



Environmental impacts of ancient copper mining and metallurgy: Multi-proxy investigation of human-landscape dynamics in the Faynan valley, southern Jordan



Kyle A. Knabb^{a, b, *}, Yigal Erel^c, Ofir Tirosh^c, Tammy Rittenour^d, Sofia Laparidou^e,
 Mohammad Najjar^f, Thomas E. Levy^{b, f}

^a Archaeology Division, Ben Gurion University of the Negev, Israel

^b Department of Anthropology and Levantine Archaeology Laboratory, University of California, San Diego, USA

^c The Fredy and Nadine Herrmann Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel

^d Department of Geology, Luminescence Laboratory, Utah State University, USA

^e Department of Anthropology, The University of Texas at Austin, USA

^f Center for Cyber-Archaeology and Sustainability, Qualcomm Institute, University of California, San Diego, USA

ARTICLE INFO

Article history:

Received 8 June 2016

Received in revised form

15 August 2016

Accepted 3 September 2016

Keywords:

Environmental history

Paleo-pollution

Metallurgy

Geochemistry

Phytoliths

Luminescence dating

ABSTRACT

The environmental impact of mining and metallurgy is an issue that has affected societies in the ancient Near East over the past 8000 years. We present the results of a multidisciplinary project using agricultural sediments from ancient terraces as a cultural archive of environmental pollution and land use in the copper ore-rich Faynan valley of southern Jordan. Due to the simultaneous production of agricultural goods and copper metallurgy throughout the last 6000 years in the valley, environmental pollution and its consequences for human health have been considered as a factor in settlement abatement. Sediments from two farming terrace systems adjacent to the major mining and smelting locales were analyzed. The sediment analyses included metal concentrations, lead-isotopes and phytolith analysis, and OSL dating. Although measurable concentrations of lead and other heavy metals persist in ancient metallurgical waste piles, our investigations found minimal evidence for contamination in the adjacent terrace systems. Based on these results, we argue that the occurrence of environmental pollution in the Faynan valley is highly variable, and that the distribution of heavy metals resulted from a combination of natural and cultural factors, including persistent landscape features that helped contain the most polluted metallurgical deposits. These findings are significant for understanding the processes of landscape change and human impacts on desert environments, including the ways in which past human actions have negatively affected the environment, as well as preserved and protected the environment from further degradation.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

The mining and smelting of copper metals was an essential component of the ancient political economy of complex societies. The remnants of these activities often leave a lasting imprint on the landscape visible even in modern times (Pyatt et al., 2002b). One such locale is the Faynan Valley of southern Jordan, where settlement organization in the valley changed significantly in response to

the economic interests of the region's copper producers (Fig. 1). As Wadi Faynan was a locus of agricultural production and copper exploitation for the last 10,000 years, the region is an excellent case study for the evolution of socio-political complexity and environmental degradation. Through time, communities in Jordan's marginal desert zones responded to changing political, economic, and environmental shifts in a number of ways. Their strategies ranged from participation in the 'boom and bust' economics of copper mining (Barker et al., 2007; Knauf, 1992; Levy et al., 2014b), to creating small-scale subsistence economies that were based on risk-management, flexibility, and commensalism (Hill, 2006; Laparidou and Rosen, 2015; Lev-Tov et al., 2011; Porter, 2011). In

* Corresponding author. Ben-Gurion University of the Negev, Archaeological Division, P.O. Box 653, Beer Sheva, 84105, Israel.

E-mail address: knabb@post.bgu.ac.il (K.A. Knabb).

