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Test excavations and initial results at the Middle and Upper Paleolithic sites of Gilvaran, Kaldar, Ghamari caves and Gar Arjene Rockshelter, Khorramabad Valley, western Iran

Sondages et premiers résultats acquis sur les sites paléolithiques de la vallée de Khorramabad, Iran occidental : Gilvaran, Kaldar, Ghamari, Gar Arjeneh

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ABSTRACT

This paper introduces the excavations in several Paleolithic sites in the Khorramabad Valley, Western Iran. Apart from the two well-known sites of Ghamari Cave and Gar Arjene rock shelter, first excavated by Frank Hole and Kent Flannery in the 1960s, the Gilvaran and Kaldar caves were excavated for the first time. Here we present the stratigraphy of these sites, general data from the lithic assemblages, and the identifications of a small part of the faunal remains. Preliminary results are showing that all of the sites were occupied from the Middle and Upper Paleolithic onward, and therefore provide great potential for the study of the transition between these cultural periods. Our preliminary techno-typological observations show that the lower levels of the Gilvaran and Ghamari sequences may represent an early phase of the Middle Paleolithic.

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Mots clés :
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Abri d'Arjeneh
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RÉSUMÉ

Ce texte résume les résultats de fouilles paléolithiques menées par une équipe internationale dans différents sites de la vallée de Khorramabad, en Iran occidental. Les sites de Ghamari et Arjeneh ont, à l'origine, été fouillés par Frank Hole et Kent Flannery dans les années 1960. Ceux de Gilvaran et Kaldar ont été explorés pour la première fois par notre équipe. Nous présentons la stratigraphie ainsi que des données générales et les résultats quantitatifs obtenus pour l'essentiel des composantes lithiques ; l'identification préliminaire de la faune est aussi fournie. Ces résultats provisoires montrent que tous ces sites ont été occupés durant le Paléolithique moyen et supérieur. Ils fournissent ainsi un puissant potentiel pour l'analyse des processus de transition entre ces phases culturelles. Des échantillons ont été prélevés aux différents sites, afin d'y établir une séquence chronologique. Les études techniques et typologiques montrent que les phases anciennes de Gilvaran et de Ghamari appartiennent au Paléolithique moyen.

1. Introduction

Recent research in paleoanthropology underscores the importance of Southwest Asia for the evolution of hominins and their dispersal to other regions (Hughes et al., 2007; Martinón-Torres et al., 2007). Its geographic position as a crossroad between Africa, Europe and eastern Asia plays a strategic role in the understanding of the biological developments of different human lineages and of the spread of different knapping technologies (Bermúdez de Castro and Martinón-Torres, 2013). Consequently, SW Asia, including Iran, certainly played an important role in Paleolithic cultural development. However, the patchy distribution of archaeological evidence and the diverse local research traditions entail some differences within these territories. The Zagros Mountains are a key area to disentangle the events that mostly marked the archaeological record of the Late Pleistocene.

The spread of techno-complexes of blades/bladelets associated with Anatomically Modern Humans across Eurasia is documented at 45–40 kyr before present (Goring-Morris and Belfer-Cohen, 2003; Mellars, 2006). This technological innovation was accompanied by other cultural novelties such as portable art, graphic representations, musical instruments and bone projectiles (Bar-Yosef and Zilhão, 2006; Conard, 2003; Conard et al., 2009). In the same chronological interval, Neanderthals, who lived in an area that extended from the Iberian Peninsula to Siberia, suddenly disappeared. Several hypotheses have been advanced but the causes that led to the Neanderthal extinction are still debated (Lowe et al., 2012; Tzedakis et al., 2007; Valet and Valladas, 2010; Wolff and Greenwood, 2010). In this scenario, tracing where these blade/bladelets industries developed is crucial to figure out the patterns of dispersal of Anatomically Modern Humans, the possible interaction with Neanderthals and the causes of their disappearance.

