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# Playas and Middle Paleolithic settlement of the Iranian Central Desert: The discovery of the Chah-e Jam Middle Paleolithic site

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A B S T R A C T

Geomorphological studies indicate that the current Iranian Central Desert has previously consisted of several large lakes, the remains of which are still visible in the form of numerous playas across the desert. The Northern edge of the Iranian Central Desert has been subject to several seasons of systematic Paleolithic surveys from 2009. As a result of these surveys, several Paleolithic settlements have been recorded, the most significant of which include the Middle Paleolithic sites of Mirak, Soofi-Abad and Chah-e Jam. In order to test whether any Middle Paleolithic sites existed around the boundary of such playas, one of them (Chah-e Jam Desert), which is located at the southern outskirts of the modern city of Dāmghan (300 km east of Tehran), was selected for intensive walking survey in July–August 2014. During the course of the survey, a large exposure of lithic artefacts, 8.5 km in length, was discovered. Techno-typological analysis of the lithic assemblages indicates an abundance of Levallois technology and numerous retouched tool types (e.g., Levallois points, and all types of convergent scrapers), leading the site to be attributed to the Middle Paleolithic. The presence of some typological elements of later periods indicates the site has been inhabited during Upper/Epipaleolithic periods as well. This site, along with other Middle Paleolithic settlements in this landscape, indicate that climatic conditions during the Late Pleistocene were significantly different to present, and the presence of numerous lakes and associated vegetation permitted hominin populations to occupy currently arid areas.



## 1. Introduction

The Iranian Plateau has been identified as one of the most important dispersal corridors in the Near East (Vahdati Nasab et al., 2013), presenting accessible routes for hominins dispersing out of Africa to the east. Between three major seas (Caspian Sea to the north and Persian Gulf and Oman Sea to the south), the coastal regions of the Iranian Plateau could have been used for such dispersals (e.g. Field and Lahr, 2006). This led numerous pioneers of the Iranian Paleolithic archaeology to concentrate their field work on excavation and survey of the northern and southern coast of the Iranian plateau (Coon, 1951; Hume, 1976). Aside from its strategic location, the Iranian Plateau is adjacent to sites yielding important hominin fossils, the most significant of which include Dmanisi (Abesalom et al., 2002) and Shanidar (Solecki, 1954). Although a handful of Paleolithic localities have been recorded on the Iranian Plateau (based on their cultural materials), few have been tested archaeologically and even fewer provided hominin remains (e.g., Bistun rock shelter (Coon, 1951), Eshkaft-e Gavi (Rosenberg, 1985), Wazmeh (Trinkaus et al., 2007)).

The history of the Paleolithic archaeology of Iran can be divided into three major phases: a) prior to the Second World War, during which time only a few sporadic field missions were conducted; b) from 1950s to 1979, when the area witnessed several Paleolithic surveys and excavations; and c) from 2000 onwards, following a reawakening of the field of Paleolithic archaeology of Iran after a gap of two decades (Vahdati Nasab, 2011). Since 2000, a substantial number of Paleolithic field missions in Iran have been initiated (e.g., Berillon et al., 2007; Otte et al., 2007; Conard et al., 2009; Jaubert et al., 2009). Only a few Iranian experts are active in this field, and most of their research has concentrated on the Zagros Mountains. The significance of the northern part of the Iranian Central Desert (the ICD) as an additional major dispersal route has been noted since 2007. Since then, several Paleolithic surveys have been conducted in the region, although some major time gaps occur between them. The Paleolithic Survey of the Iranian Central Desert Project (PSICDP) was established in 2009 in order to evaluate the

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Paleolithic potential of the region. This project targets the ICD knowing that it experienced different climatic conditions during the Pleistocene, including phases in which environmental conditions were able to support Paleolithic groups, such as peak humidity during MIS 5e (Groucutt and Blinkhorn, 2013, Fig 2b).

## 2. Background

### 2.1. Landscape of the Iranian Central Plateau

The Iranian Central Plateau (The ICP) is flanked by the Zagros Mountains to the west, the Alborz Mountains to the north and northeast, and the Lut desert in south (Fig. 1), and occurs at an average elevation of 1200 meters above the sea level (Wilson, 2011: 3). The ICP is the physical remains of some large playas, which once covered much of the area (Krinsley, 1970: 23). Although no unanimous agreements exists about the exact boundaries of the ICP, because of significant geographical overlap between the ICP and the Iranian Central Desert (The ICD) (Fig. 1): in this article we use ICP. The presence of two distinct geomorphological formations of desert and mountains in close proximity has created a unique geography in the region, with several corridors lying between them, which could have been used by Pleistocene populations (Vahdati Nasab et al., 2013). The width of these corridors has been subjected to constant changes through expansions and contractions of the ICD.

Here, we focus on the northern edge of the ICP, which is surrounded by the Alborz Mountains and Central Desert. From the Alborz Mountains southwards, the landscape changes from the rocky body of the mountains, through alluvial fans and pediments, leading to floodplains and lowlands, ending in sandy and highly saline, barren lands, which are the remnants of ancient playas. In contrast to the Zagros Mountains, which is a karst landscape containing numerous parallel intermountain valleys, the Alborz possesses few such valleys (Oberlander, 1968: 200). The alluvial fans below the Alborz Mountains consist of relatively large pebbles and gravels with limited cultivable soil and largely unsuitable for agricultural activities. Instead, they act as underwater reservoirs (Arzani, 2010). Following the alluvial fans, there are pediments, of which the largest ones are Garmsar, Semnan, Dāmghan and Shahrud. The pediments contain appropriate soil for cultivation and most of the Holocene settlements are located on them at the region. Increasing alkalinity of soil as the pediment meets the desert has limited the possibilities for agriculture. The salt desert is located at the very center of the ICP, where few plants and animals are suitably adapted to survive. The salt desert is the final destination of all seasonal and permanent rivers and creeks in the region.

### 2.2. Modern and ancient environments

Currently, this geographical region can be classified as semi-arid. More specifically, the studied region in this article (Chah-e Jam Paleolake) possesses an average annual temperature of 21.8 °C, which varies between 48 °C in June–July and −5 °C in winter. Concerning the vegetation of the area the *Artemisia* group with 9 species is dominant, followed by *Salsola Dendroides* (Vahdati Nasab, 2014).

