Journal of Arid Environments xxx (2017) 1–14

Contents lists available at ScienceDirect

Journal of Arid Environments

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

Dating archaeological sites in an arid environment: A multi-method case study in the Negev Highlands, Israel

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ARTICLE INFO

Article history:
Received 29 November 2016
Received in revised form
26 April 2017
Accepted 9 May 2017
Available online xxx

Keywords:
Negev Highlands
Early bronze age
Intermediate bronze age
Radiocarbon
Optically stimulated luminescence
Arid environments
Micromorphology

ABSTRACT

Archaeological surveys of the Negev Highlands show that the settlement history of this arid environment oscillated widely over time. This observation is almost entirely based on scant sherd assemblages from surveys, with only a few chronometric ages from one or two archaeological features at a given site. The reasons for the scarcity of chronometric ages include insufficient attention to radiocarbon dating in past research, low amounts of datable organic material for radiocarbon dating and issues related to low rate of site accumulation, and incomplete preservation of activity remains. In order to overcome these problems, we present here the results of a detailed chronometric radiocarbon and optically stimulated luminescence (OSL) dating study exploring the development of Negev archaeological sites in the third millennium BCE. The study included micromorphological analyses to aid identification of sedimentological and post-depositional processes at the studied sites. At Nahal Boqer 66, one of many small Negev third millennium BCE sites, seven radiocarbon ages were determined from archaeological contexts that suggest repeated discontinuous activity throughout the Early Bronze (EB) and early part of the Intermediate Bronze Age (IBA) (c. 3300–2350 BCE). At Ein Ziq – one of a few large sites in the region – seven samples were dated; they show a very short period of activity in the beginning of the IBA (c. 2450–2200 BCE). OSL age determinations at this site provided evidence for the rapidity of site burial by sediment accumulation. Also, OSL ages from secure depositional contexts – verified via micromorphology – are in agreement with those obtained by radiocarbon dating. Taken together, the results provide new systematic evidence for the timing of EB–IBA activity in the arid Negev Highlands.

1. Introduction

Central to the investigation of archaeological settlements is the determination of their place in time. Chronometric dating is preferred but a single method cannot always address all aspects of human habitation and abandonment. In archaeology, the most common method is radiocarbon dating, which targets organic materials deposited in conjunction with human activity. While radiocarbon dating is limited to the last 50,000 years, optically stimulated luminescence (OSL) dating covers even longer periods of time, serving as an important dating method in prehistory (e.g. at arid sites, Feathers et al., 2006; Olley et al., 2006; Holzer et al., 2010; Armitage et al., 2011; Chazan et al., 2013; Porat et al., 2013; Davidovich et al., 2014; Fattahi, 2015). Another main difference between radiocarbon and OSL dating is the dated event, with radiocarbon dating the time of death of organisms associated with human activity (e.g., fire activities, food remains, burials) while OSL dates sedimentation events, therefore determining the time before, concurrent with, or after human activity (Boaretto, 2007; Junge

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http://dx.doi.org/10.1016/j.jaridenv.2017.05.006
0140-1963/

et al., 2016). Complications for both dating methods include in radiocarbon the possibility of a time gap between the death of the dated organism and its deposition (e.g., 'old wood effect', Schiffer, 1986; Olsen et al., 2013), and in OSL issues of mixing or incomplete bleaching are well-known (e.g. Porat et al., 2006; Araujo et al., 2008; Feathers et al., 2010).

High-resolution dating of human activity within arid landscapes is notoriously difficult. The main problem stems from the short-term nature of activity in harsh environments, resulting in sites that generally represent seasonal occupation rather than long-term sedentism. Even when sites in arid environments show evidence for activities spanning more than one period, habitation gaps are characteristic. Therefore, while dating of multi-period sites in sedentary areas can rely on well-developed stratigraphic and ceramic sequences to constrain systematic chronometric schemes, dating short-term sites – particularly those located in arid environments – is more challenging.

Apart from the absence of clear stratigraphic sequences, habitation phases of sites in arid environments are difficult to date because of thin occupation layers, reflecting the relatively short duration of habitation (Banning and Kohler-Röllefson, 1992; Saidel and Erickson-Gini, 2014). A further issue is post-depositional mixing at these sites, either by later human activity or due to scavengers and faunal and floral turbation (e.g. in general, Wood and Johnson, 1978; for radiocarbon, Boaretto, 2007; for OSL, Bateman et al., 2007; David et al., 2007). Post-depositional mixing and shifting of light/small artifacts (i.e., removal of top parts of anthropogenically deposited materials) may also be caused by high intensity precipitation or strong winds. Lastly, post-depositional processes may reduce the preservation of datable organic materials (charcoal, bone) due to prolonged surface exposure (e.g. Behrensmeyer, 1978). It is therefore highly important to deploy all possible tools to successfully date archaeological sites in arid environments.

Recently we have conducted microarchaeological investigations which included a dating component at Bronze and Iron Age sites in the Negev Highlands, Israel – a region which belongs to the arid belt in the Southern Levant. Average temperature in the Negev ranges from 10 °C in the winter months (November–March) to 25 °C during the summer. Direct precipitation is highly variable year to year (Evenari et al., 1971; Shanan, 2000: 88), averaging between 80 and 150 mm, mostly concentrated during the winter months (Goldreich, 2003). Local flora is dominated by Saharo-Arabian and (to a lesser extent) Irano-Turanian species such as *Zygophyllum dumosum*, *Retama raetam*, and *Artemisia herba alba* (Danin and Plitmann, 1987).

