



Vegetation history and human-environment interactions through the late Holocene in Konar Sandal, SE Iran

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ABSTRACT

The Jiroft valley, situated on banks of the Halil Rud developed as an important agricultural and trading center during the Early Bronze Age. Known for its famous steatite sculptures and clay pottery, the first settlement in Konar Sandal collapsed around 3rd millennium BCE. A second shorter, but major phase of occupation in the settlement occurred towards the end of 2nd millennium BCE. A 250-cm long peat sequence near the archaeological complex at Konar Sandal was investigated to reconstruct the human-environment history using palynological, sedimentological and geochemical data. With a basal age of 4 ka, the core traces the hydroclimatic changes and human activities that started just after large scale abandonment of Konar Sandal and extends from the late Bronze Age to the Mongol invasion. The results show that Jiroft had an arid dry climate dominated by the Saharo-Sindian open pseudo-savanna vegetation. However, due to human clearance and intensified agro-sylvo-pastoral activities, and climatic factors, the land-cover shifted from open xeric scrublands to a more open degraded landscape. The principal human occupation was cereal cultivation and herding. However, it is likely that during the more arid periods, communities retreated and abandoned agriculture, facilitating successional processes. Such droughts occurred around 4.0–3.8 ka and 3.4–2.8 ka and are related to the Siberian Anticyclonic system. Declining *Artemisia* and shrubs indicate milder climates *ca.* 3.8–3.4 ka and 2.8–0.6 ka. The latter period that started with the rule of the Persian empires (550–650 BCE), and continued through the Islamic era, coincides with intensive human activities, and the highest degradation of vegetation.

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1. Introduction

During the 3rd millennium BCE, Early Bronze Age (EBA) urban centers rose and flourished in Kerman and neighboring provinces in southeastern Iran. Some of the most important settlements were based in Shahr-i sokhta, Tepe Yahya, Bampur, Shahdad, Tal-i Iblis, and Konar Sandal (Dyson and Voigt, 1990; Madjidzadeh and Pittman, 2008; Lawler, 2011). These centers were vital for trade, agriculture and cultural exchange that flourished in the region.

In 2001, massive flooding exposed a historic and mostly intact cemetery located in Konar Sandal (KS) situated on the banks of the

Halil Rud (*rud* means river in Persian) in south of Jiroft (Fig. 1; Madjidzadeh and Pittman, 2008). The discovery unfortunately coincided with systematic looting and illegal trading of precious artifacts retrieved from the site by local villagers (Madjidzadeh and Pittman, 2008). Scrutiny of some of these artifacts confiscated by the Iranian government in 2001 revealed that people in KS, developed the unique, so-called 'Jiroft' artistic style. This feature was evident in the steatite engravings and clay pottery (Madjidzadeh, 2003; Madjidzadeh and Pittman, 2008). Further, it was claimed that people in Jiroft even had an early writing system (Madjidzadeh and Pittman, 2008; Desset, 2014), but this is debated. Since the 1970s, archaeological surveys conducted by the Iranian teams with participants from different countries particularly from USA and France discovered the rich heritage and historical significance. Multiple expeditions by French archeologists including those

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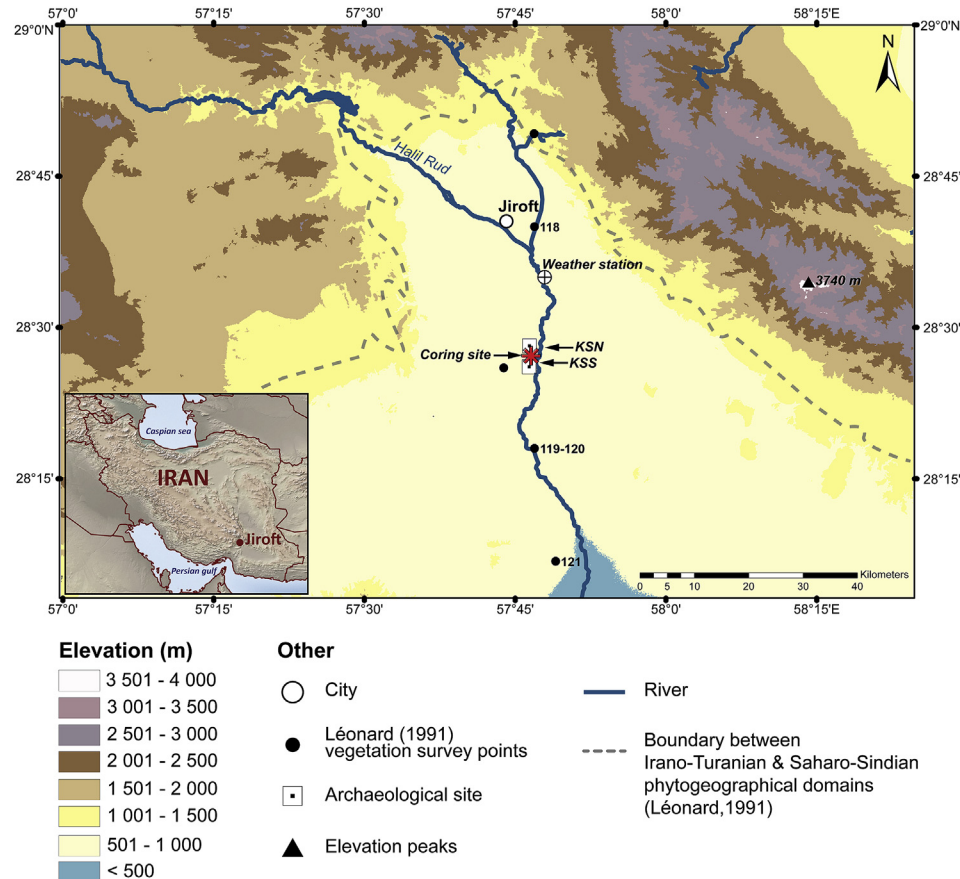


