-Sammak and Tucker, 2002); (2) coast west of Alexandria, Egypt (Stanley and Hamza, 1992; Warne and Stanley, 1993; El-Sammak and Tucker, 2002); (3) Kattavia Road Cut, Rhodes Island, Greece (Hansen, 2001; Titschack, 2006; Milàn et al., 2007); (4) Neapolis, southern Peloponnesus, Greece (Richter, 1976); (5) Djerba Island and north of Zarzis, Gulf of Gabes, Tunisia (Fabricius et al., 1970); (6) El Pinet, southeast Spain (Jedoui et al., 2002; Mauz et al., 2012), (b) Simplified geology map of the Gökova province (modified from Görür et al., 1995), showing the main lithological units. Inset shows the location of Cleopatra Beach (Sedir Island, Gökova Bay) in the Aegean Sea, (c) Location map for the exposed sedimentary units constituting the coastal ridges near Alexandria, along the northwestern coast of Egypt (compiled from Stanley and Hamza, 1992; El-Asmar and Wood, 2000; El-Sammak and Tucker, 2002).

2. Geological setting

The Cleopatra Beach sediments are found in a small cove at the northern margin of Sedir Island facing to Gökova Bay (Fig. 1a, b). Girgin and Ertürk (2010) provide detailed information on morphology of Sedir Island and its environs. Geology and geomorphology of Sedir Island are considered to be related to rifting of Gökova Bay and its infills (Kurt et al., 1999; Çağlar and Duvarcı, 2001). Cleopatra Beach is approximately 30 m long in the east–west direction and 15 m wide in the north–south direction, and has a sediment thickness of up to 80 cm (Özhan, 1990; El-Sammak and Tucker, 2002; Girgin and Ertürk, 2010). The thickness of the ooid-rich sediments decreases towards the sea and the sands disappear at a depth of 15 m (El-Sammak and Tucker, 2002). The island is made up of Tertiary (Miocene) polygenic conglomerates, which underlie the ooid-rich sediments in the small cove (Öztürk et al., 1998; El-Sammak and Tucker, 2002; Girgin and Ertürk, 2010). These conglomerates are comprised of mainly well rounded pebbles of recrystalized limestone, gneiss, schist, quartz and chert which are derived from the Lycian Nappes (Görür et al., 1995). However, Üsenmez et al. (1993), Çağlar and Duvarcı (2001) and Öztürk (2004) suggest Pliocene age for these conglomerates.

Little information is available in the literature concerning the northern Mediterranean coast of Egypt along which recent coastal sediments and a series of carbonate ridges extend parallel to the present shoreline (Fig. 1a, c; Wali et al., 1994; Hassouba, 1995, 1996; El-Asmar and Wood, 2000). At least eight carbonate ridges are distinguished (Stanley and Hamza, 1992; Wali et al., 1994), of which the first four are well developed (El-Shahat, 1995; El-Asmar and Wood, 2000). These ridges are beach dunes of Late Pliocene to Early Holocene age and composed mainly of white oolitic and biogenic grainstones (Wali et al., 1994; El-Shahat, 1995; Hassouba, 1995, 1996; El-Asmar and Wood, 2000). The coastal ridges have undergone diagenesis in marine-phreatic and freshwater-phreatic environments (Wali et al., 1994). The ridges are separated by linear depressions filled by sabkha-lagoonal deposits (Hassouba, 1995, 1996). The Quaternary coastal plain is confined by Middle Miocene Marmarican limestone forming a tableland (Hassouba, 1995; El-Asmar and Wood, 2000).