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Microarchaeology of a grain silo: Insights into stratigraphy, chronology and food storage at Late Bronze Age Ashkelon, Israel

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ABSTRACT

Pits and silos are storage features that often occur at prehistoric archaeological sites. Their shape, size and content may show a large degree of variability, and their function may be related to a number of behaviors that can provide valuable insight into the occupational history of a site. Such structures are usually investigated through the study of their macroscopic content, which may include stone, ceramic and metal artifacts, charred remains, and plant material in the case of good preservation conditions. However, pits and silos are generally characterized by complex life cycles that encompass also the partial or total removal of fill deposits, and the re-use of earlier structures, which hinder a proper interpretation of their function. This requires the application of a microarchaeological approach to the study of the sedimentary matrix of fill deposits, especially when macroscopic remains are absent or not uniquely related to a specific human activity. Here we present the study of a series of pits from the Late Bronze Age levels at Ashkelon, Israel, which were characterized by multiple fills layers. Using a combination of infrared spectrometry, phytolith analysis, and micromorphology of sediments, we show that one of the pits was used as grain silo and maintained through time. Radiocarbon dating of charred wheat seeds recovered from the primary depositional context thus identified caused a fundamental re-evaluation of the stratigraphy of the excavation area and a better understanding of its chronology.

1. Introduction

Sunken storage features are a common component of the archaeological record, especially at prehistoric sites (Halperin, 1994; Vigil-Escalera Guirado et al., 2013; Peña-Chocarro et al., 2015; Howey and Frederick, 2016; Martín-Seijo et al., 2017). These features, which are called pits or silos, generally appear as hemispherical depressions in the ground that may considerably vary in shape, volume and building technology. Storage pits were used as long-term repositories for food or other valuable goods such as stone tools, pottery and metal objects, and thus can provide invaluable information regarding a variety of behaviors (Bradley, 1990; Kuijt, 2009; Cunningham, 2011; Garrow, 2012; Fokkens and Harding, 2013; Peña-Chocarro et al., 2015; Yahalom-Mack et al., 2017).

The study of pits and silos usually focuses on their macroscopic contents, which may be related to their primary purpose (Martín-Seijo et al., 2017). In addition, the characterization of the building technology of the container itself can shed light on its original function (Fairbairn et al., 2007; Garfinkel et al., 2009; Kuijt and Finlayson, 2009; Milevski et al., 2012). However, it has been shown that the items recovered from archaeological storage pits rarely reflect their primary use (e.g. Cunliffe, 1992; Liesau von Lettow-Vorbeck et al., 2014). This is because most pits had life cycles that encompassed a construction phase of the container, followed by a period of primary use that ended with deliberate backfilling or accidental filling after abandonment (Reynolds, 1974; Martín-Seijo et al., 2017). This model is usually complicated by the fact that storage pits were often re-opened and their fills partially or totally removed, thus hindering a proper assessment of their original function (e.g. Schiffer, 1987; Garrow, 2006). The latter may be inferred if the sedimentary matrix accumulated during use still preserves diagnostic components such as ash, botanical remains, and metallic compounds. Therefore, a microscopic characterization of sediments is required in order to determine the nature of the contents of a storage pit or silo prior to its degradation and filling by different natural

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and anthropogenic processes (Weiner, 2010).

To date, the microarchaeological approach has been used only in a few studies of archaeological pits, but provided fundamental evidence for determining the primary use of pits and silos that yielded undiagnostic artifacts. More specifically, the application of Fourier transform infrared spectrometry (FTIR), micromorphology of sediments, phytolith analysis and X-ray fluorescence to extract information embedded in sediments has been crucial in identifying grain silos (Lu et al., 2009; Balbo et al., 2015), storage bins (Kadowaki et al., 2015), smelting pits (Eliyahu-Behar et al., 2012) and trash pits (Shahack-Gross et al., 2004; Macphail et al., 2008; Kadowaki et al., 2015), and in obtaining accurate radiocarbon dates (Asscher et al., 2015; Alex et al., 2017; Regev et al., 2017a; Toffolo et al., 2017c).

Here we report the microarchaeological study of a series of pits from the Late Bronze Age levels of Ashkelon, Israel, which were characterized by multiple fill layers. Using FTIR spectrometry, phytolith analysis and micromorphology of sediments, we identified in a single pit alternating beds of ash rich in burnt phytoliths and beds of pure cereal inflorescence phytoliths, which are consistent with the use and maintenance of food storage. Further, the condition of the sediments indicated that the deposit had remained undisturbed since its original use, allowing us to argue that the seeds recovered from the deposit are contemporary with the use of the pit rather than being residual. These observations, together with radiocarbon dating of charred seeds recovered from the ash layer, caused a fundamental re-evaluation of the stratigraphy of the area. With this study we aim at showing how a careful sedimentary characterization of pits can contribute to the assessment of the use of such ubiquitous archaeological features, and to a better understanding of stratigraphic and chronological sequences, especially at multi-layered tell sites.

