



# Iron Age Nomads and their relation to copper smelting in Faynan (Jordan): Trace metal and Pb and Sr isotopic measurements from the Wadi Fidan 40 cemetery



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## ABSTRACT

The Faynan region in southern Jordan is the largest copper ore resource zone in the southern Levant and was exploited for these ores beginning ca. 8000 years BP. We discuss the relationship between nomadic populations and major copper smelting sites during the Iron Age (ca. 1200–500 BCE) based on mortuary excavations and toxic metal analyses at the Wadi Fidan 40 cemetery, the largest Iron Age mortuary complex in southern Jordan. The Iron Age represents the first industrial revolution in this part of the Middle East. The study presented here is the first to employ chemical and isotopic measurements from a systematically excavated Iron Age mortuary population to determine exposure to Cu and Pb pollution and mobility patterns (based on Sr isotopes). We describe a methodology to control for post-depositional diagenetic uptake of chemical elements in human teeth recovered from the cemetery that has not previously been applied in Faynan in ancient pollution studies. The results suggest that most of the excess of Pb and Cu measured in tooth enamel samples were a product of post-depositional diagenetic addition. Our findings suggest that the majority of people buried at the Wadi Fidan 40 cemetery were not exposed to metal pollution during their lives. The few individuals who were exposed to metal pollution exhibited a spectrum of traits indicative of lifestyle and social status. The results bring into question how severe the ancient pollution impacted the lives of the Iron Age population living in Faynan.

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## 1. Introduction

The Faynan copper ore region in southern Jordan is the largest such resource zone in the southern Levant (i.e. Jordan, Israel, Palestinian territories, Lebanon, southern Syria and the Sinai Peninsula). The ca. 400 km<sup>2</sup> area was exploited for lead-rich copper ore used in jewelry and decorative pigment during the Pre-Pottery Neolithic B period, ca. 10,500–8250 BP (Kuijt and Goring-Morris, 2002). Widespread mining and smelting took place in the region from the Early Bronze Age I (ca. 3600 BCE) to Medieval Islamic times (ca. 1400 CE) (Hauptmann, 2007; Levy and Najjar, 2007).

During this long period of time, the peak in copper production

occurred during the Iron Age, specifically in the 10th and 9th centuries BCE, when the first industrial revolution occurred in this part of the Middle East. Previous research by Hauptmann (2007, Table 5.3, p. 147) showed that there was an exponential increase in the amount of copper slag (and hence, copper metal) produced during the Iron Age, compared to the preceding Early Bronze Age and post-Iron Age), based on the amounts of slag recorded on the surface at copper production sites throughout the Faynan region. Thus, during the Early Bronze I period the total estimate is 2 kg, and in the Early Bronze II period the estimated amount of slag rises to 5000 tons. During the Iron Age the quantity of slag ranges from 100,000 to 130,000 tons of slag. Based on these data, it is possible to characterize the astronomical rise in Iron Age slag as indicative of the first industrial revolution in the southern Levant. Additional data for this exponential rise in smelting activities has been recently obtained through the first stratigraphic excavations of copper production sites in the Faynan regions, most importantly at

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the site of Khirbat en-Nahas, a ca. 10 ha production swathed in widespread mounds of copper smelting waste (Levy et al., 2008; Levy et al., 2014a), as well as Khirbat al-Jariya (Ben-Yosef et al. 2010), and other sites in Wadi Faynan (Grattan et al., 2007; Hunt and El-Rishi, 2010 Figs. 8.9 and 8.10, p.130-31, Mattingly et al., 2007). The tight stratigraphic control from the excavations at Khirbat en-Nahas, coupled with the application of high precision radiocarbon dating and Bayesian analyses (Levy et al., 2008) made it possible to obtain sub-century precision to monitor technological change from the 13th to the 9th century BCE at what is perhaps the largest Iron Age copper smelting center in the southeastern Mediterranean (Levy et al., 2012; Levy et al., 2014b). Excavations at Khirbat en-Nahas were carried out as part of the Edom Lowlands Regional Archaeology Project (ELRAP). As part of the surveys and excavations conducted for ELRAP, beginning in 1997, large-scale

excavations were initiated at the site of Wadi Fidan 40 (30.673926N, 35.381107E) near the mouth of Wadi Fidan where it debouches into the Arabah valley that separates modern Jordan and Israel (Fig. 1). Excavations were carried out in 1997, 2003, 2004, and 2009, and revealed a mortuary site utilized by pastoral nomads during the Iron Age II, ca. 10th and 9th centuries BCE (Beherec, 2011; Beherec et al., 2014; Levy et al., 2004a; Levy et al., 1999, 2005). Building on the results of this previous research, this study examines the relationship between nomadic populations and smelting sites evidenced by isotopic and chemical analyses.