Fig. 1. Key physical, archaeological and phytogeographical features in the Jiroft valley. The coring site is in a peat deposit close to the archaeological sites KSN (Konar Sandal North) and KSS (Konar Sandal South). The inset showing the physiographic map of Iran in the bottom left corner shows location of the Jiroft valley in southeastern Iran.

in KS between 2001 and 2006 established that the Jiroft culture must have been a socio-economically advanced agrarian society with extended trade links with other cultural centers during the 3rd millennium BCE. Agricultural activities in the community included growing cereals (wheat, barley), fruits (dates and grapes), and domestication of animals (bovines, goats, sheep and horses) that are well-preserved in the archaeological surveys conducted by Mashkour et al. (2013). The notable discoveries of Jiroft-style stoneware vessels in Sumerian cities (Steinkeller, 1982) and a seal with Indus style iconographic components found in KS (Vidale and Frenez, 2015), validates the importance of this settlement as an EBA trade center. The archaeological discoveries captivate our imagination about flourishing agricultural practices, ancient trade routes, and business links that existed between these distant cities ca. 4000 years ago.

Nevertheless, during the late 3rd millennium BCE, KS and the other EBA settlements in the region steadily declined (Madjidzadeh and Pittman, 2008; Lawler, 2011). Such a collapse may have occurred due to the possible impact of the 4.2 ka regional drought, which is believed to have caused the decline and collapse of agrarian societies in the earlier Akkadian Empire and the Old Kingdom of Ancient Egypt (Weiss et al., 1993; Booth et al., 2005). Further to the east, the Indus Valley Civilization (Dixit et al., 2014; Sarkar et al., 2016; Dutt et al., 2018) and the Early Bronze Age cultures in China (Gao et al., 2007) were also affected. This led Ponton et al. (2012) to conclude that the 4.2 ka event was perhaps the beginning of a steady and gradual decline noted across different agrarian societies and urban nation states. Poor rainfall and consequential desertification could have disrupted agriculture, and eventually led to the decline

and/or abandonment of these societies.

The harsh environmental conditions combined with complex phytogeographic settings imply that data from paleoenvironmental studies are important to understand the cultural dynamics and its advancement in southeastern Iran home to many EBA settlements. To date the key investigations in KS have focused on archaeological findings (Madjidzadeh and Pittman, 2008), bioarchaeological surveys (Mashkour et al., 2013) and geomorphology (Fouache et al., 2005). However, lack of multi-proxy high-resolution paleoenvironmental data from the region hampers our understanding of the role of environment on ephemeral communities and their societal interactions. Moreover, the general lack of suitable sedimentary archives, e.g., wetlands, caves, and lake systems pose another level of complexity for paleoclimate studies in these dry and generally barren regions. As a result, we know very little about how the historic societies in this region coped with aridity, their cultivation practices, and adaptation to episodic wet or dry periods during late Holocene. Here, we report a detailed palynological study reconstructed from a sediment core retrieved from a peat deposit near the excavation site in KS (Fig. 1) that will be further supported by other sedimentological and geochemical proxies. The aims of this paper are to: (1) establish hydroclimatic changes and landscape evolution in the Jiroft valley during the late Holocene, and (2) reconstruct the human-environment interactions and the history of agro-pastoralism in relation to environmental changes in southeastern Iran. As a first multi-proxy high-resolution study from the region, our investigation provides important data on climate and its impacts on the socio-cultural and physical changes in the region, and its continued development over the last 4000 years.

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