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The earliest well-dated archeological site in the hyper-arid Tarim Basin and its implications for prehistoric human migration and climatic change

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ABSTRACT

The routes and timing of human occupation of the Tibetan Plateau (TP) are crucial for understanding the evolution of Tibetan populations and associated paleoclimatic conditions. Many archeological sites have been found in/around the Tarim Basin, on the northern margin of the Tibetan Plateau. Unfortunately, most of these sites are surface sites and cannot be directly dated. Their ages can only be estimated based on imprecise artifact comparisons. We recently found and dated an archeological site on a terrace along the Keriya River. Our ages indicate that the site was occupied at ~7.0–7.6 ka, making it the earliest well-dated archeological site yet identified in the Tarim Basin. This suggests that early human foragers migrated into this region prior to ~7.0–7.6 ka during the early to mid-Holocene climatic optimum, which may have provided the impetus for populating the region. We hypothesize that the Keriya River, together with the other rivers originating from the TP, may have served as access routes onto the TP for early human foragers. These rivers may also have served as stepping stones for migration further west into the now hyper-arid regions of the Tarim Basin, leading ultimately to the development of the Silk Road.

Introduction

It has been suggested that there were three processes for the occupation of the interior high Tibetan Plateau (TP) (Brantingham et al., 2003; Brantingham and Gao, 2006; Brantingham et al., 2007). These processes involved an initial colonization of lowland zones below 3000 m a.s.l. (such as Gansu, Inner Mongolia and the Xinjiang desert region), the colonization of a middle-elevation zone between 3000 and 4000 m a.s.l., and finally the colonization of the high plateau (>4000 m). The Tarim Basin (TB), to the north of the TP and with elevations of only 800–1200 m (Fig. 1), was likely an important region supporting initial human migration to the higher TP. Relatively abundant resources in the foothills of the western Kunlun Mountains in the transition zone between the TB and the Chang Tang region of the northern TP may have supported the upslope expansion of these early populations. This region is also where the famous Silk Road, supporting communication and human commercial trade between the East and the West, developed during the Holocene. Therefore, studies of archeological sites in and around the TB are crucial for the reconstruction of both cultural evolution and climatic change in this hyper-arid inland Asian area.

Over the last several decades, a large number of prehistoric archeological sites have been found in the TB. However, most of the sites are lag deposits on the modern ground surface, and thus offer no absolute ages. Sites thought to date to the early Neolithic have chronologies based on artifact characteristics and geomorphological setting, rather than on direct dating. Such sites include the Bash Sura site (Wang and Zhang, 1988), the Yeniuquan site (Taklimakan Desert archaeology group, 1990), the Qiemo (Yidilis, 1993), the Ashikule site (Huang and Wu, 1991), Kaerdun site (Taklimakan Desert archaeology group, 1990) and some sites found by Huang et al. (1988) on Yurungkash River, Niya River as well as Keriya River (see Fig. 1 for locations). There are, however, also a number of sites dated to the late

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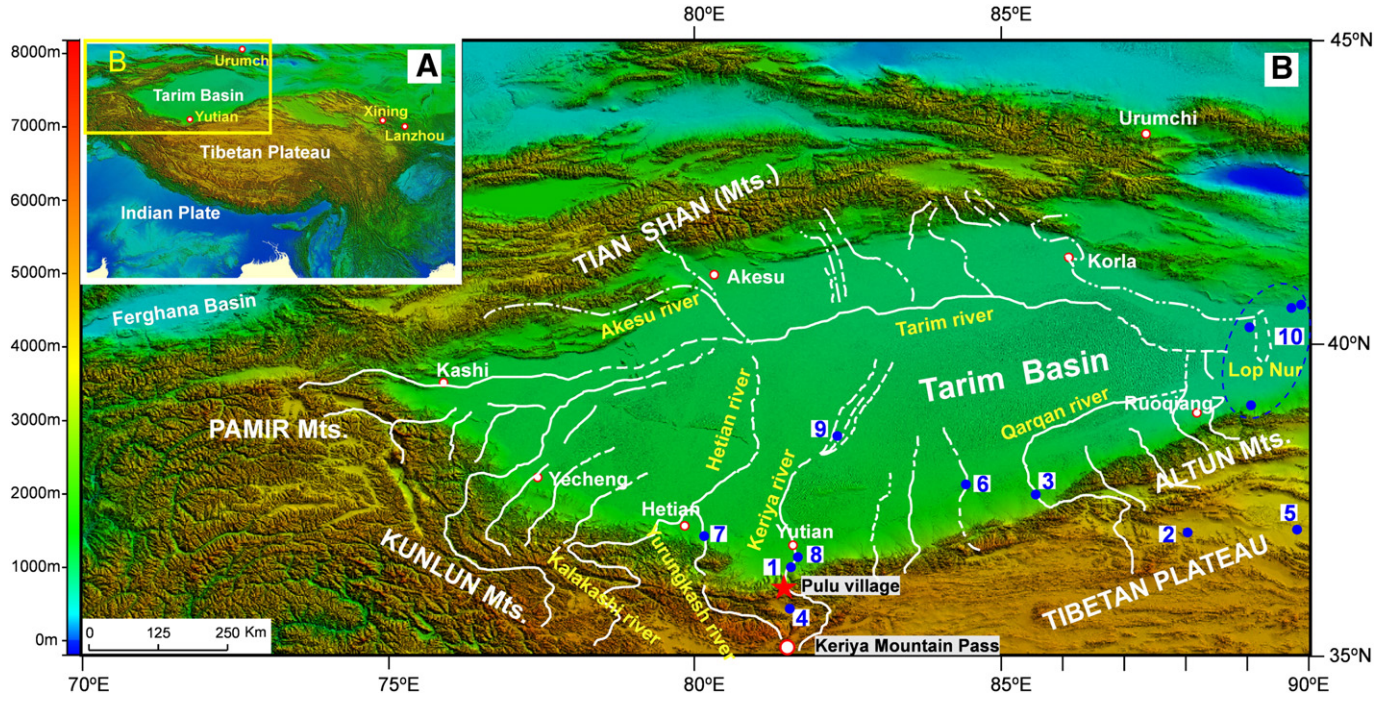