In the central Zagros, several sites document the presence of blade/bladelet assemblages, the oldest one named Baradostian (Garrod, 1937) and a younger one indicated as Zagros Aurignacian (Olszewski and Dibble, 1994, 2006). Some stone tools (Gar Arjeneh points, rectilinear and curved bladelets with inverse retouch) were found in these lithic assemblages, that resemble elements of the typical toolkits of the European Proto-Aurignacian and Aurignacian such as Font-Yves and Krems points, and Dufour bladelets (Tsanova, 2013). Few dates are available for these sites but the recent radiocarbon dating of charcoals from Yafte Cave (Iran) reveals that the Baradostian levels predate the chronological range of the Levantine Aurignacian, predate and overlap with some Early Ahmarian dates, and are contemporaneous with assemblages of the northern Caucasus (Otte et al., 2011). These results place the Iranian Late Paleolithic in an intermediate chronological position between the Levant Ahmarian and the Kozarnikien (Tsanova et al., 2012), suggesting its possible role as a source for the development of the Aurignacian culture (Otte and Kozłowski, 2004; Otte et al., 2012).

The Khorammabad Valley is a narrow passage connecting the northern highlands with the southern lowlands of Khuzistan and constitutes one of the important passageways for both humans and animals to cross the Zagros mountain range. The presence of numerous caves and rock shelters, springs and rivers and the Pleistocene paleoenvironment seem to have been favorable for human settlement in the area. As a consequence, the Khorramabad Valley likely played a significant role in human adaptation and dispersal during the Quaternary. However, there are only a few studies that deal with the sites in this area (Baumler and Speth, 1993; Field, 1951a, 1951b; Hole and Flannery, 1967; Otte and Kozlowski, 2007; Otte et al., 2007, 2011; Roustaei et al., 2002, 2004; Shidrang, 2007; Speth, 1971; Tsanova, 2013; as well as a reassessment paper on the Hole and Flannery report: Vahdati Nasab, 2010).

In this paper we are presenting preliminary results of the archaeological excavations at four Paleolithic sites in the Khorramabad Valley (Western Iran) (Fig. 1) of which the well-known sites of Ghamari cave and Gar Arjeneh rock shelter were excavated after Hole and Flannery's excavation in 1960s, while the Gilvaran and Kaldar caves were excavated for the first time. In all these sites, Middle and Upper Paleolithic human occupations were documented, adding new data to this important period of human evolution.

A general summary of the findings in the 4 excavated sites (Table 1), and detailed quantification results of the

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Table 1
Summary of the archaeological materials recovered in the 2011–2012 seasons at the Khorramabad Valley sites.
Tableau 1
Résumé du matériel archéologique découvert en 2011–2012.

Site	Lithic remains	Faunal remains
Gilvaran (GLV-AY1)	5391	2740
Gilvaran (GLV-A8)	1818	871
Kaldar (KLD)	1394	1296
Ghamari (GHM)	1106	1475
Gar Arjeneh (GRA)	566	698
Total	**10,275**	**7080**

levels attributed to Middle and Upper Paleolithic in 3 of these localities are shown in the Tables 2 and 3. The results comprise two sections. The first section presents the four sites, making special reference to the main stratigraphic issues and to the lithic assemblages. The second is dedicated to the paleontology: it gives detailed descriptions in the Supplementary Online Materials (SOM), gives the faunal lists and briefly discusses some biogeographic aspects.

2. The archaeological sites

2.1. Gilvaran Cave

The cave is situated in the northwestern part of the Khorramabad Valley and located in 48°:18′:56″E longitude, 32°:28′:12″N latitude, and about 1225 m a.s.l (SOM Fig. 1A and E). It is 16 m long, 17 m wide and 7 m high. In 2002, the cave was officially included with record number 5971 into the Lorestan Cultural Heritage, Handicraft and Tourism Organization (LCHTO) archive as an Upper Paleolithic site by A. Parviz. The site has been visited twice; by an Iranian team in 2002 and by international team in 2004, both lead by K. Roustaei. They have systematically carried out surface collection on this locality. "Twenty-one collections ranging in size from a single artifact (Dozaleh II rock shelter, region 3) to 357 pieces (Gilvaran I, region 1) were recovered" (Roustaei et al., 2004, p. 7).

