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Human impact around settlement sites: a phytolith and mineralogical study for assessing site boundaries, phytolith preservation, and implications for spatial reconstructions using plant remains

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ABSTRACT

Defining the extent of human activity around settlement sites is of particular significance in archaeology as it may define peripheral activity areas and thus the site's boundary. In Near Eastern archaeology, site boundaries are usually defined by the presence of architectural and other macroscopic archaeological remains. Here we use the phytolith concentrations and morphotype assemblages, as well as changes in the mineralogical composition of the sediments in and around the small Iron Age site of Izbet Sartah in central Israel to determine the site boundaries. The site has a shallow stratigraphy and highly bioturbated sediments. Coincidental changes in the clay/quartz ratio and phytolith concentrations define the boundary between high and low impact anthropogenic activities. This boundary is generally some 20 m away from the architectural remains. In addition, we note that the phytoliths in the site's core show clear evidence of having been affected by chemical dissolution (i.e., diagenesis), while those in the vicinity of the site's boundary have undergone severe diagenesis. These observations indicate that phytolith diagenesis will affect site boundaries determination, as well as phytolith-based reconstructions of activity areas. We propose that phytolith preservation depends on the initial amount of available silica, the depth of burial with respect to the active root area of modern vegetation, and the presence of fresh phytoliths in the soil.

1. Introduction

Human activities in the landscape are not restricted to settlement sites. Past human behaviour is therefore sought around ancient settlement sites using a variety of techniques such as satellite/aerial photography, remote sensing, phosphate concentrations, and coring (Banning, 2002; Binford, 1982; Butzer, 1982; Gallant, 1986; Plog et al., 1978; Renfrew and Bahn, 2004: 75–120; Vita-Finzi, 1978). Traditionally, Near Eastern archaeologists, mainly those studying historical periods, focus their research on the built-up sectors of settlement sites, and not on the large open areas within and around the settlements. However, ethnographic accounts of pre-modern towns and villages show that a variety of activities are actually performed at the periphery of the built-up parts of settlement sites. For example, Kramer (1982) and Watson (1979) noted that peripheral activities in agro-pastoral villages in Iran include disposal of domestic waste, preparation of dung cakes, and threshing. These and other studies demonstrate the importance of studying "empty" grounds around ancient settlement sites. Conventional Near Eastern archaeological survey methods often cannot help in recognizing such peripheral activity zones as the scatter of macroscopic artifacts around a site is often not distinctive enough to answer this question, and in many cases this scatter is the result of post depositional erosion processes that are not related to in-situ human behaviour in the past. Here we present a study of phytoliths and minerals in which we mapped the extent of human impact beyond the architectural remains of a small agricultural rural settlement site.

Previous studies on phytoliths in ethnographic contexts as well as in archaeological sites have shown that various human activities result in concentrations of vegetal matter in settlements. Livestock enclosures and hearths, for example, may have phytolith

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concentrations that are several orders of magnitude higher than the soils/sediments sampled well outside the ethnographic context or archaeological site (Albert et al., 1999, 2008; Shahack-Gross et al., 2003, 2005; Tsartsidou et al., 2008, 2009). None of these studies have however addressed the reasons for this marked difference: is the transition abrupt or gradual, and whether this difference between the site and its surroundings relates to human activities around the site or to phytolith diagenesis? One aim of this study is therefore to better understand the dichotomy in phytolith concentrations between archaeological sites and anthropogenically less affected soils around them.

When studying phytolith concentrations it is important to determine whether low concentrations of phytoliths are a result of low vegetal input at the site, or a high vegetal input whose phytoliths underwent chemical dissolution (i.e., diagenesis). The latter possibility is consistent with research into phytolith taphonomy, the study of phytolith incorporation into soils and sediments, as well as studies of phytoliths in relation to the terrestrial silicon cycle that show that phytoliths may undergo dissolution and transport in the burial environment (Albert et al., 2006; Cabanes et al., 2011; Jenkins, 2009; Fishkis et al., 2010; Osterrieth et al., 2009; Piperno, 1985; Borrelli et al., 2010; Fraysse et al., 2006; Wilding and Drees, 1974). Here we present a study in which we introduce two new methods for determining the state of preservation of phytolith assemblages. We also show that if phytolith assemblage preservation is well defined and supported by independent mineralogical data, the phytoliths can be used to infer human impact on the periphery of a rural site and effectively determine its boundaries. Our study was conducted at the site of Izbet Sartah in central Israel.

1.1. Izbet Sartah

Izbet Sartah is a small Iron Age I-early IIA (ca. 1150/1100–900 BCE) village near Rosh Ha'ayin, located on a small limestone hill overlooking the central coastal plain of Israel, ca. 3 km east of the major ancient city of Aphek (for Izbet Sartah see Finkelstein, 1986; for Aphek see Gadot and Yadin, 2009) (Fig. 1). Izbet Sartah is located in the Mediterranean climatic zone of Israel. The architectural remains cover an area of ca. 60 × 60 m, that is, ca. 0.3 ha. The overall thickness of the sediment accumulation varies from around 1 m at the center to several centimetres in the west, east and south of the architectural remains. In the north the slope (beyond the built-up area) is truncated by a modern highway. The foundations and lower parts of the walls are built of stones, but there is evidence for the use of mud bricks in the upper sections of the walls.