Due to research conducted by Kehl (2009) and Frechen et al. (2009) on loess deposits of the southern parts of the Caspian Sea,

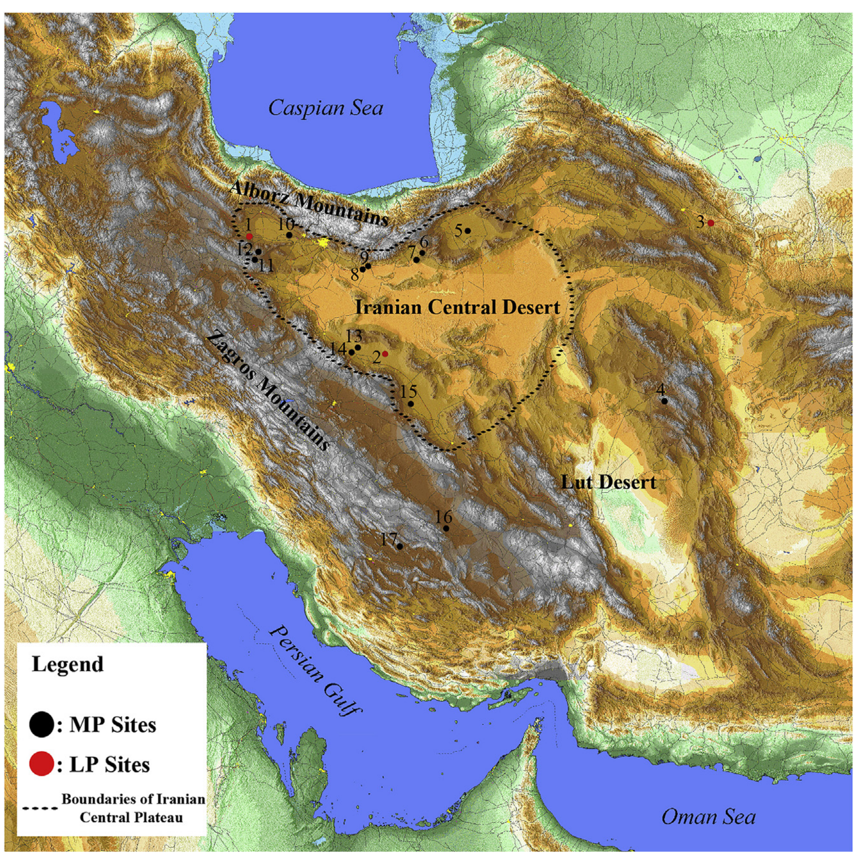


**Fig. 1.** Iranian Central Plateau and location of mentioned sites on it. 1. Tappeh Khaleseh, 2. Geleh, 3. Kashaf Roud, 4. Khunik, 5. Chah-e Jam, 6. Mirak, 7. Soufi Abad, 8. Moghanak, 9. Otchounak, 10. Sepid Dasht, 11. Nargeh, 12. Zavieh, 13. Qaleh Gousheh, 14. Holabad, 15. Qaleh Bozi, 16. Arsanjan, 17. Eshkaft-e Gavi.

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**Fig. 2.** Landscapes of Mirak (above), Zavieh (middle), and Qaleh Gusheh (bottom), indicating the remnants of some paleolakes, after Heydari-Guran et al., 2015.

it has been possible to evaluate climate change during the Pleistocene. These studies indicate a mild and wet environment on the ICP during MIS 7, 9, 11 and perhaps older interglacial phases (Kehl, 2009). During the Lower-Middle Pleistocene the climate of the ICP was cooler and probably moister than today (Krinsley, 1970). In addition, the pollen record of Lake Urmia in northwest of the ICP indicate the climate was warmer and moister in MIS 5e than during the Holocene (Djamali et al., 2008). In MIS3 and the Last Glacial Maximum (LGM), the accumulation of loess points to a cold and dry condition (Frechen et al., 2009).

Paleoclimatic analysis of pollen and loess samples from northwestern and northern Iran clearly indicates that during the period of 40–32 ka, the ICP had relatively warm and humid conditions (Djamali et al., 2008). Between 32 and 24 ka the region faced a drop in temperature associated with aridity evident in the Caspian Sea, which decreased in depth by 58 m (Coolidge, 2005: 4; Djamali et al., 2008). Consequently around 24 ka the LGM started and lasted for almost 4000 years. The ICP experienced particularly harsh conditions such that its maximum temperature during the hottest months of the year did not exceed 10–12 °C (Djamali et al., 2008). As a consequence, the ICP lost most of its vegetation and fauna.

## 3. History of research in the northern part of the ICP

The first reference to the Paleolithic occupations in the ICP is related to the activities of de Morgan in the early twentieth century at the east of Demavand Mountain in Lar valley. During his surveys de Morgan collected numerous stone samples, which he proposed were artifacts (De Morgan, 1907). Close examination of his findings at the Saint Germain En Laye museum by one of the authors revealed that most of them are natural rocks (Vahdati Nasab, 2011). Between 1939 and 1949, Hubert Reiben conducted Paleolithic surveys at the southern part of Tehran and reported some Mousterian-like artifacts in the Kahrizak area (Rieben, 1955). In 1967 Vita-Finzi conducted surveys in the northern part of the ICP in Eyvan-Key region (almost 60 km east of Tehran) and reported some Paleolithic artifacts tentatively assigned to the Upper Paleolithic (Vita-Finzi, 1968). Archaeological surveys at Semnan in 1984 by Mehryar and Kabiri resulted in the identification of archaeological mounds south of the modern city of Semnan in the northern part of the ICP, named Delazian and Mirak. In their report Mehryr and Kabiri clearly signified the noticeable abundance of lithic materials on the surface (Mehryar and Kabiri, 1985: 34). In 1994 Malek Shahmirzadi reported a small collection of Paleolithic artifacts from the northwestern part of the ICP near Massile Basin in southwestern Tehran (Malek Shahmirzadi, 1994). In 2005 the French-Iranian Paleoanthropological Project (FIPP) surveyed some regions in the foothills of Demavand and reported two surface scatters known as Moghanak and Otchunak, both assigned to the Middle Paleolithic (Berillon et al., 2007; Chevrier et al., 2010).

### 3.1. Recent Archaeological Research

Following upon the earlier research of Mehryr and Kabiri, the mounds at Delazian were visited by Rezvani in early 1990 (Rezvani, 1990). In 2007, one of the authors revisited the region and conducted some limited surface sampling (Vahdati Nasab et al., 2010). Subsequently, the first season of the PSICDP was conducted at the sites of Delazian and Mirak in 2009 (the former assigned to the Upper/Epipaleolithic and latter to the Middle Paleolithic: Rezvani and Vahdati Nasab, 2010; Vahdati Nasab et al., 2013; Vahdati Nasab and Clark, in press). In 2012, the second season of the project was conducted at the southern part of city of Sorkheh, 20 km west of Delazian and Mirak, leading to the discovery of another huge lithic scatter called Soofi-Abad, which contained cultural materials assigned to the Middle/Upper and Epipaleolithic periods (Vahdati Nasab and Feiz, 2014). This paper presents the results of the third season of the project, in the southern part of Dāmghan, about 100 km east of Delazian and Mirak.