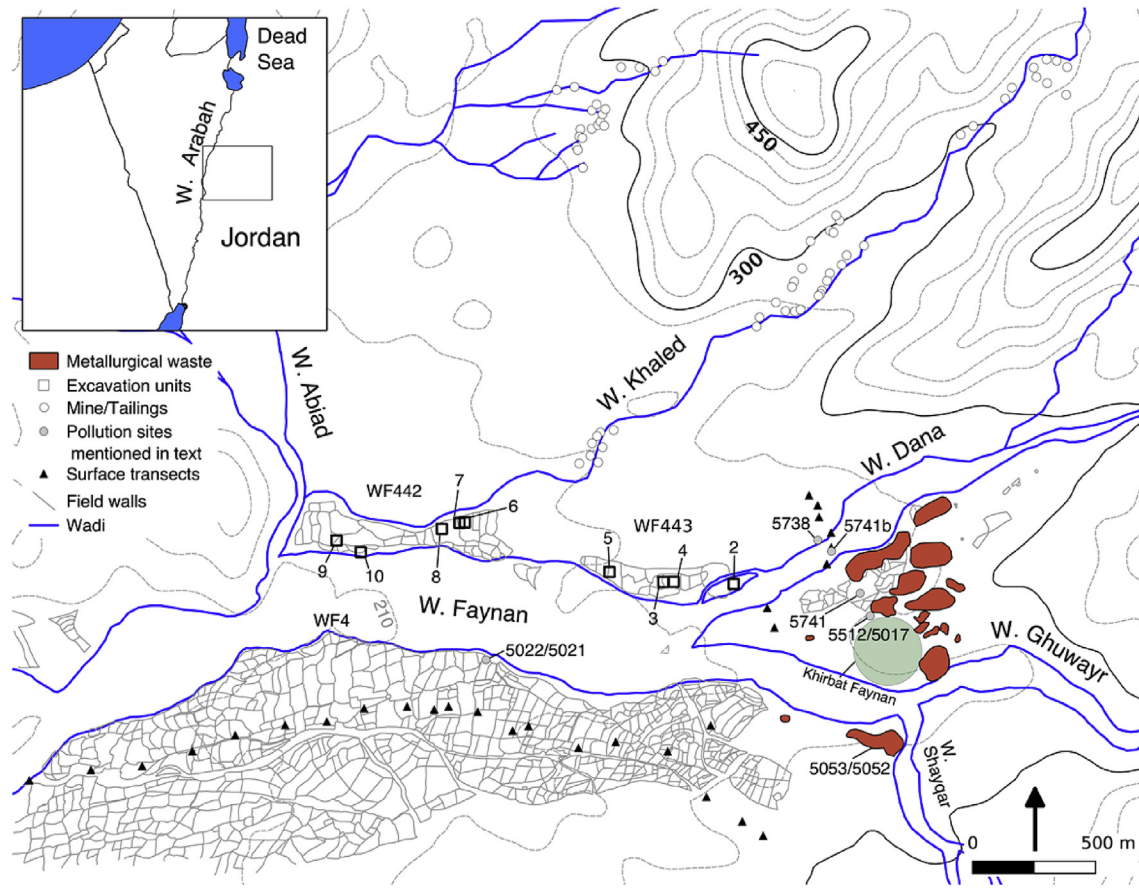


Fig. 1. Map of Wadi Faynan research area, showing the main tributary valleys and their relationship to archaeological features and excavation units. Topographic lines indicate 150 m intervals (solid) and 30 m intervals (dashed). Unit 1 was not included in the study and is not shown on the map. The agricultural terraces are ca. 2–7 m above the modern Wadi Faynan channel. Mining activities are concentrated in the valleys north of Wadi Faynan. The densest concentration of smelting debris can be found in the areas around Khirbat Faynan, the largest settlement in the valley. The locations of major pollution study sites summarized in Table 1 are also shown. Inset shows location of Faynan valley within the eastern Mediterranean area.

all these cases, human actions, decisions, and choices in the realms of politics, economy, and social life had both intentional and unintentional consequences for the surrounding landscape they inhabited. The Faynan Valley has been the primary focus of the University of California, San Diego's Edom Lowlands Regional Archaeological Project (ELRAP) for nearly two decades.

1.1. Ancient environments: human adaptations and impacts

The study of human impacts on the environment has become one of the most important areas of study in archaeology, driven by one of the fundamental questions of human nature – is the evolution of complex society maladaptive? This question has been taken on recently by those in the field of socio-natural studies (Butzer and Endfield, 2012; Fisher et al., 2009; Hill, 2004; Kohler and Leeuw, 2007; Scarborough, 2003; van der Leeuw and Redman, 2002), whose research has centered on topics of deforestation, erosion, climate change, mass extinction, salinization, and pollution. Within this line of inquiry, archaeologists seek to understand the relationship between increasing political economic complexity and human impacts on the environment (Adams, 1965; Butzer, 1982; Redman, 1999; Sanders et al., 1979; Steward, 1968; van der Leeuw, 1998). Because human societies require physical resources to develop, subsidize, and expand, the local ecology is an important variable in understanding how societies changed, and how they changed their environment (Balée, 1998; Butzer, 2015;

Crumley, 1994). In this article we present a long-term, multi-proxy record of land use and environmental pollution from ancient agricultural terraces in the Faynan Valley, southern Jordan, focusing primarily on the presence of lead and copper. Based on the results of optically stimulated luminescence (OSL) dating, geochemical, and phytolith analysis, we propose that – unlike nearby loci of copper smelting and waste disposal – the agricultural terraces were much less affected by heavy metal pollution despite their close proximity to the sources of contamination.

One framework for understanding the dynamic relationships between society and the environment is a form of landscape modification known as “landesque capital”, a term originally coined by Brookfield (1984) and later taken up by ecologists and archaeologists (Blaikie and Brookfield, 1987; Brookfield, 2001; Fisher, 2009; Håkansson and Widgren, 2014; Kirch, 1994). Landesque capital is a concept used to identify the manipulation of a landscape for long-term gains in productivity, and can include terraces, irrigation, and other infrastructures that involve labor-saving inputs for future production. It allows for further infrastructural improvements from continued occupation of the land, and innovations that lead to further improvements in production (Brookfield, 1984). It is similar to the concept of biocultural structures in resiliency theory (Gunderson and Holling, 2002; Redman, 2005). In the archaeological literature, landesque capital has mostly been applied to agricultural intensification, but it could easily be applied to any production system that requires the

Download English Version:

<https://daneshyari.com/en/article/7441156>

Download Persian Version:

<https://daneshyari.com/article/7441156>

[Daneshyari.com](https://daneshyari.com)