As a result of those projects, the ELRAP team discovered and excavated the largest (ca. 3,450 m<sup>2</sup>) Iron Age mortuary complex in southern Jordan (Fig. 2). High precision radiocarbon dating places the cemetery securely in the Iron Age IIA period. A total of 245 cist graves, as well as other mortuary features, were excavated. The

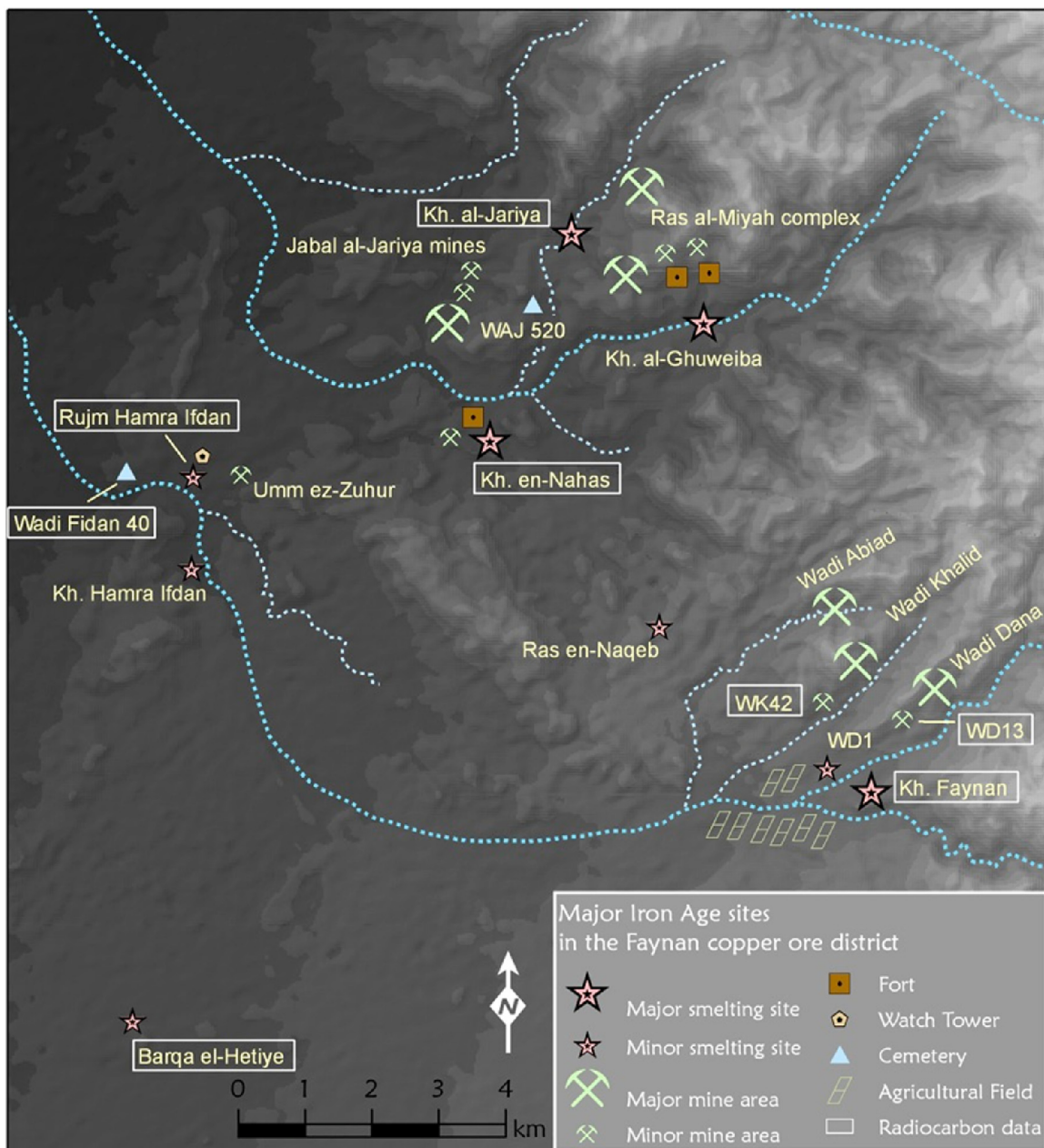


Fig. 1. Overview map of Iron Age Faynan, Jordan.

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