



Chronometric investigations of the Middle to Upper Paleolithic transition in the Zagros Mountains using AMS radiocarbon dating and Bayesian age modelling



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ABSTRACT

The Middle to Upper Paleolithic transition is often linked with a bio-cultural shift involving the dispersal of modern humans outside of Africa, the concomitant replacement of Neanderthals across Eurasia, and the emergence of new technological traditions. The Zagros Mountains region assumes importance in discussions concerning this period as its geographic location is central to all pertinent hominin migration areas, pointing to both east and west. As such, establishing a reliable chronology in the Zagros Mountains is crucial to our understanding of these biological and cultural developments. Political circumstance, coupled with the poor preservation of organic material, has meant that a clear chronological definition of the Middle to Upper Paleolithic transition for the Zagros Mountains region has not yet been achieved. To improve this situation, we have obtained new archaeological samples for AMS radiocarbon dating from three sites: Kobeh Cave, Kaldar Cave, and Ghâr-e Boof (Iran). In addition, we have statistically modelled previously published radiocarbon determinations for Yafteh Cave (Iran) and Shanidar Cave (Iraqi Kurdistan), to improve their chronological resolution and enable us to compare the results with the new dataset. Bayesian modelling results suggest that the onset of the Upper Paleolithic in the Zagros Mountains dates to 45,000–40,250 cal BP (68.2% probability). Further chronometric data are required to improve the precision of this age range.

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1. Introduction

The Middle to Upper Paleolithic (M–UP) transition, dating to between 50,000 and 30,000 years Before Present (BP), marks a pivotal point in late human evolution. It involves the dispersal of anatomically modern humans (AMHs) outside of Africa, the

concomitant replacement of Neanderthal populations across the Eurasian record, and the emergence of what is widely termed the ‘Early Upper Paleolithic’ (EUP)—a period often associated with novel symbolic and behaviorally mediated artefacts thought to represent an important change in the cognitive processes of modern humans (see White et al., 1982; Mellars, 1991; Klein, 1995; Bar-Yosef, 2002). It is axiomatic that a reliable chronology is required to compare archaeological sites and material culture across space and place the biological and cultural developments occurring at this

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time in a proper context. So far, however, the vast majority of Paleolithic archaeological sites that have been investigated chronometrically in any great detail are in Europe. Elsewhere, as is the case with the Zagros Mountains, the archaeological record is not only less abundant, but chronometric data are often absent. Considering that this geographic region acts as a corridor linking Africa to the Levant and Eurasia, establishing a spatio-temporal sequence for the Zagros is crucial. Due to political circumstances within the region and the poor preservation of organic material (bone collagen, in particular) extracted from archaeological sites, however, a clear chronological definition for the M–UP transition has not yet been achieved—very few absolute dates have been published (e.g., Solecki, 1963; Conard and Ghasidian, 2011; Otte et al., 2011; Bazgir et al., 2017; Heydari-Guran and Ghasidian, 2017). In this article, we present new accelerator mass spectrometry (AMS) radiocarbon results from three archaeological sites in the Zagros Mountains and model chronometric data using Bayesian statistics.

2. Background

2.1. Neanderthals and AMHs

Neanderthals and AMHs are hominin groups that are morphologically and genetically distinct from each other. Modern humans evolved in Africa around 200,000 years ago, exited the continent about 60,000–50,000 years ago (or earlier), and reached Eurasia and Australia by about 50,000–45,000 years ago (see Groucutt et al., 2015 for a recent review). Regions adjacent to East Africa—Arabia, Sinai, the Levant, and the Iranian Plateau—record the first modern humans migrating out of this continent and, as ‘first contact’ areas, hold great paleo-anthropological and archaeological potential. The weight of archaeological and fossil evidence suggests that Neanderthals evolved outside Africa, inhabiting Europe, western Asia, and the Middle East starting from, roughly, 250,000–300,000 years ago (see Hublin, 2009 for a review). Neanderthal occupation ended in Europe at around 41,000–39,000 (95.4% probability) calibrated (cal) BP, strongly suggesting an overlap with AMHs for several thousand years in the region (Higham et al., 2014). Numerous hypotheses have attempted to explain the disappearance of Neanderthals from the archaeological record. These often involve the role of climate (e.g., Finlayson and Carrion, 2007; Jiménez-Espejo et al., 2007) and the perceived superiority of AMHs over Neanderthals in terms of technology, diet, and cognition (e.g., Binford, 1985; Mellars, 1989; Richards and Trinkaus, 2009). Recent ancient genetic research suggests that Neanderthals and AMHs interbred outside of Africa (e.g., Green et al., 2010; Prüfer et al., 2014), resulting in the intrusion of Neanderthal-derived DNA at a proportion of 1.5–2.1% in all non-African modern humans (Prüfer et al., 2014).