### 3.2. The first inhabitants of the ICP

Paleoanthropology and archaeology of neighboring regions to Iran (e.g., Georgia, Uzbekistan, India) as well as data derived from within geographical boundary of the Iranian Plateau have

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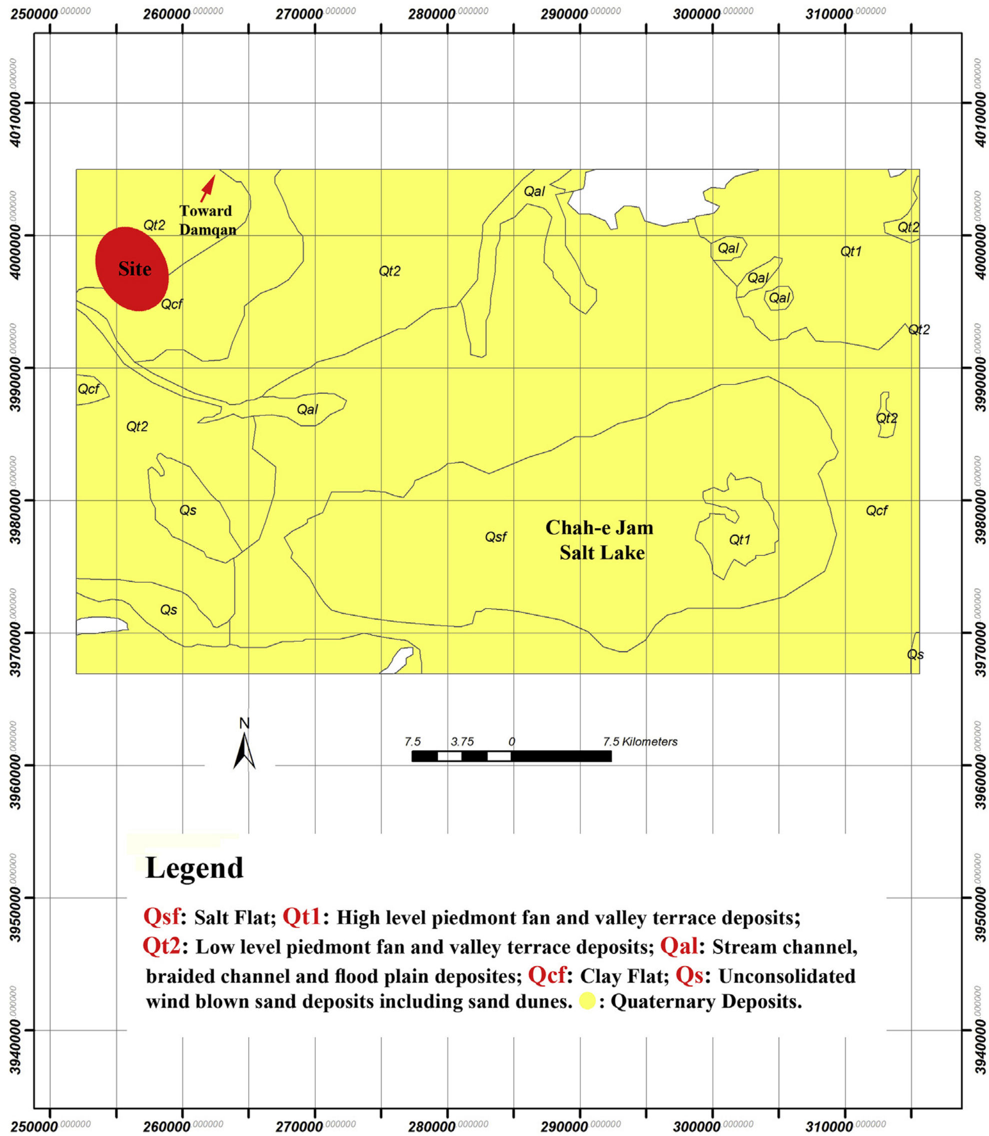


**Fig. 3.** Map of quaternary sediments at the study area.

**Fig. 4.** Chah-e Jam salt Lake.

**Fig. 5.** General view of Chah-e Jam.

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demonstrated that the ICP has been a dwelling place for the early Pleistocene hominins. At present, no physical remains of such hominins have been reported from the area, although some authors estimate the presence of hominins might go back as early as 2 Ma (Speth, 2014).

There is ample archaeological evidence to prove that some types of *Homo erectus* were the first hominins who left Africa around 2 Ma and soon dispersed across Eurasia (Bar-Yosef and Belfer-Cohen, 2001; Dennell and Roebroeks, 2005; Tattersall, 2008: 64). Solid evidence of such early dispersal includes five prominent fossilized skulls dated to 1.75 Ma have been reported from Dmanisi (Georgia) occurring northwest of Iran (Abesalom et al., 2002). In addition, widespread fossil evidence of early hominins from eastern Asia (mostly assigned to the species of *H. erectus*) combined with the strategic geographical location of the Iranian plateau suggests that the ICP formed important dispersal corridors, as well as landscapes occupied in their own right, during the Early Pleistocene. Elsewhere, it has been speculated that during the last 2–1 Ma groups of such early hominins inhabited some reservoirs around the paleolakes of the ICP making their lives through scavenging, gathering, and even some hunting activities (Speth, 2014). The remains of such lakes, in the form of playas, are observable across the entire Iranian Central Desert (e.g., Qom, Kāshān, Semnan, Dāmghan).

The Lower Paleolithic (LP) is, perhaps, the most understudied archaeological period in Iran. To date, no LP site with confirmed chronology has ever been reported. Instead, knowledge concerning the LP occupations in Iran consists of a few open sites with some

**Fig. 6.** Points/convergent scrapers of Chah-e Jam.

surface lithic scatters, which are unable to offer an absolute chronology. In absence of any datable material, techno-typological study of lithic materials and comparisons with dated materials from neighboring regions has provided some insights into the Iranian LP. In the ICP, the LP sites have been reported from Zanjan (Tappeh Khaleseh, Alibaigi and Khosravi, 2009), Kāshān (Geleh, Biglari and Shidrang, 2006), and Khorasan (Kashaf-Rud River terraces, Ariai and Thibault, 1975; Jamialahmadi et al., 2008) (Fig. 1). Comparative studies of lithics from these sites with those from the neighboring regions indicate the occurrence of both Oldowan and Acheulian industries in the region. Abundant research on the Levant, Caucasus, and Central Asian LP sites have clearly demonstrated that these Oldowan and Acheulian industries could be well associated with several groups of hominins such as *Homo ergaster*, *Homo erectus*, and *Homo heidelbergensis*. In the absence of any fossil record, identifying which of these hominins was the tool makers of the Iranian LP sites remains problematic.

