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Environmental reconstruction and dating of Shizitan 29, Shanxi Province: An early microblade site in north China

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ABSTRACT

Global cooling during the Last Glacial Maximum (LGM) posed significant challenges to peoples living in northern Eurasia. Using micromorphology, pollen and non-pollen palynomorphs (NPP), and faunal analyses, this study reconstructs the local paleoenvironmental contexts of repeated ephemeral occupations at Shizitan 29 in Shanxi Province, North China, across the LGM, from *ca.* 28 to 18 Ka cal BP, followed by a gap until a final occupation *ca.*13.5 Ka cal BP. Among the significant finds at Shizitan 29 are remains of 285 hearths and a rich lithic assemblage that contains the earliest radiocarbon-dated evidence for microblades in China, appearing first in Layer 7. The environmental data show that the low mountains and tributary river valleys of the Yellow River in the Loess Plateau provided abundant sources of water and food in spite of environmental fluctuations. Microblade-producing groups repeatedly visiting this locality survived severe climate change by making use of fire, selective herbivore hunting, processing plant foods with grinding stones, and symbolic ornamentation such as ostrich shell beads. NPP data also indicate the potential presence of flax and other fiber processing. The Shizitan 29 data demonstrate how humans adapted to challenging local conditions throughout the LGM, allowing them to stay within this northerly region without migrating to warmer southern latitudes.

1. Introduction

Understanding how Upper Paleolithic mobile hunter-gatherer groups adopted temporary or permanent solutions when faced with climate change raises the question of the sustainability of subsistence in the affected area. During the Last Glacial Maximum (LGM), groups that formerly survived for many generations in certain regions faced potential extinction unless they could adapt to worsening environmental conditions. Their options included technological innovation and cultural, economic, and social change to stay in place, or long distance migration to regions with better conditions: any of these would have an impact on the archaeological record where these groups lived. In this paper, we describe research on the changing environmental conditions at the Shizitan 29 site (Song and Shi, 2017) whereby we can establish the environmental contexts of the various technological and cultural adaptations indicated in the archaeological record.

Shizitan 29 was occupied ephemerally but repeatedly from ca. 28 Ka cal BP to 18 Ka cal BP (dating discussed below), meaning humans were active at the site from before and throughout the LGM. Because of its location and long sequence during one of the most severe cold ages of the Pleistocene, studying Shizitan 29 offers a unique opportunity to learn about adaptations to LGM climate

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change in the northern latitudes of eastern Eurasia. The LGM is signified by the largest extension of land-based ice sheets and a continuous reduction in air surface temperatures causing drier conditions (Clark et al., 2009). However, although colder, many mid-latitude glaciers retreated at this time due to increasing aridity, including in East Asia (Hughes et al., 2013; Hughes and Gibbard, 2015). The substantial cooling during the LGM as defined in the Greenland Ice Core record is correlated with Greenland Stadial 3, which represents the period 27.54 to 23.34 Ka cal BP. The end of the LGM event is marked by Heinrich Event 2, the period marking the onset of the collapse of the Laurentide Ice Sheet at ca. 24 Ka, along with other ice sheets in the North Atlantic region. Earlier publications on the Chinese Upper Paleolithic often refer to the LGM as falling between ca. 24-18 Ka cal BP, so this more recent chronological definition that is based on the coldest period, i.e., Greenland Stadial 3 (Hughes et al., 2013; Hughes and Gibbard, 2015), forces us to look carefully again at correlations with the archaeological record, which indicates a progressive depopulation in Europe and North Asia after 25 Ka BP (Gamble et al., 2004), and in China possibly around the same time period north of 41° latitude (Barton et al., 2007; Gao and Dennell, 2014; Ji et al., 2005; Yi et al., 2016).

The Loess Plateau of northern China already provides preliminary clues concerning the impact of the LGM on the distribution of sites: although the number of dated Upper Paleolithic sites is limited, there is a clear decrease during the LGM (Barton et al., 2007; Qu et al., 2013; Yi et al., 2016). The northernmost sites that remain during this period include Youfang in Hebei Province (40°14′ N, 114°41′ E) (Nian et al., 2014), the Shuidonggou localities in Ningxia Province (38°21 N, 106°29′ E) (Pei et al., 2012), the Shizitan localities in Jixian, Shanxi Province (36°2′ N, 110°35′ E), Longwangchan in Shaanxi Province (36°9′45″N, 110°26′15″ E) across the Yellow River from Shizitan (Yin and Wang, 2007; Zhang et al., 2011), and Xiachuan, also in Shanxi (35°25′ N, 112°00′ E) (Wang et al., 1978; Shi, 1989; Chen, 1996; Tang, 2000). The excavations of these sites show ephemeral occupations during the LGM. The evidence from Shizitan 29 facilitates testing the impact of LGM climatic conditions on humans at this locality.