2.2. The Zagros Mountains

The Zagros Mountains are a series of parallel mountain ridges interspersed with plains that cross Iran from northwest to southeast, reaching the northeast of Iraq and the southeast of Turkey. The geomorphological setting of the Zagros, a karstic system reaching over 4,000 m above sea level (m.a.s.l.), lends itself to the formation of caves that offer ample opportunities for both paleo-environmental and archaeological research. Given the physical geography of Iran, bounded in the north and south by mountains, the region has long been considered a potential dispersal corridor for hominins emerging out of Africa. Indeed, Vahdati Nasab et al. (2013) have posited a number of distinct migration routes

according to the naturally occurring boundaries in the landscape, including a passageway south of the Zagros Mountains.

2.3. Previous research within the Zagros

Early archaeological research in the Middle East began in the 1920s with researchers such as D.A.E. Garrod, who analysed local lithic assemblages in direct reference to European Paleolithic traditions, i.e., the Mousterian (assigned to Neanderthals and the MP) and the Aurignacian (attributed to AMHs and the UP), according to their typological features (see Garrod, 1928, 1951; Garrod and Bate, 1942). In the 1950s, R. and R. Solecki excavated Shanidar Cave in Iraqi Kurdistan, where a number of Neanderthal individuals were found buried within the MP deposit and the UP material culture was named ‘Baradostian’ (see Solecki, 1955, 1957, 1960, 1963; Solecki and Solecki, 1993). In addition to this work, C.S. Coon excavated the sites of Bisitun, Tamtama, and Khunik (Coon, 1951); R. Braidwood worked at Warwasi (Braidwood et al., 1961); F. Hole and K. Flannery excavated Kunji, Gar Arjeneh, Pa Sangar, Ghamari, and Yafteh Cave (Hole and Flannery, 1968); and M. Rosenberg investigated Eshkaft-e Gavi (Rosenberg, 1985; Scott and Marean, 2009). In the early 1980s, field investigations in Iran decreased in frequency due to political factors and, as Vahdati Nasab (2011) suggests, the lack of enthusiasm shown by local archaeologists. During this time, workers re-evaluated archaeological collections stored outside of the Zagros. Dibble (1984), for instance, re-studied artefacts from Bisitun, and posited that, in contrast to previous claims concerning the lack of Levallois attributes in Mousterian industries from the Zagros, the assemblage showed a relatively high frequency of the technique. A decade later, through the re-analysis of the Warwasi assemblage, Olszewski and Dibble (1994) proposed the renaming of the Baradostian tradition to ‘Zagros Aurignacian’, given the perceived similarities with Aurignacian material, and suggested the possibility of an in situ origin for the Aurignacian industry. Beginning in the early 2000s and into the present, joint Iranian-European teams have surveyed, excavated, and reported results from multiple Paleolithic sites across the Zagros Mountains (e.g., Conard et al., 2006; Jaubert et al., 2006; Otte et al., 2007; Conard and Ghasidian, 2011; Bazgir et al., 2014, 2017; Heydari-Guran and Ghasidian, 2017). This new field research may shed light on some of the major questions of interest to prehistorians in this region, including the issue of the origin of the Aurignacian and the Zagros Mountains, as well as the potential presence of mutually distinct and coeval lithic industries within the region during the UP (see Ghasidian et al., 2017).

3. Archaeological sites

We have obtained new chronometric results for Kaldar Cave, Ghār-e Boof, and Kobeh Cave, and analysed previously published radiocarbon dates for the sites of Yafteh and Shanidar Cave (Fig. 1)—all within the Zagros Mountains region. These archaeological sites are briefly described in the following sections.

3.1. Yafteh Cave

Yafteh Cave is located in the Khorramabad region of Lorestan province, western Iran (at 1278 m.a.s.l.; 33°30′30″N, 48°12′41″E), and was excavated in 1965 by Hole and Flannery (1968). The lithic technology at the site has assumed importance in discussions concerning the origin of the Aurignacian tradition due to its morphology and, as reported, similarity to European material (see Otte and Koziowski, 2004). For this reason, a group from the University of Liège recommenced excavations at the site in 2005 and 2008. Following an analysis of the lithic assemblage, workers

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