### 3.3. Middle Paleolithic settlements of the ICP

It appears that there is a discontinuity in the archaeological materials from LP to the Middle Paleolithic (MP) of the ICP exists. While LP sites and lithic assemblages are rare, a more abundant record of MP occupations of the region is evident. In the Near East, the MP is present between 245 and 45 ka (Shea, 2013: 7), a timeframe which witnesses the appearance of two new hominins in the region: Neanderthals and Anatomically Modern Humans (AMH). Although fossil evidence of AMH have never been reported beyond the Levantine regions (e.g., Qafzeh and Skhul; see Shea and Bar-Yosef, 2005), Neanderthal remains in forms of fossilized bones and archaeological materials were recorded from a number of sites across the eastern Levant (e.g., Shanidar in Iraq (Solecki, 1954), Dederieh in Syria (Akazawa et al., 1995), and Teshik Tash in Uzbakistan (Weidenreich, 1945). In the ICP, evidence of MP occupations are evident at sites such as Khunik in northeastern of Iran (Coon, 1951), Chah-e Jam in southern Dāmghan, Mirak in southern Semnan (Vahdati Nasab et al., 2013), Soofi Abad in southwestern of Semnan (Vahdati Nasab and Feiz, 2014), Moghanak and Otchunak in Demavand plain (Chevrier et al., 2006; Berillon et al., 2007), Sepid Dasht (Vahdati Nasab et al., 2009), Nargeh (Biglari and Shidrang, 2006), and Zavieh (Heydari-Guran et al., 2015: 171) all located in the Qazvin plain, Holabad and Qaleh Gusheh in Arisman near Kāshān (Heydari-Guran et al., 2015: 171), Qaleh Bozi (Biglari et al., 2009), and Arsanjan (Tsuneki and Mirzaye, 2012) and Eshkaft-e Gavi (Rosenberg, 1985) both in Fars province (Fig. 1).

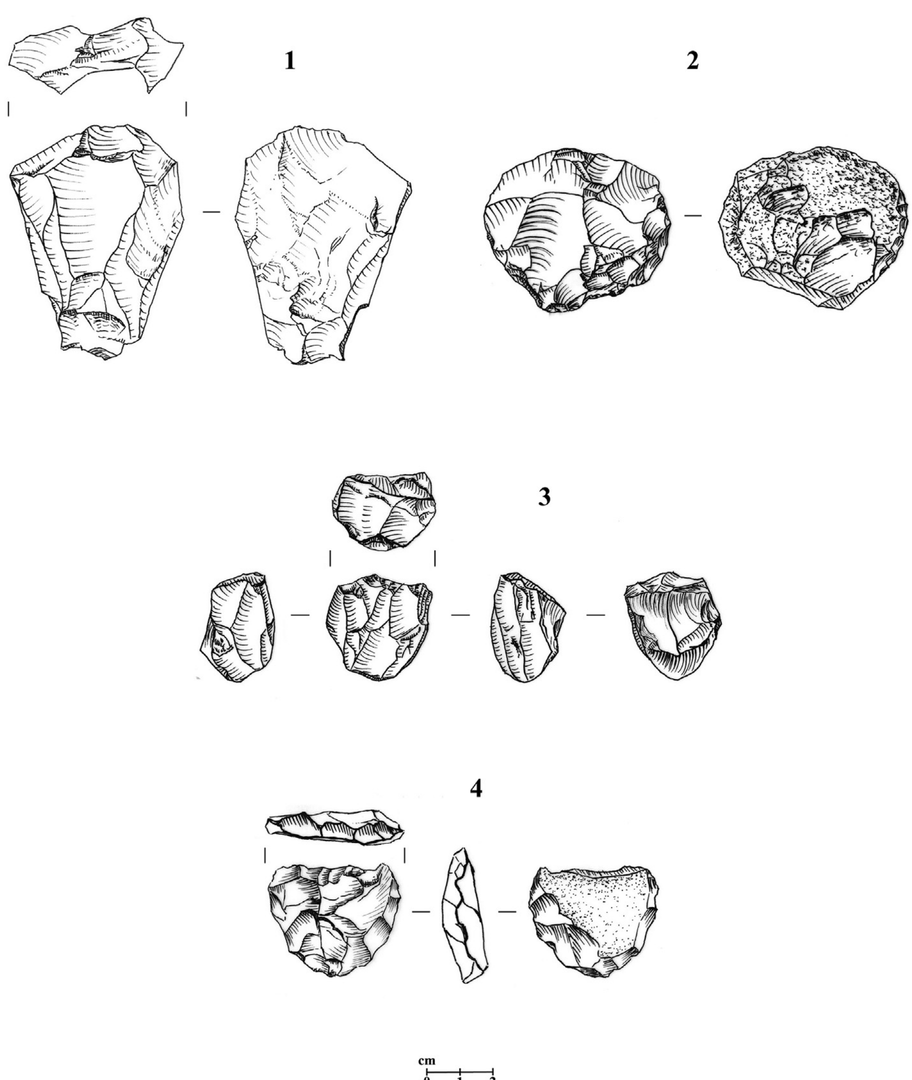


**Fig. 7.** Chah-e Jam cores: 1 bidirectional Levallois core; 2, 4 centripetal Levallois cores; 3 bladelet core.

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Various studies have highlighted the significance of hunting among MP societies (Gaudzinski, 1996; Gaudzinski and Roebroeks, 2000; Shea, 2001, 2006). Numerous convergent scrapers and Levallois points along with abundant remains of large mammals (rhino, bison, red deer, wild goat and wild sheep) have been argued to indicate the importance of hunting activities within these populations (Villa et al., 2009). Based on geomorphological data, it seems that MP localities such as Mirak, Zavieh, Holabad and Qaleh