Paleoclimatic studies suggest the Negev Highlands have been arid throughout the last 5000 years (Babenko et al., 2007; for the Southern Levant generally see Kagan et al., 2015; Langgut et al., 2015; Langgut et al., 2016), and relatively similar to current climatic conditions. Archaeological surveys (e.g. Cohen, 1981, 1985; Haiman, 1991, 1993; Avni, 1992; Rosen, 1994; Baumgarten, 2004) attest to several waves of settlement during the past few millennia. Based on ceramic typologies they have traditionally been dated to the Early Bronze (EB) II (c. 3000-2900 BCE, Regev et al., 2012), Intermediate Bronze (IBA, c. 2500-1950 BCE, Regev et al., 2012; also known as Early Bronze Age IV), Iron Age IIA (c. 940-780 BCE, Finkelstein, 2014), and Byzantine/Early Islamic (c. 300–900 CE, Magness, 2003) cultural-historical complexes. Other eras, such as the Middle and Late Bronze Ages and medieval periods are hardly represented archaeologically (for detailed discussions, see Rosen, 1987, 2011; Haiman, 1989; Avner and Carmi, 2001; Finkelstein, 1995 and references therein). Sharp settlement oscillations thus characterize the history of the Negev Highlands.

Most sites in the Negev Highlands have been dated only using ceramic typologies (e.g. survey results in Cohen, 1985), predominantly based on sherd collection rather than large assemblages of vessels. However, several site reports include a few radiocarbon ages (e.g. Har Dimon, Nahieli and Tahal, 1993; Be'er Resisim, Ein Ziq and others, Segal, 1999; The Camel Site, Rosen, 2011), while other sites were radiocarbon-dated, but are incompletely published (e.g. sites in the Uvda Valley, Avner and Carmi, 2001). More rarely, OSL investigations of terraces in the Negev (e.g. Avni et al., 2013), and occasionally at prehistoric open air sites (e.g. Holzer et al., 2010) have also been carried out.

Nevertheless, systematic *site-specific* chronometric dating in the Negev Highlands only began in the 2000s. A research project that explores the settlement oscillations in the Negev Highlands, led by two of the authors (I.F. and R.S-G.), demonstrated that the Iron Age wave of settlement was confined to c. 100 years spanning the late 10th to late 9th centuries BCE (Shahack-Gross and Finkelstein, 2015). Though just slightly later than the traditional dating, this investigation led to a novel historical reconstruction. It used radiocarbon age determination of short-lived charred materials obtained from securely defined activity contexts such as hearths, sealed by c. 1 m thick deposits of collapsed constructional debris (stones and mud-based building materials) and covered by aeolian deposits (Boaretto et al., 2010; Shahack-Gross et al., 2014).

The Negev Highlands Iron Age sites, despite having only one thin occupation horizon and being rather short-lived, supplied well-preserved datable organic material for radiocarbon dating from clearly sealed depositional contexts. Yet, the second phase of the Negev Highlands project, which explores the IBA settlement wave in the region, encountered difficulties with dating. This is because the IBA sites generally consist of much shallower (thinly covered) occupation deposits, possibly featuring different modes of activity. In our experience these sites rarely include charred organic materials (Dunseth et al., 2016), a condition that underscores the importance of applying OSL dating to archaeological contexts. An initial study at the site of Mashabe Sade (Junge et al., 2016) has shown that despite lower precision relative to radiocarbon dating, OSL age determinations can be valuable in desert sites, especially when questions which do not require high-precision dating are at stake or radiocarbon dating is not possible due to the lack of organic material. Moreover, OSL dating not only provides ages of certain layers, but can also establish a chronostratigraphy of a sequence to allow the investigation of the sedimentation history. In addition, Junge et al. (2016) used micromorphology in tandem with OSL dating which helped verifying that the dated sediments accumulated following site abandonment. Micromorphology also contributed information on the modes of sediment deposition, showing that post-abandonment, the circular stone structures typical of the central IBA sites act as traps for both wind-borne material and water-lain sediments. Lastly, micromorphology showed that bioturbation had a negligible effect on the sediment profile, thus rendering a rather precise dating sequence possible.

Here we present a chronological study that explored two archaeological sites in the region that exhibit IBA pottery (Fig. 1), employing OSL dating, radiocarbon dating and micromorphological investigations in tandem, in order to obtain a comprehensive picture that allows chronometric dating with higher interpretational certainty. One site – Ein Ziq – is large (often termed 'central'; Haiman, 1996; Dunseth et al., 2016). According to ceramic evidence it was inhabited during the IBA and revisited much later during the Nabatean period (Hellenistic-Roman era, c. 3rd century BCE – 2nd century CE; Cohen, 1999: 137–188). The second site – Nahal Boqer 66 – is much smaller and characterized by large courtyards, which are presumed to have served as animal pens (Cohen, 1999: 60–61). According to conventional pottery typology it was inhabited in two periods – the Early Bronze Age II (radiocarbon dated to 3000–2900