2. Materials and methods

2.1. Archaeological context and sampling strategy

The ancient city of Ashkelon, located on the coast of Israel (Fig. 1), has been extensively investigated by the Leon Levy Expedition to Ashkelon between 1985 and 2016. The site was continuously occupied from the Chalcolithic until the 13th century CE, when it was destroyed by the Mamluks. It became a major port in the Early Bronze Age and its fortifications encompassed an area of some 60 ha in the Middle Bronze Age. During the Late Bronze Age the city answered to 18th and 19th Dynasty pharaohs from Egypt (Martin, 2008; Stager et al., 2008).

The samples reported in this study were collected from Grid 38, an 850 m^2 trench excavated into the northern flank of the Ashkelon central mound. Grid 38 features a long stratigraphic sequence spanning the Middle Bronze Age II through the Crusades. More specifically, the Grid 38 sequence identified five architectural phases from the Bronze Age, dated by the excavators to Middle Bronze Age IIC (MB IIC, Phases 25–24), Late Bronze Age I (LB I, Phase 23), and Late Bronze Age IIB (LB IIB, Phases 22–21). From the outset, several of these phases were very difficult to distinguish because they consisted of heavily pitted outdoor deposits. One of the clearer phases was Phase 21, which corresponds to the LB IIB (ca. 1300–1175 BCE) (Stager et al., 2008). Phase 21 was by and large characterized by scanty remains of outdoor occupation. Yet, at the southern end of Grid 38, in Square 84, the northern end of a massive building was exposed (Wall 1080), built of mudbrick preserved to a height of up to three courses (Fig. 2). Several architectural traits characterize this feature as Egyptian fortress or administrative building. Significantly, Phase 21 in Grid 38 yielded substantial amounts of Egyptian-type pottery, including both imported and, predominantly, locally produced (Egyptian-style) material (Martin, 2008). It should be conceded that the direct stratigraphic link between the building and the remains further north (i.e. the silos) was interrupted by later erosional activity (Stager et al., 2008). However, at roughly the founding levels of the wall, a series of pits and silos were uncovered underneath Iron Age material. These features extended over the entirety of Grid 38 and were represented in Square 84 by Silos 1133 and 1148, and Pit 1122 (Fig. 2).

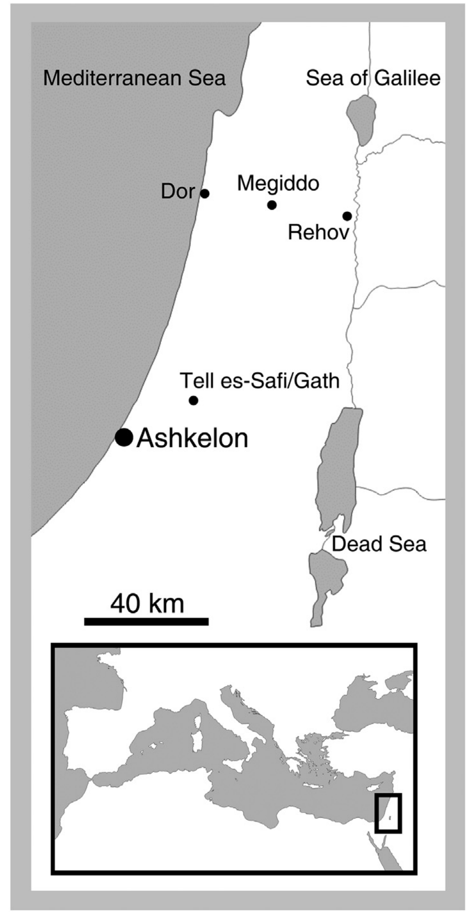

Fig. 1. Map of southern Levant showing the location of Ashkelon and other major Late Bronze Age sites.

The focus of this paper is Pit 1122, discovered about 2.5 m north of the Egyptian wall (Fig. 2 and Fig. 3). Indeed, given its founding level, and the many silos that had been found elsewhere in this area, it was immediately identified as a Phase 21 pit. The feature had a diameter of roughly 2 m and a depth of ca. 1 m. The uppermost fill layer (Layer 1123) contained a rich collection of Phase 21 pottery and animal bones, including an articulated calf cranium. These finds were interpreted as waste disposal. The sedimentary matrix of Layer 1123 was characterized by a mix of sand and ash. A second layer, 1139, was sharply distinct but appears to follow the contours of Pit 1122. The sedimentary matrix of Layer 1139 consisted of the degraded mudbrick sediment found ubiquitously in Grid 38. A third fill layer (Layer 1154), composed by a markedly different grey ashy sediment, marked the bottom of the silo and was 30 cm thick. Because of the differences in these sediments, there was substantive debate by the excavators over whether these were layers of sediment within a single pit or whether the changes in sediment indicated a wholly different deposit. Indeed, the field excavators argued that the bottom of Pit 1122 had been reached, only to change their minds when the deposit below followed similar contours. The bottommost layer, 1154, featured at least five lenses of white sediment between 2 mm and 2 cm in thickness, which resembled lime plaster after visual inspection (Fig. 4). These lenses followed the contours of the northern edge of the original outlines of Pit 1122 and were ultimately determined not to extend beyond it. Layer 1154 ran from the northwestern edge of the pit towards its center, and was set on top of a layer of natural sand that represents the bottom of anthropogenic deposits in the excavation area. To the south, Layer 1154 cut into Pit 1198