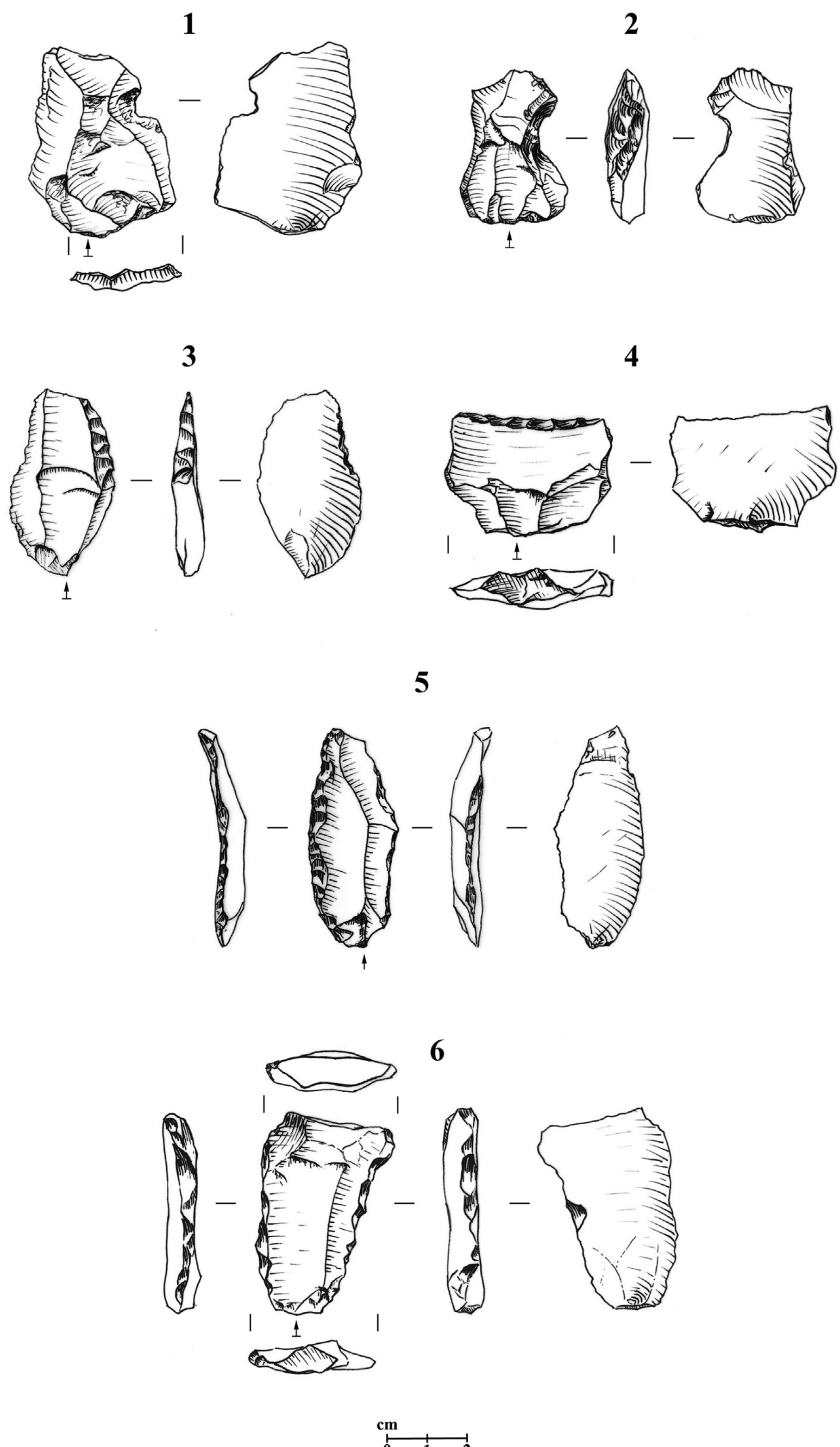


**Fig. 8.** Chah-e Jam retouched pieces: 1, 2 notch; 3, 5 side scrapers; 4 transverse scraper; 6 double side scraper.

Gusheh once were situated at the shore of ancient playas (Fig. 2). Although the current arid climate makes these landscapes inhospitable to human populations, plentiful Mousterian and Levallois lithic assemblages may imply extensive occupation throughout the region.

## 4. Materials and methods

In July–August 2014, one of the playas in the ICP was chosen for close examination in order to test the significance of these sites as a magnet for Pleistocene human populations. Chah-e Jam (also known as Kavir-e Haji Ali Qoli) salt lake stretches along the southern part of the modern city of Dāmghan, Semnan province (300 km east of Tehran) (Fig. 4). Chah-e Jam playa covers an area of 2391 square kilometers, and is located about 1050–1094 meters above sea level (Vahdati Nasab, 2014). There is a gentle slope from the Alborz Mountains in north toward Chah-e Jam salt Lake at south which guides all the current waters toward the salt lake.

Based on sedimentological studies, the Chah-e Jam Desert is divided into three distinct zones (Krinsley, 1970: 56) (Fig. 3). First the sandy clay part contains about 47% of the desert, and surrounds the two other zones. The second zone is the salty desert area (34%),