We explored the sediment fill of this cave with two test-pits of 2 × 2 m named AY1 and A8. AY1 is situated at the southern side of the cave opening at about 20 m

Table 2
Quantification results of the lithics attributed to Middle Paleolithic levels of the three excavated sites in the 2011–2012 seasons at the Khorramabad Valley.
Tableau 2
Résultats de la quantification des industries lithiques des trois sites fouillés au cours des années 2011–2012 dans la vallée de Khorramabad, attribués aux niveaux du Paléolithique moyen.

	GLV-AY1-Level 5		GLV-A8-Level 3		KLD-Level 5		GHM-Level 5	
	n	%	*n*	%	*n*	%	*n*	%
Cortical piece	101	*4.0*	162	*11.3*	6	*5*	27	*12.1*
Levallois flake	66	*2.6*	66	*4.6*	8	*6.6*	28	*12.5*
Levallois blade	11	*0.4*	12	*0.8*	4	*3.3*	4	*1.8*
Levallois point	48	*1.9*	15	*1.1*	9	*7.4*	16	*7.1*
Levallois core	7	*0.3*	7	*0.5*	1	*0.8*	–	–
Other types of core	4	*0.2*	1	*0.0*	3	*2.5*	–	–
Retouched tool	227	*9*	119	*8.3*	42	*34.7*	68	*30.4*
Flake byproducts	1894	*75.1*	N/A	*N/A*	16	*13.2*	63	*28.1*
Debris	149	*5.9*	211	*14.7*	31	*25.7*	18	*8*
Hammerstone	14	*0.6*	9	*0.6*	1	*0.8*	–	–
Total	2521	*100*	1428	*N/A*	121	*100*	224	*100*

Due to the hybridity caused by fallen rocks in level 3 of A8 trench of Gilvaran, distinguishing Levallois and blade byproducts was not possible, therefore in this case and in this trench, we presented exceptionally the same total numbers for the GLV-A8-Level 3 in the Tables 2 and 3. The sign "N/A" here means "data not applicable".
The total numbers given for "Retouched tool" in the Tables 2 and 3 for all the sites excluded other retouched tools such as retouched Levallois points, Levallois flakes, etc.

Table 3
Quantification results of the lithics attributed to Upper Paleolithic levels of three of the excavated sites in the 2011–2012 seasons at the Khorramabad Valley.
Tableau 3
Résultats de la quantification des industries lithiques des trois sites fouillés au cours des années 2011–2012 dans la vallée de Khorramabad, attribués aux niveaux du Paléolithique supérieur.

	GLV-AY1-Level 4		GLV-A8-Level 3		KLD-Level 4		GHM-Level 4	
	n	%	*n*	%	*n*	%	*n*	%
Cortical piece	43	*3.8*	–	–	2	*0.3*	6	*4.2*
Blade	196	*17.5*	88	*6.2*	92	*16.4*	27	*18.9*
Bladelet	180	*16.0*	73	*5.1*	89	*15.8*	17	*11.9*
Blade core	7	*0.6*	3	*0.2*	1	*0.2*	–	–
Bladelet core	3	*0.3*	1	*0.1*	1	*0.2*	–	–
Retouched tools	146	*13*	–	–	11	*1.9*	33	*23.1*
Other type of core	2	*0.2*	–	–	1	*0.2*	–	–
Blade byproducts	365	*32.6*	N/A	*N/A*	312	*55.6*	46	*32.1*
Debris	179	*16.0*	–	–	53	*9.4*	14	*9.8*
Hammerstone	–	–	–	–	–	–	–	–
Total	1121	*100*	1428	*N/A*	562	*100*	143	*100*