Three levels of occupation were uncovered at the site (Fig. 2; Finkelstein, 1986). The lowermost Stratum III lies directly on the limestone bedrock. Architecturally, it features an oval belt of peripheral rooms enclosing a large courtyard (Fig. 2). The habitation of this stratum is followed by an occupational gap. Stratum II features a large central house of the four-room type surrounded by numerous stone-lined storage pits (silos) (Fig. 2) and smaller houses on the periphery. Stratum I shows changes in the central house and the array of silos around it. No traces of violent destruction were revealed in any of the strata, though stratum I includes relatively large amounts of pottery (Finkelstein, 1986). The sediment typical for Stratum III is light grey-brown loam, and for the latter two strata is reddish-brown loam (Finkelstein, 1986). Stratum I is overlain by very thin dark-coloured organic-rich top soil.

2. Materials and methods

2.1. Field methods

An initial set of samples was collected during October 2009 when three different areas were excavated: North area, Square L16; South area, Squares H8 and H9; and East area, Squares N11 and O10 (Fig. 2). About 300 samples were collected, from which 88 were selected for determining phytolith concentrations, and from those samples 36 were selected and used to study phytolith morphologies. The sub-sampled sets more or less represent the overall lateral and depth distribution of the total sample set, i.e., they cover all excavation areas and all three strata. In addition, 11 control samples were collected nearby the site (Fig. 2). Initial results showed a marked difference between phytolith concentrations in the control samples (lower than 0.5 million phytoliths in 1 g

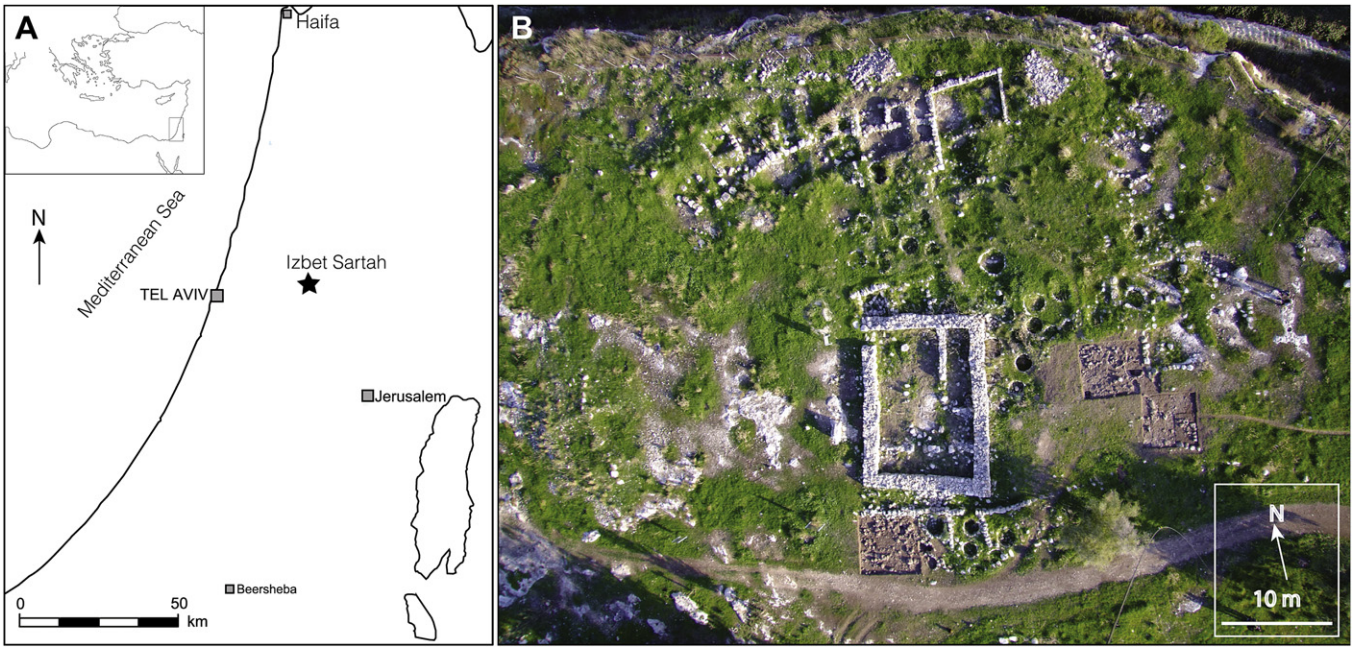

Fig. 1. (A) Map showing the location of the site of Izbet Sartah. (B) Aerial view of the site at the end of the 2010 excavation season. The large building is reconstructed.