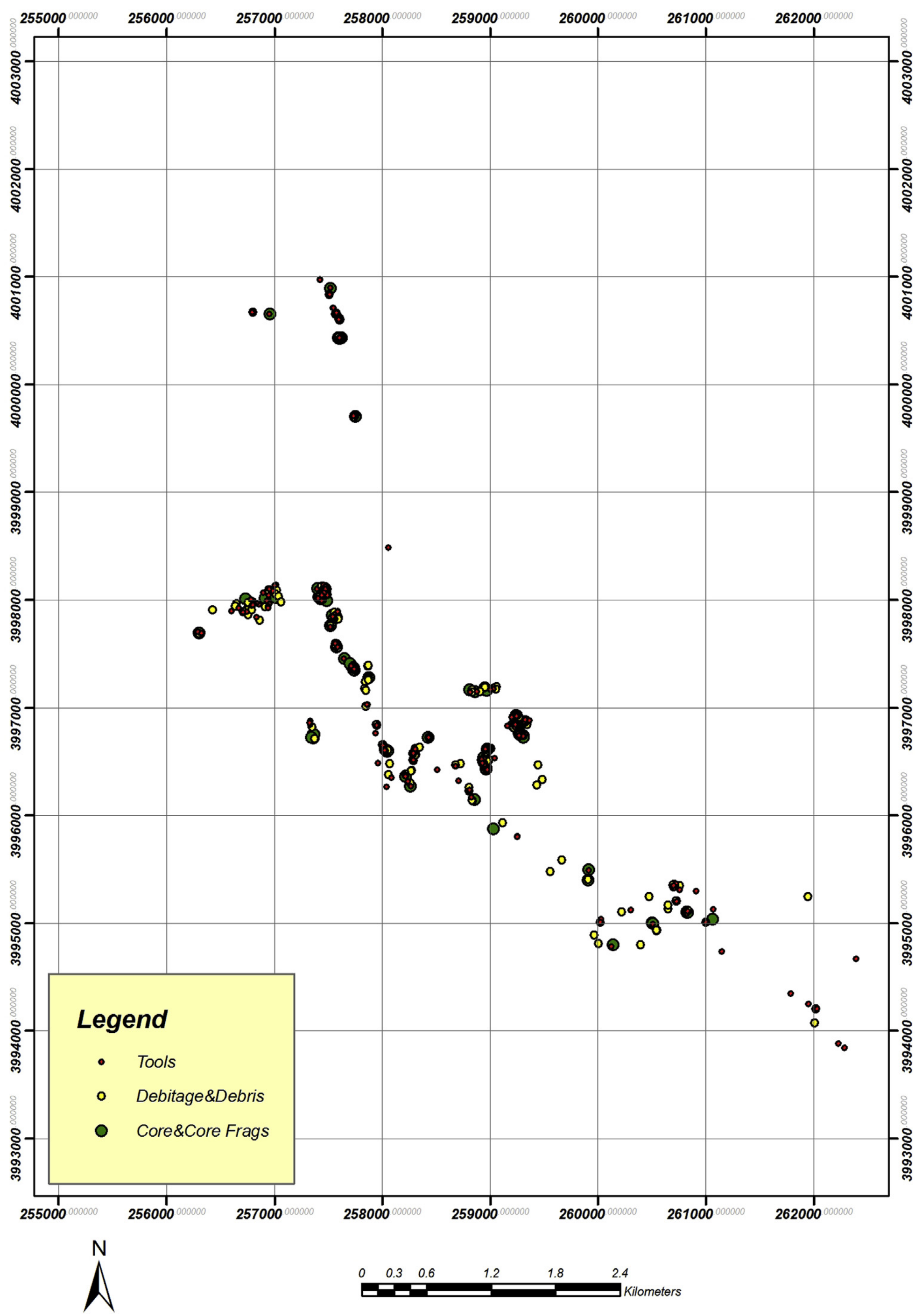


**Fig. 9.** Dispersions of flakes, blades, and bladelets throughout the Chah-e Jam surveying area.

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which starts after the sandy clay parts and ends up to the third zone which is a swamp right at the middle of the salt Lake (19%). Since no scientific work has ever been done on the expansions and contractions of Chah-e Jam Lake during the Pleistocene, the outer-most zone was selected as the hypothetical shore of the lake. Therefore, areas in the north, east and southern part of Cheh-e Jam playa were chosen for further study.

A desk-based assessment of locations for sampling was made, to identify sites with suitable combinations of presence of Quaternary sediment deposits, proximity to water resources and accessibility for field survey. We then undertook localized transect surveys on foot, with 4 team members spaced 30–50 m apart, assessing 6 locations at the edge of Cheh-e Jam playa. During the surveying of the nominated points, all lithic artifacts were collected and their position was recorded by GPS.

## 5. Results

The first Paleolithic find was identified on a low height mound covered with sandy clay and small size gravels (Fig. 5). Our survey expanded from this location to determine the extent of the artefactual deposits, ultimately identifying an 8.5 km by 3 km region (E 0260723, N 3995350) (Fig. 9). Lithic artefacts were recovered from sediments with a gentle southward slope that has been significantly impacted by human activity (e.g., agricultural fields and orchards, villages, graveled roads, railway, Steel factory) as well as natural erosive processes.

### 5.1. Lithic materials

A total of 525 lithic artifacts were collected during the 2014 field mission. The artifact raw material typology is presented in Table 1. Various rocks with volcanic origins (e.g., igneous and Tuff) make over 50% of the assemblage, while the other half is made on chert, sandstone, and siltstone. No outcrops of chert and tuff were seen in the area. In consideration of the size and curvature of the dorsal part of the pieces with cortex, river cobbles appear to have been the major sources for lithic raw materials. Because of the dispersed nature and very low density of the lithic scatters and taphonomic impacts to the area, all lithic materials were collected. Among collected artifacts, 56 pieces (close to 10%) show various amount of desert patination. The majority of the collected artifacts demonstrate signs of weathering, and only one piece represents evidence of water erosion.

**Table 1**
Chah-e Jam, raw material typology.

| Type | Number | Percentage |
|---|---|---|
| Chert | 95 | 18.1 |
| Tuff | 134 | 25.5 |
| Igneous | 146 | 27.8 |
| Sandstone | 96 | 18.3 |
| Siltstone | 54 | 10.3 |
| Total | 525 | 100.0 |

Table 2 demonstrates the overall classifications of the artifacts in four major categories of tools, debitages, core/core fragments, and debris. The artefact assemblage is mostly comprised of tools (42%) followed by debitage (33%). No particular preference was employed during the course of artefact collection and all lithic materials were collected, therefore the relative high frequency of tools is something needs to be considered. Among 222 pieces which were classified as tools, scrapers are the most abundant forms (almost 57%, Fig. 6), followed by retouched pieces (27%), and notches/denticulates (9%) (Table 3). Table 4 summarizes all classes of scrapers within tools collected from Chah-e Jam Paleolithic site.

**Table 2**
Chah-e Jam – lithic summary.

| Type | Number | Percentage |
|---|---|---|
| Tools | 221 | 42.1 |
| Debitage | 173 | 33.0 |
| Core/Core Frags | 78 | 14.9 |
| Debris | 53 | 10.1 |
| Total | 525 | 100.0 |

**Table 3**
Classification of tools.

| Type | Number | Percentage |
|---|---|---|
| Biface | 2 | 0.9 |
| Chopper | 1 | 0.5 |
| Scrapers | 126 | 57.0 |
| Knife | 1 | 0.5 |
| Notch/Denticulates | 20 | 9.0 |
| Dufour | 4 | 1.8 |
| Limace | 3 | 1.4 |
| Retouched Pieces | 60 | 27.1 |
| Carinated Pieces | 4 | 1.8 |
| Total | 221 | 100.0 |

**Table 4**
Classes of scrapers within tools collected from Chah-e Jam.

| Type | Number | Percentage |
|---|---|---|
| Side Scraper | 20 | 15.9 |
| Double Side Scraper | 9 | 7.1 |
| Carinated Scraper | 5 | 4.0 |
| Convergent Scraper | 73 | 57.9 |
| Transverse Scraper | 8 | 6.3 |
| End Scarper | 8 | 6.3 |
| Thumbnail Scarper | 3 | 2.4 |
| Total | 126 | 100.0 |

In case of knapping techniques, 284 pieces (64%) were made by Levallois technology, which is of some significance for developing a relative chronology for the site. The remaining elements of the lithic technology were concentrated on flake production (Table 5). Table 6 outlines some of the metric descriptions of the assemblage.