Shizitan 29 is one of a cluster of localities first discovered in the 1980s situated on the terrace of the Qingshui River in the loess highlands of Jixian County (Fig. 1). The first excavated and reported site, then called Shizitan (Linfen Administrative Bureau of Culture, 1989), is now referred to as Locality 1 (Fig. 1). From 2000 to 2010, excavations were carried out at Locality 9 (Shizitan Archaeological Team, 2010; Liu et al., 2013; Song, 2012; Sheahan et al., 2014), Locality 12 (Zhao, 2008; Shizitan Archaeological Team, 2013b), Locality 14 (Shizitan Archaeological Team, 2002, 2013a; Liu et al., 2013), and Locality 29 (Song and Shi, 2017). Shizitan 29, discussed here, is a locality with deposits spanning across the entire LGM, and so its study provides us a rare insight into hunter-gatherer behaviors in northern latitudes in China throughout this cold period.

The present study of Shizitan 29 is unique for its acquiring of a systematic series of radiocarbon dates and the combined application of soil micromorphological, pollen and non-pollen palynomorph (NPP), and faunal analyses in order to reconstruct the paleoenvironmental background of human occupations and cultural adaptations. Furthermore, the large scale of the 1200 m^2 of excavated deposits, reaching 15 m in depth, provides a rich dataset unmatched by other local LGM sites. The NPP analysis is also new to China. In other world regions, the potential of NPP studies for environmental reconstruction has been demonstrated, most often in lake boreholes, but in this study we further show the potential for NPPs to reveal not only evidence for the immediate environment of the site but also for human activities (e.g., Van Geel, 1998; Van Geel and Aptroot, 2006). Although further research and analyses are necessary to clarify NPP findings of fibers in the Shizitan 29 samples, there are indications of the presence and perhaps processing of flax fibers and wool. These materials have not previously been found in Paleolithic contexts in China, but their microscopic presence in the cultural strata at the site, which still should be supported by additional studies before further conclusions can be drawn, may indicate that such fibers were part of the suit of local adaptations to cold climate.

2. Stratigraphy and cultural components

2.1. Stratigraphy

Shizitan 29 (36°2′54″N, 110°35′22″ E) is located 723 m above sea level approximately 500 m east of Shizihe Village, Jixian County, Shanxi Province (Figs. 1 and 2). It is the largest excavated site among the Shizitan group, and it provides a continuous depositional sequence through the LGM, with wide horizontal exposures showing human activity (e.g., 285 hearths) in multiple layers through 15 m of deposits (Figs. 3 and 4). The 1200 m^2 area was excavated because a new highway was being constructed through the site. The excavations were carried out by a joint team from the Shanxi Provincial Museum and Shanxi University Archaeology Department from March 2009–October 2010, with breaks during colder weather, typically with a team of at least 30 members excavating. During the excavations, eight cultural layers (defined below) up to 1.5 m thick [Level 7]) were exposed, with the basic excavation unit being 1 m × 1 m squares divided into quadrants and typically dug in spits of 10 cm. Proveniences of lithics and other cultural materials were recorded in three dimensions during excavation using a level for depth measurements from datum and tape measurements for horizontal distances from the site datum. Smaller artifacts and ecofacts were also recovered through dry and wet screening of fill and recorded by square and depth. Of the eight assemblages, those from Layers 7-1 are characterized by the presence of microblades (Table 1). Hearths and artifacts were exposed in every cultural layer, with a total of 285 hearth features and more than 75,000 artifacts. Only very few artifacts were found in the 0.5–1.5 m thick, mostly redeposited loess accumulations that separated each of the cultural Layers 1–7. Micromorphological study of samples from the cultural and natural layers is included in this study (below) and informs us of several shifts in the depositional history of the site that could be tied to environmental changes during LGM.

It should be noted that the term “cultural layer” is the common terminology used in Chinese archaeological literature for defining a layer within which human occupation, artifacts, and other signs of anthropogenic inputs are exposed. Hence, a “cultural layer” is also a well-defined stratigraphic unit, similar to the “ethno stratigraphic unit” as discussed in Stein (1990). Such cultural layers form the archaeological sequence. For consistency with the literature, we retain the use of the term in this report. The natural layers between the cultural layers are distinguished by their apparent lack of anthropogenic inputs, but low numbers of artifacts can sometimes be found within them, either from ephemeral and limited human activity or post-depositional agencies.

A large number (285) of exposed hearths in the various layers at Shizitan 29 provides a rare dataset into human behavioral patterns and activities associated with pyrotechnology over the long history of the site (Fig. 5). Features recognized to be hearths were uncovered in every cultural layer. The criteria to identify features as hearths were combinations of the following: their rounded shapes in plan view and lens shape in profile; the presence of reddened earth, likely from firing, thicker at the central area of the lens; the presence of burnt bone and charcoal; and the occasional presence