Figure. 1. Map showing the physical geography of the Tarim Basin, the location of the study site (red star), and some main rivers flowing into the Tarim Basin. Note: The blue solid circles are archeological sites in Tarim Basin: 1) Bash Sura site (Wang and Zhang, 1988); 2) Yeniuquan site (Taklimakan Desert archaeology group, 1990); 3) Qiemo site (Huang and Wu, 1991); 4) Ashikule site (Yidilis, 1993); 5) Kaerdun site (Taklimakan Desert archaeology group, 1990) and some sites found by Huang et al. (1988) on Niya River (6) Yurungkash River (7), as well as Keriya River (8); 9) site located on end areas of the Keriya River (Zhang et al., 2011) and sites around the Lop Nur region (10) (Lü et al., 2010).

Neolithic period (e.g., Debaine-Francfort, 1988; Lü et al., 2010; Zhang et al., 2011). As a result, the timing of the prehistoric occupation of the TB is still unclear, hindered by the lack of directly dated sites, especially for the sites of the earliest stage of human occupation.

We recently found and investigated a hearth on the bottom of an 18.1 m eolian sequence situated on a terrace of the Keriya River, a large river in the TP–TB transition zone that flows into the Taklimakan Desert (Fig. 1). Stone tools, a large number of bones, and charcoal, were associated with the hearth, providing an opportunity to precisely date the age of these artifacts and place constraints on cultural change in the region and on the climatic conditions that accompanied that change.

Previous studies have demonstrated the suitability of OSL and ^{14}C dating to determine the age of archeological sites in the TB (e.g., Zhang et al., 2011) as well as the TP (e.g., Madsen et al., 2006; Hou et al., 2012; Sun et al., 2012). Here we apply OSL and ^{14}C dating to provide a systemic chronological framework for this archeological site, and discuss the timing and possible routes of early human migration/occupation in the region in relation to corresponding paleoclimatic conditions.

Geological setting, section and samples

The TB, a large endorheic basin in northwestern China, is dominated by the Taklimakan Desert, the world's second largest dune field (Fig. 1). It is bordered by the Pamir Mountains to the west, the Tian Shan Mountains to the north, and the Kunlun Mountains to the south (Fig. 1). Due to its location north of the TP, the basin is characterized by hyper-arid conditions, with mean annual temperatures of 9–11°C and mean annual precipitation (MAP) of <100 mm (<50 mm in most places). The interior of the basin is an average of 800–1300 m a.s.l., with surrounding mountains exceeding 4000 m a.s.l. Glacier-fed streams transport clastic sediments from these high mountains into the basin, leading, over time, to the creation of huge alluvial fans along the foothills of these surrounding mountains. Superimposed on these fan surfaces and fan-derived river terraces are widely-distributed eolian sediments derived from the Taklimakan Desert (Liu, 1985; Fang et al., 2002a,b; Sun, 2002).

The Kunlun Mountains constitute the watershed between the TP and TB. Many rivers, originating in the western Kunlun Mountains on the northern margin of the TP, feed northwards into the Taklimakan Desert, connecting the TP and the TB. The Keriya River, located on the south-central TB margin, is one of these, and it originated from the Keriya (7176 m) and Qiongmuzitage (6920 m) peaks of the Kunlun Mountains (Fig. 1). The two main branches of the Keriya River, the Wugeyeke River and the Kulapu River, cross the steep upper slopes of the mountains and converge at Pulu village. The river then flows northward through the alluvial/fluvial plain and vanishes into the Taklimakan Desert. The full length of the Keriya River is about 800 km.

The Yangchang (YC) eolian section (36°13′8.8″ N, 81°31′14″ E, 2440 a.s.l.) in the village of Pulu is situated on the fifth terrace of the Keriya River (Fig. 2). There are a series of terraces on both sides of the Keriya River in the YC region. The observed highest terrace is at least 130 m higher than the modern river bed, and a hearth was found on the fifth terrace on the left bank of the Keriya River. The fluvial gravel layer is 8–10 m thick and 50 m above the modern river bed. The fluvial sand and 18.1 m thick eolian sediments, mainly composed of sandy loess bracketing a light brown weak paleosol, overlie on the gravels. A roughly circular (100 cm dia.) 15 cm thick hearth was found in the lower part of the loess section about 1 m above the fluvial gravels (17.1–17.25 m in depth) (Fig. 2).

A variety of artifacts including flakes, scrapers, and blades made from white quartzite were recovered from this hearth (Figs. 2 and 3). Some blades are long, with one blade measuring 54 mm in length (Fig. 3D). This production of abnormally large blades appears to be a characteristic of the early Holocene occupation of the northern TP. Recent work by Brantingham et al. (2013) in the eastern Kunlun Mountains area of the northern Tibetan Plateau suggests that such