**Table 5**
Chah-e Jam blank types.

| Type | Number | Percentage |
|---|---|---|
| Flake | 323 | 82.0 |
| Blade | 39 | 9.9 |
| Bladelet | 32 | 8.1 |
| Total | 394 | 100.0 |

**Table 6**
Metric descriptions (mm).

| Type | Average length | Average width |
|---|---|---|
| Flake | 34.8 | 26.6 |
| Blade | 42.6 | 15.2 |
| Bladelet | 30.8 | 14.1 |
| Retouched pieces | 36.1 | 25.2 |

From 78 collected cores and core fragments, we are able to determine the core reduction technology of 61 pieces (Table 7). Flake and bladelet core/core fragments stand for the majority of the pieces (over 90%) (Fig. 7). Over half of the flake cores (14 pieces) are Levallois cores, of which the majority were made by recurrent bidirectional technique (close to 80%) and the rest with a centripetal method. In contrast to the blade and bladelet cores, these specimens lack evidence for pressure flaking.

**Table 7**
Core typology.

| Type | Number | Percentage |
|---|---|---|
| Flake core | 26 | 42.6 |
| Blade core | 3 | 4.9 |
| Bladelet core | 30 | 49.2 |
| Blade/let core | 2 | 3.3 |
| Total | 61 | 100.0 |

With regards to platform typologies, plain, prepared, and linear are the most abundant forms (Table 8). When debitage and retouched pieces were compared in their platform typologies, no substantial differences were observed except in two instances: retouched pieces show a higher frequency of prepared platforms (35.9% vs 20.8%) and on the other hand debitages demonstrate twice as great a frequency in linear platforms (20.2% vs 10.4%). It seems blanks selected for retouching exhibit greater preparation of platform surfaces than unretouched flakes, potentially suggested some connection between debitage and faconnage processes. Concerning the frequency of Levallois technique among debitages and retouched pieces, no significant difference was seen. However, retouched pieces demonstrate a slightly higher frequency (82% for the debitages and 89% for the retouched pieces).

**Table 8**
Chah-e Jam platform types.

| Type | Plain | | Prepared | | Cortical | | Lineal | | Crushed | | Dihedral | | Stepped | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| Debitages | 84 | 50.0 | 35 | 20.8 | 6 | 3.5 | 34 | 20.2 | 3 | 1.0 | 5 | 2.9 | 1 | 0.5 |
| Retouched Pieces | 79 | 41.1 | 69 | 35.9 | 13 | 6.7 | 20 | 10.4 | 3 | 1.5 | 7 | 3.6 | 1 | 0.5 |

The index of invasiveness proposed by Clarkson (2002) was used to establish patterns of retouch intensity. The majority of pieces (74%) demonstrate medium to low retouch, and only 26% have heavy retouch (Fig. 8). The amount of cortex on the dorsal part of the artifacts was divided to three classes of no cortex, less than 50% and more than 50%. The results imply that over 73% of the pieces show no signs of cortex on their dorsal parts. That observation might indicate access to the raw material and that the decortication process occurred somewhere off site.

## 6. Discussion and conclusions

A tentative relative chronology can be proposed based upon our assessment of lithic technology and tool typology of the selected pieces from Chah-e Jam lithic scatters. Firstly, the concentration on flake production, abundance of Levallois technology, Levallois cores, and high frequency of prepared platforms alongside the presence of some distinctive tool types, including Levallois points, convergent scrapers, and high proportions of notch/denticulates suggest the presence of Middle Paleolithic populations. In contrast, elements of Upper Paleolithic technologies may be represented by the presence of blade and bladelets, blade and bladelet cores, tools made on blade/lets. The distribution of artefacts within the site is not clearly separated by these tentative technological categorizations. That means the entire area might have been in use during different Paleolithic periods (Fig. 9). However such a claim demands more in depth geomorphological studies to shed light on the nature of site formation process. In addition, this dispersion along with scarcity of lithics throughout a vast area may be due to the aforementioned post-depositional processes; therefore, one should not categorize the Chah-e Jam lithic assemblage into *in situ* artifacts.

### *6.1. Comparison of Chah-e Jam with Mirak, Soofi-Abad and Delazian*

It has been proposed that the MP of the ICP might deviate from that of the Zagros Mountains (Vahdati Nasab et al., 2013). The most evident sign of such difference is the frequency of Levallois technologies in the ICP sites. Although presence of Levallois technologies in relative high frequency had been reported from a few MP sites in the Zagros (e.g., Dibble, 1984; Roustaei, 2010), generally the absence of such technology and abundance of various kinds of retouch on small size raw materials have been considered as main features of the Zagros MP (Hole and Flannery, 1967; Baumler and Speth, 1993). Unfortunately, because of a shortage of publications and old fashioned methods of excavation, not that much data exist in the case of the technological aspects of the Zagros MP sites (e.g., relative frequencies of blade, bladelets, etc). As a result, comparisons here focus on sites that have been recently introduced and their technological features published.

The technological characteristics of the ICP Middle Paleolithic (Chah-e Jam, Mirak, Soofi-Abad) are summarized in Table 9. In addition, Delazian, known for its UP components, was chosen as an outgroup to make the comparison even more cohesive. As illustrated in Fig. 10, Mirak and Chah-e Jam are highly comparable in a number of technological features (e.g., frequencies of flakes versus blades and bladelets). On the other hand, both of these sites deviate from Soofi-Abad and Delazian. The least resemblance is seen between Delazian versus Mirak and Chah-e Jam. A close similarity between Chah-e Jam and Mirak offers additional support for the proposed chronology of Chah-e Jam, as Mirak is already known for its MP materials (Vahdati Nasab et al., 2013). More in depth comparative analysis of diagnostic tools (e.g., points) between Mirak and Chah-e Jam might shed light on some aspects of settlement patterns in the northern part of the Iranian Central Desert during the MP and to show to what extent the inhabitants of these two regions, which are 100 km apart, belonged to the same population.

