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OSL dating of pre-terraced and terraced landscape: Land transformation in Jerusalem's rural hinterland

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ABSTRACT

The recent success in dating dry farming terraces by Optically Stimulated Luminescence (OSL) enables scholars to evaluate for the first time construction events of terraces in their true social and economic context. Presented here are 36 new ages from two study areas located along the Upper Soreq catchment, highlands of Jerusalem, Israel. Field operations were targeted at locating Bronze Age and Iron Age agricultural activities while evaluating possible methodological limitations in using OSL for dating terraces.

The results convincingly show that in the Mediterranean highland environment, soil erosion and rebuilding activities have only a mild impact on the resulting OSL dating. When combining the new ages with the ~60 ages that were published previously in the study area, it is possible to conclude that in the more favorable ecological niches of the highlands of Jerusalem terraces began ca 2400–2200 years ago. This was followed by two or three waves of wide-scale terracing, taking place mainly in the last 800 years. Finally, we were able to recognize a unique ecological niche that preserved ancient (ca 2500 years old) pre-terracing activities as it was not densely covered by later terraces.

1. Introduction

The construction of bench terraces for the conduct of dry farming constitutes a major point-of-no-return in human alteration of the natural environment (Bevan and Conolly, 2011). In the Mediterranean basin, terraces became one of the most defining features of the scenery, the result of prolonged formation processes. Using terrace walls for artificial creation of arable plots was a major technological innovation that has led to the complete alteration of the natural terrain. It is thus not surprising that terraces attract the attention of scholars from a range of disciplines covering geomorphological and hydrological processes (Arnaez et al., 2015), ecological modelling and human-environment interplay (Bevan et al., 2013; Tarolli et al., 2014), as well as human subsistence strategies and social history (Gibson, 2003; Wilkinson, 2003). For the archaeologist, terrace construction mirrors socio-economic processes related to organization of rural labor, economic decision-making and, possibly, carrying capacities and demographic trends (Gadot et al., 2016a).

An in-depth study of ancient terraces within their true social context is dependent however on reliable dating, an aim that is notoriously difficult to achieve. Archaeology depends on stratigraphy and on in situ dateable material in order to date layers and features. When dealing with landscape features such as terraces, there are major difficulties regarding both absolute and relative dating, since the palimpsest nature of human exploitation of the landscape limits the use of these basic dating tools (Roberts and Jacobs, 1992: 347–348; Wilkinson, 2003). Consequently, scholars must search for alternative dating methods. Recent scholarship has raised the option of using Optically Stimulated Luminescence (OSL) for dating terrace construction (Davidovich et al., 2012; Kinnaird et al., 2017). This dating method identifies the last time the soil was exposed to light and so can be utilized for dating soil movement, whether natural or anthropogenic. In recent years OSL has been applied for dating a range of man-made features in the landscape (Fuch and Wagner, 2005; Walsh, 2014: 93; Ackermann et al., 2014; Davidovich et al., 2014; Dunseth et al., 2017; Kinnaird et al., 2017).

The aims of this study are twofold: First to consolidate the value of

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OSL dating in studying archaeological landscapes and their evolution, and second to highlight a different mode of landscape exploitation for farming other than terracing.

1.1. Research history

“The Formation of Terraced Landscapes in the Judean Highlands, Israel,” is a project whose aim is to use OSL dating for recognizing the introduction of terrace construction in order to evaluate the reasons for their construction (Gadot et al., 2015). The opening/first stage of research was method development that included ground surveys and the excavation of 10 test pits (Davidovich et al., 2012). It tested the possible contribution of OSL coupled with standard excavations as a major tool for dating dry farming terraces. Distinct events of soil movement, whether natural or by man, were recognized. The research was then expanded to two other regions in the highlands of Jerusalem, Mount Eitan and N. (Nahal; an ephemeral stream in Hebrew) Refa'im (see Gadot et al., 2015, 2016a, 2016b). Results collected from these study areas led us to assert that, at least in the highlands of Israel, wide-scale terracing began roughly 2200 years ago, during the Hellenistic and Roman periods, and that most of the terraces seen today in the landscape date to the past 800 years (Davidovich et al., 2012; Gadot et al., 2015, 2016a, 2016b; Porat et al., 2017). Since it is clear that the highlands were already permanently settled during the second millennium BCE (Middle Bronze Age), long before known terracing activities, these findings contradict the paradigm that permanent settlement in the highlands depends on the ability to terrace the slopes (Finkelstein, 1995; Gibson, 2001).

