Journal of Archaeological Science: Reports 1 (2015) 73–80

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: http://ees.elsevier.com/jasrep

Paleo-environmental evolution of the Larnaca Salt Lakes (Cyprus) and the relationship to second millennium BC settlement

Benoît Devillers [a,b,*], Michael Brown [c], Christophe Morhange [d]

[a] ASM — Archéologie des Sociétés Méditerranéennes, UMR5140, Univ Montpellier 3, CNRS, MCC, 34000 Montpellier, France
[b] Labex ARCHIMEDE, IA-program ANR-11-LABX-0032-01, France
[c] Department of Archaeology, Durham University, South Road, Durham DH1 3LE, UK
[d] CEREGE, Université d'Aix-Marseille, Europôle Méditerranéen de l'Arbois, Avenue Louis Philibert, BP 67, 13545 Aix en Provence Cedex 04, France

ARTICLE INFO

Article history:
Received 13 August 2014
Received in revised form 3 November 2014
Accepted 13 November 2014
Available online 28 November 2014

Keywords:
Geoarchaeology
Coastal geomorphology
Late Bronze Age
Harbour engineering
Dromolaxia-*Vyzakia*
Cyprus
Mediterranean

ABSTRACT

New coring data provides a complete ^{14}C dated sequence covering the paleo-environmental evolution of the Larnaca Salt Lakes from c. 9000 BP onwards. This suggests the formation of a relatively confined lagoon after 4000 cal. BP. On the western shore of the main Aliki basin, overseas imports from the Late Bronze Age site of Dromolaxia-*Vyzakia* (Hala Sultan Tekke) reflect use of the Salt Lakes as a harbour during the second millennium BC. Coring and geomorphological mapping were employed to determine routes of navigation between this port and the open sea, with two main natural channels identified. A third potential communication in the form of an artificial cut, previously dated by Gifford (1978) to the Venetian period, is discussed with reference to changes in relative sea level along the island's south-east coast. Abandonment of settlement at Dromolaxia-*Vyzakia* in the early 12th century BC relates to the gradual isolation of the Salt Lakes lagoon from the surrounding marine environment through sedimentation. The timing of this event correlates with other known instances of population displacement throughout the eastern Mediterranean c. 1200 BC.

1. Introduction

The most prominent hydrological feature in Larnaca Bay is the Salt Lakes which cover an area of c. 57 km^2 (Fig. 1). Until recently the annual salt harvest provided Cyprus with one of its oldest and best known exports (Yon, 1992). Prior to formation of the Salt Lakes this area of coastline was connected to the sea, latterly in the form of a lagoon which gradually became isolated through sedimentation. In the second millennium BC this lagoon formed the largest sheltered anchorage on the island.

The main focus of Late Bronze Age occupation on the shore of the Salt Lakes was at Dromolaxia-*Vyzakia* (otherwise known as Hala Sultan Tekke). Excavated remains at the site primarily date to its final major phase of occupation between c.1190–1175 BC in Late Cypriot IIIA. The late Paul Åström, who led the Swedish Cyprus Expedition between 1971 and 2008, characterised this settlement as, "*an international harbour town … (with) Mycenaean jars and krators from mainland Greece, early vases and stirrup jars of oatmeal fabric from Crete, Grey ware from Troy, Canaanite jars from Cicilia, Syria and Palestine, elephant tusks and faience from the Near East and Egypt, and lapis lazuli from Badakstan in the north-east of Afghanistan*" (Åström, 1986, 8).

Dromolaxia-*Vyzakia* was also a likely point of departure for locally manufactured goods going overseas. Crushed murex shell heaps have been interpreted as evidence for purple cloth manufacture in the early 12th century BC (Åström, 1986, 11). Lead isotope analyses by Renson et al. (2007) on white slip and white painted wheelmade ceramics found at Dromolaxia-*Vyzakia* indicate that clay was sourced from the near vicinity, implying that the site was one of a number of manufacturing hubs for these major categories of Late Bronze Age Cypriot export (Artzy, 2001). In addition, the site appears to have been a regional centre for outlying rural settlements including Dromolaxia-*Trypes* (Åström, 1977).