**Table 9**
Relative frequencies of major technological groups at Chah-e Jam, Mirak, Soofi-Abad, and Delazian.

| | Core[a] | Tools | Blades | Bld'lets | Flakes | Debris |
|---|---|---|---|---|---|---|
| **Sites** | | | | | | |
| Chah-e Jam | 14.9 | 42.1 | 9.9 | 8.1 | 82 | 10.1 |
| Mirak[b] | 4.2 | 49.3 | 4.9 | 6.8 | 88.3 | 15.3 |
| Soofi-Abad[c] | 6.6 | 22.1 | 9.2 | 7.2 | 54.3 | 28.7 |
| Delazian[d] | 15 | 7.9 | 13 | 22 | 44 | 13 |

[a] Cores and fragments.
[b] Compiled from Vahdati Nasab et al., 2013.
[c] Compiled from Vahdati Nasab and Feiz, 2014.
[d] Compiled from Vahdati Nasab and Clark, in press.

Due to the extensive dimensions of the site, the nature of sampling, and taphonomy, it is currently difficult to assess site function. However, the proliferation of points/convergent scarpers might suggest concentration on hunting activities at least during the MP period. Plotting data on the GIS maps indicates that it is not possible to associate any particular part of the surveyed area with some specific functions (e.g., decortication, knapping, butchering, retouching), as all types of tools and blanks were dispersed over the area with no particular clustering (Fig. 9).

With few exceptions, most of the Paleolithic archaeological surveys in the ICP have resulted in the discovery of substantially more MP sites compared to UP assemblages. The UP period has been well known for its glacial fluctuations. In absence of any direct paleoclimate data from the ICP, data derived from the adjacent areas such as Caspian Sea to the north and Neor Lake to the northwest might help to reconstruct the region's climate during the UP period. The deterioration of environmental conditions in the ICP from 32 ka onwards may explain the shortage of Upper Paleolithic occupations in the region.

The 2014 field mission provides further support for the significance of the northern edge of the Iranian Central Desert as a dispersal corridor during the Pleistocene (Vahdati Nasab et al., 2013). In addition, this field mission has clearly indicated the importance of playas and paleolakes as magnets for human

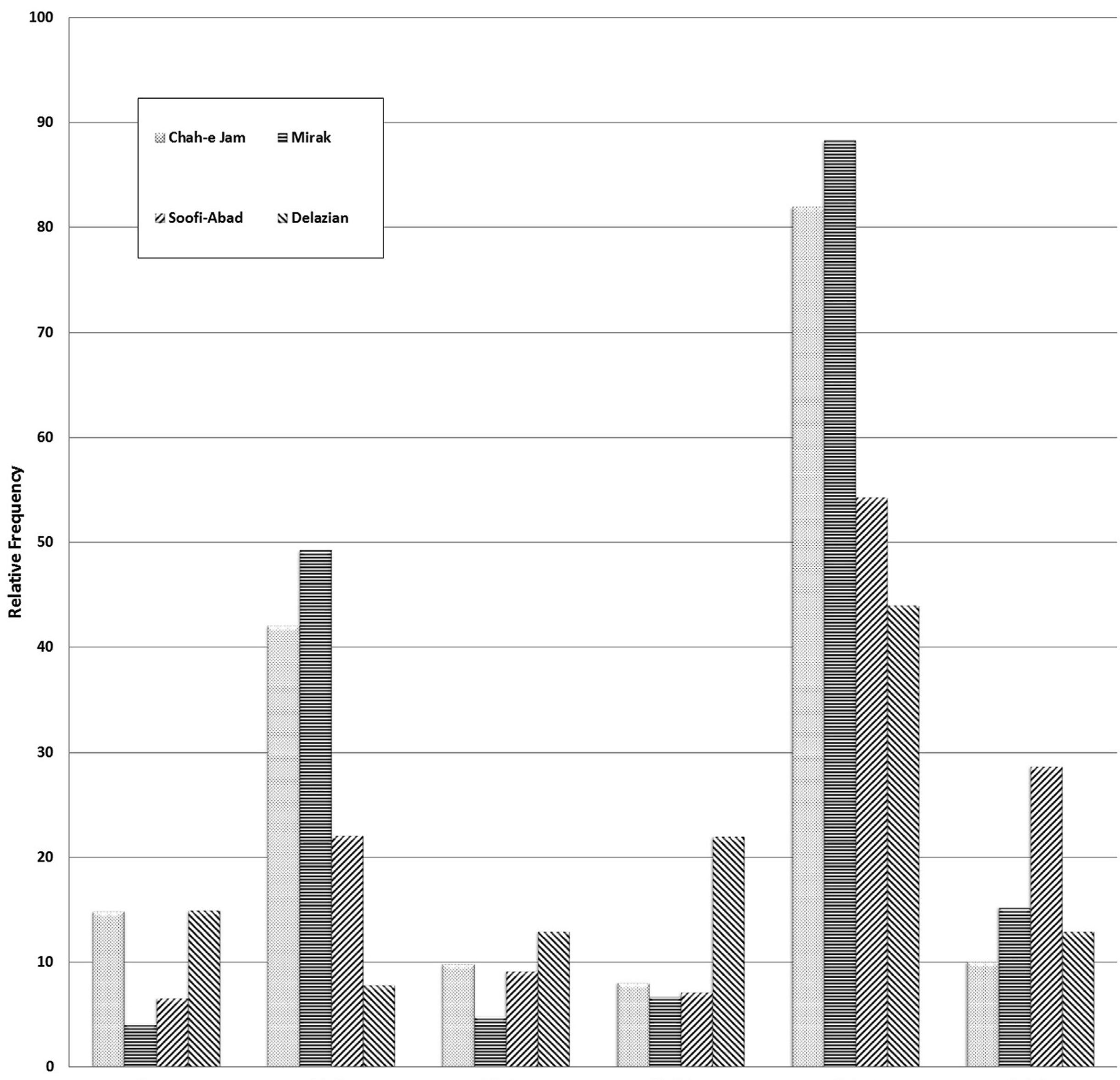


**Fig. 10.** Comparisons of major technological groups at Chah-e Jam, Mirak, Soofi-Abad, and Delazian.

settlements during the Pleistocene in this region. The northern edge of the Iranian Central Desert is a vast area, which demands years of field work. Aside from systematic surveys of the region, complementary research such as paleoclimate, sedimentology, raw material resources, and landscape archaeology must be done in order to make the surveying job comprehensive. The 4th season of the field work conducted by this project, involving excavating at Mirak Middle Paleolithic site, is currently underway. This field mission is trying to obtain sedimentological, paleoclimatic, archaeobotanical, faunal, and dating samples in order to reconstruct the climatic fluctuations through the Late Pleistocene period in the region.

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