The implication of these results led us to evaluate different factors that may affect the validity of the method (and see concerns raised by Gibson, 2015). Soil movements and concurrent bleaching could result from various natural processes and/or human-induced actions which are not necessarily related to the activity of interest (Avni et al., 2006; Gibson, 2015). We first evaluated whether the terrace walls examined have undergone continuous reconstruction, resulting in soil recycling and erasure of earlier terrace construction events. On Mount Eitan (Fig. 1) we indeed found many terraces with OSL ages spanning close to 700 years, indicating that they had been constructed and repaired continuously over the centuries (Gadot et al., 2016a). However, another study based on the Mount Eitan data showed that recycling of soil during repair and rebuilding always leaves a trace of older, unbleached grains in the OSL record (Porat et al., 2017), allowing us to recognize older episodes of terrace building even in younger terrace soils. The possibility of complete bleaching of all soil grains was therefore ruled out. We then examined the possibility that the soil held by the terraces had eroded downslope when the walls collapsed during episodes of no maintenance. The results of a study conducted along the western slopes of N. Shemuel (and see Fig. 2) show that the main body of terraces there was first built ~800 years ago and maintained until 180–100 years ago, after which they were abandoned and subsequently degraded. Since then 30–45% of soil volume was lost to erosion, however steady-state was reached at a relatively high slope of 65%, stabilized by vegetation (Porat et al., 2018). Though further study is in place, it seems to us that in a Mediterranean environment soil erosion does not explain the disappearance of entire periods from the OSL record.

Another scenario that might have shaped the results gained in past field operations is that built terraces, constructed and operative during the last 700 years, conceal older building events. On Mount Eitan we indeed found terraces constructed in two or more phases separated by centuries or even a millennium. Only excavation down to bedrock exposed these early phases (Gadot et al., 2016a). To find older terraces dating to periods earlier than the Hellenistic era, we may need to examine collapsed terraces that have not been in use in the last millennium.

To address the possible effects of this scenario, we designed archaeological field work in areas that were intensively exploited since the second millennium BCE and that had almost completely collapsed terraces. At the same time we searched for positive evidence of an alternative subsistence strategy that may have been applied by Bronze and Iron Age settlers prior to the adaption of wide scale terracing. If dry farming terrace construction began only in the second part of the first millennium BCE, and since there is no doubt that a significant human settlement had already begun in the second millennium BCE, an explanation for the existence strategy of human permanent settlement in the highlands must be proffered.

1.2. The Upper Soreq catchment

We chose to concentrate our efforts on the formation of the agricultural landscape along the upper reaches of N. Soreq – a major river draining the northwestern region of the Jerusalem highlands – and its many tributaries (Fig. 1). We focused on a 6 km stretch of the river (Fig. 2), an area that includes the river's main channel as well as five short tributaries that join it from the north, northwest and west: Atarot, Shemuel, Luz, Halilim and Arza. Together they form the upper Soreq catchment. The Soreq main channel is moderately wide, ranging from 50 m in the east and broadening to 220 m in the west. The width of the tributaries ranges between 20 and 40 m, in all cases wide enough to be cultivated. The slopes are mostly moderate, with only small cliffs that are entirely bare of soil.

N. Soreq is located within the Mediterranean climate zone. The rainy season lasts from October to May, while most of the precipitation falls between December and March, and the average annual rainfall is ca. 550 mm. Summer (June–September) is hot and dry, and the average daily maximum temperature reaches 29 °C. The surrounding mountains are composed of thick sedimentary carbonate sequence (limestone, dolomite, chalk and marl) of the Upper Cretaceous Judea Group, and along the Soreq a series of faults have led to the exposure of different formations at varying levels (Sneh and Avni, 2011; Fig. 3). Along the slopes of Shemuel tributary, for example, it is possible to encounter on the same elevation different formations such as Keslaon, Beit Me'ir, Moza, Aminadav, Kefar Shaul and Weradim. The tributary is a mosaic of different slope angles, soil types and thickness, vegetation and finally agricultural activities. The effect the various rock formations had on the development of agricultural strategies is most vividly seen when one compares the Halilim and Shemuel tributaries (Fig. 3). The slopes of N. Halilim are underlain by Beit Meir and Keslaon formations which are naturally stepped and were completely terraced (Fig. 4). N. Shemuel tributary, on the other hand, is characterized by steep and irregular slopes underlain by several rock formations (Fig. 3), and its slopes were only sporadically terraced (Fig. 5). Furthermore, outcrops of Aminadav and Weradim formations are not covered with soil, which is restricted to small and shallow pockets. Traditionally these pockets are considered uncultivable but, as we show below, it is exactly these environments that preserve the activities of pre-terracing agriculture (and see Davidovich et al., 2006).

Surveys and excavations prove that the upper reaches of N. Soreq served as Jerusalem's breadbasket since the Iron Age, if not earlier. Three hundred and forty-four archaeological sites were surveyed and/or excavated within the Soreq catchment, including large settlement sites, villages, farmsteads, isolated buildings and agricultural and industrial installations (for an updated reference list see Elgart-Sharon, 2017). Permanent settlements located within the river's drainage basin appear for the first time during the Neolithic Period and continue up to the present, with four excavated settlement sites known from the Middle Bronze Age, and others from the Persian (N = 6), Hellenistic (N = 6), Roman (N = 9), Byzantine (N = 9), Early Islamic (N = 6), Medieval (N = 9) and Ottoman (N = 5) periods. The late Iron Age (8th–6th centuries BCE) marks a peak in agricultural activities along the river, where eleven settlement sites, numerous winepresses, isolated buildings and stone piles located along the river's main channel and along its tributaries were found (Davidovich et al., 2006; Gadot, 2015).