A road running north from Dromolaxia-*Vyzakia* a short distance to the shore has been mapped using ground-penetrating radar survey (Fischer, 2011, 70; Fischer, 1980, 49). In common with other (proto-) harbours throughout the Bronze Age Mediterranean, shallow-draft vessels would presumably have been beached near to this location during loading, unloading and maintenance (for ancient depictions of this practice see Marriner et al., 2008, 1287; also Carayon, 2008; Sauvage, 2012; Tartaron, 2013).

Renewed excavations, ongoing as of 2010 under the directorship of Peter Fischer, have begun to investigate earlier occupation at Dromolaxia-*Vyzakia* in more detail. Preliminary results suggest two preceding architectural phases beginning c. 1600 BC in Middle Cypriot III–Late Cypriot I (see most recently Fischer and Bürge, 2013). The

* Corresponding author.
E-mail address: bdevillers@gmail.com (B. Devillers).

http://dx.doi.org/10.1016/j.jasrep.2014.11.004
2352-409X/

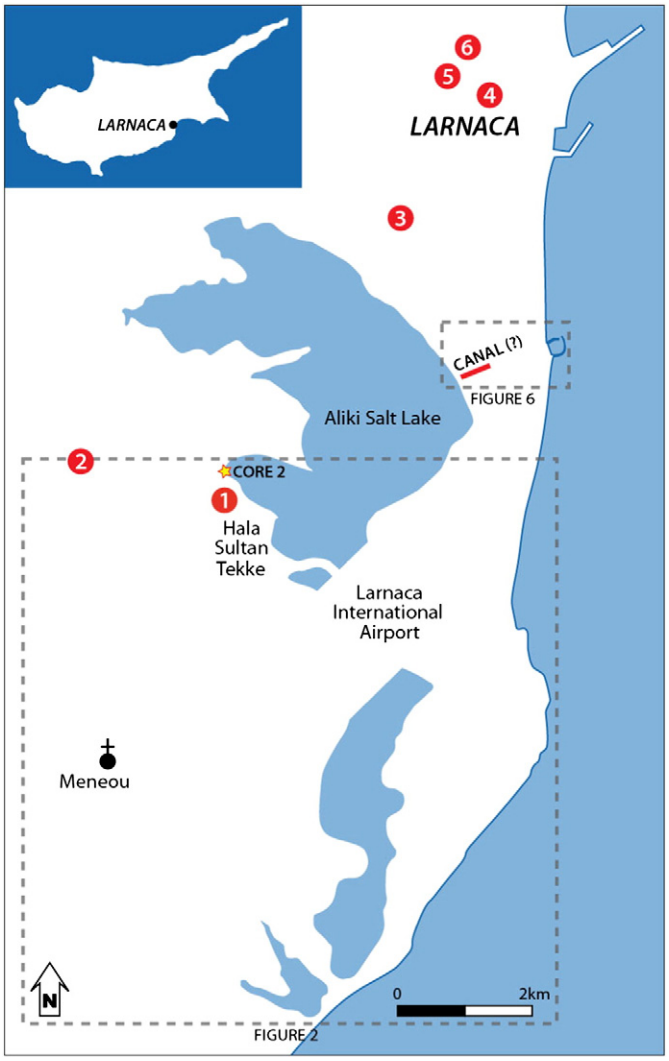

Fig. 1. The Larnaca Salt Lakes with principle sites and features mentioned in the text. 1.) Dromolaxia-*Vyzakia*; 2.) Dromolaxia-*Trypes*; 3.) Artemis Paralia; 4.) Kition-*Bamboula*; 5.) Kition-*Chrysopolitissa*; 6.) Kition-*Kathari*.

main settlement at Dromolaxia-*Vyzakia* was abandoned c. 1175 BC, with sporadic use of wells, indicated by ceramic debris, continuing into the early 11th century BC (Åström, 1998).

The geology and hydrology of the Salt Lakes were first systematically investigated by Bellamy (1900). Palaeography of the Larnaca lowlands received in-depth consideration by Gifford (1978), who produced a comprehensive regional history of human–environment interaction including the second millennium BC. Immediately to the north in the vicinity of ancient Kition, sedimentological and paleontological analysis of seventeen cores by Morhange et al. (2000) and Bony (2013) has been used to reconstruct shoreline changes over the past 4000 years. Geomorphological studies along the Gialias watershed by Devillers (2008) provide further comparanda from neighbouring areas of south-east Cyprus.

The purpose of this paper is to review recent research concerning the paleo-environmental evolution of the Larnaca Salt Lakes, and its relationship to settlement during the second millennium BC. These studies chiefly include previously unpublished results from coring and geomorphological mapping undertaken by Devillers and Morhange in 2002, together with proxy measurements for changes in relative Holocene sea-levels along the south-east coast of Cyprus by Dalongeville et al. (2000) and Morhange et al. (2000). Environmental data presented by Kaniewski et al. (2013) for the Salt Lakes region is considered with reference to eastern Mediterranean-wide climate trends and their possible social implications c. 1200 BC (the so-called 3.2 ka BP event).

2. Methods

Geomorphological mapping of the Salt Lakes region is based on coring data, supported by accompanying field survey, and remote sensing using Landsat and visible spectrum imagery (Fig. 2). Six mechanically drilled cores (LS1–4, 6–7) were retrieved in 2002 for the purposes of litho- and bio-stratigraphical analysis (Fig. 3). Core LS2 produced the greatest thickness of Holocene deposits, reaching the substrate at a depth of 18 m. Five radiocarbon ^{14}C dates were taken from this sequence for the period when the lagoon was open to the sea, and thus potentially in use as a harbour. This new data is compared with results from coring and survey previously undertaken by Gifford (1978). Geological identifications are based on Bagnall (1960).

3. Results

Core LS2 provides the most developed stratigraphical sequence, and is accordingly subject to more detailed analysis. It is also located furthest from the coast, meaning that marine influences observed in this core probably affected the majority of the surrounding Salt Lakes basin. Furthermore, because of the immediate proximity of LS2 to Dromolaxia-*Vyzakia*, it constitutes an important record of the changing geomorphological relationship between the ancient port and the open sea. As such, for the purposes of the present discussion, core LS2 can be viewed as broadly representative of its wider paleo-environmental context. The 18 m stratigraphic sequence covered by LS2 is divided into three main units (Fig. 4);

1) Base to 6 m depth, texture is silty clay interspersed with smaller amounts of sand due to detrital activity. The dark grey colour of the unit reflects the process of reduction. Manganese nodules and bedded sands show a hydrodynamic environment with subaqueous deposits. Fauna (identified by M. Bourcier, Centre d'Océanologie de Marseille-Endoume) also indicates a marine and/or lagoon environment in communication with the sea, with moderate contributions of freshwater and organic matter (Fig. 5). All radiocarbon dates are obtained from this unit (Table 1). These suggest a sedimentation period from c. 9000 BP to at least 4000 BP.
2) The middle unit between 6 and 4 m depth is richer in sand and is ocher coloured, likely due to oxidation. Some species of fauna (malacofaune, ostracods) are characteristic of freshening. Halite crystals are also present. Riverine influence from the adjacent Tremithos fluvial system appears to be apparent through freshwater input. These factors collectively favour a gradual closure of the Salt Lakes basin under the growing influence of alluvial silting, with the formation of a relatively confined lagoon after 4000 BP.
3) From 4 m deep, the top of the core is made up of beige silt and consolidated sand lying in parallel beds. A paleosoil with small brown clods is present at a depth of 3.8 m. Oxidation of clay through wetting and drying has left ocher marks. Anthropogenic deposits in the form of charcoals and ceramics are also present. This unit is alluvium (flood deposits), and represents the final phase of sedimentation leading to the emergence of the current landform through a process of aggradation.

Geomorphological mapping also highlights the underlying geological origin of the Larnaca Salt Lakes. As evidenced by the almost continuous presence of marly limestone along the current shoreline, the lagoon fits within a large Pliocene furrow. Numerous Quaternary alluvial fans on the western edge of this paleo-depression demonstrate the role of detrital erosion in the formation of the basin (Fig. 2). The present study does not provide evidence for significant shoreline progradation within the lagoon itself (for coastal progradation see below). It should