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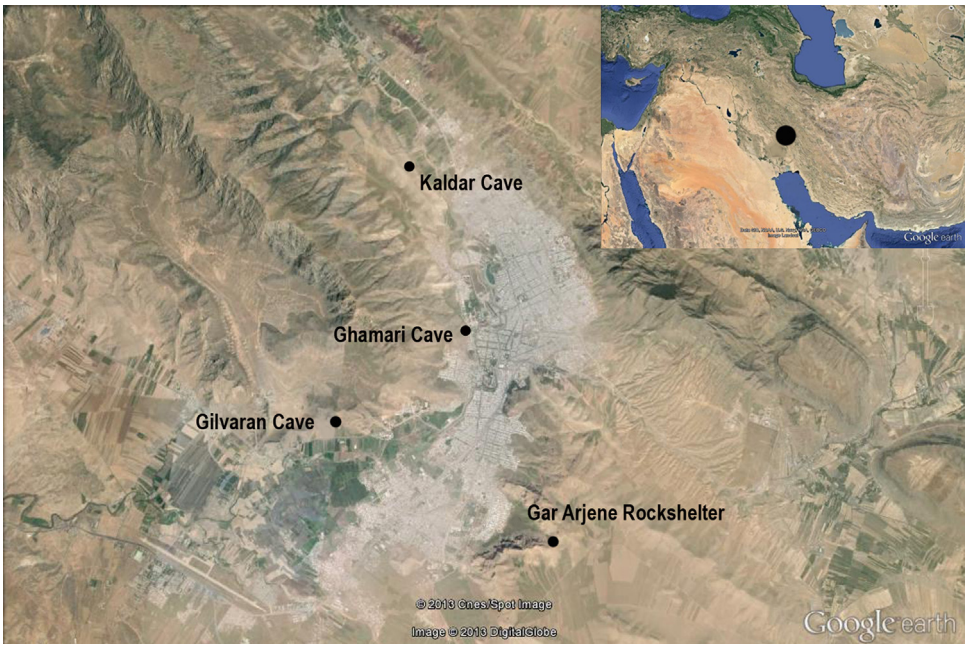

Fig. 1. (Color online). The geographic position of the Khorramabad Valley and the position of the localities indicated on an aerial photograph.
Fig. 1. (Couleur en ligne). Position géographique de la vallée de Khorramabad et localités indiquées sur la photo aérienne.

from the drip line (SOM Fig. 1 D). A8 was dug again at the southern side of the cave opening at about 4 m from the drip line (SOM Fig. 1B). Samples for contextual studies, including sedimentology paleontology paleoenvironment (pollen, charcoal, seeds, and land snails) and dating (OSL tubes and charcoal) were systematically collected (Fig. 2).

Test-pit AY1 exposed a 4.8 m section of the sedimentary deposit and is characterized by 5 main levels (Fig. 3B). Level 1 consists of ashy sediment with a blackish green color with angular stones. It has a thickness that varies from 5 to 20 cm. This is the most recent level and it contains an assemblage of Islamic materials. Level 2 consists of sediment with a fine light gray color and with few angular stones. It varies in thickness from 28 to 84 cm and it includes a Historical and Bronze Age record. Level 3 consists of grey coarse sandy sediment, that varies from 60 to 110 cm in thickness and which has mixed Chalcolithic and Neolithic potsherds and lithic industries. Level 4 consists of dark gray sediment with a large number of limestone blocks of different sizes and varies from 39 to 62 cm in thickness. It contains an Upper Paleolithic assemblage. Level 5 is a reddish brown deposit with many large limestone blocks. It increases in depth from the northern towards the southern section, varying from 2.45 to 2.85 m in thickness. It includes two sub-levels that have no difference in color. Middle Paleolithic industry is found in sub-level 1, and mixed Middle and early Upper Paleolithic/Baradostian industries in sub-level 2 (Fig. 4A1 and A2 and SOM Fig. A1 and A2).

Test-pit A8 showed a sequence of 1.5 m of sedimentary deposit, in which three levels could be recognized, (Fig. 3A) and overlying a layer of heavy rocks, deposited due to the collapse of the entry of the cave (SOM Fig. 1C). Level 1 consists of ashy blackish green sediments with a

Fig. 2. (Color online). Collection of sediment samples at Gilvaran Cave.
Fig. 2. (Couleur en ligne). Récoltes d'échantillons sédimentaires à Gilvaran.

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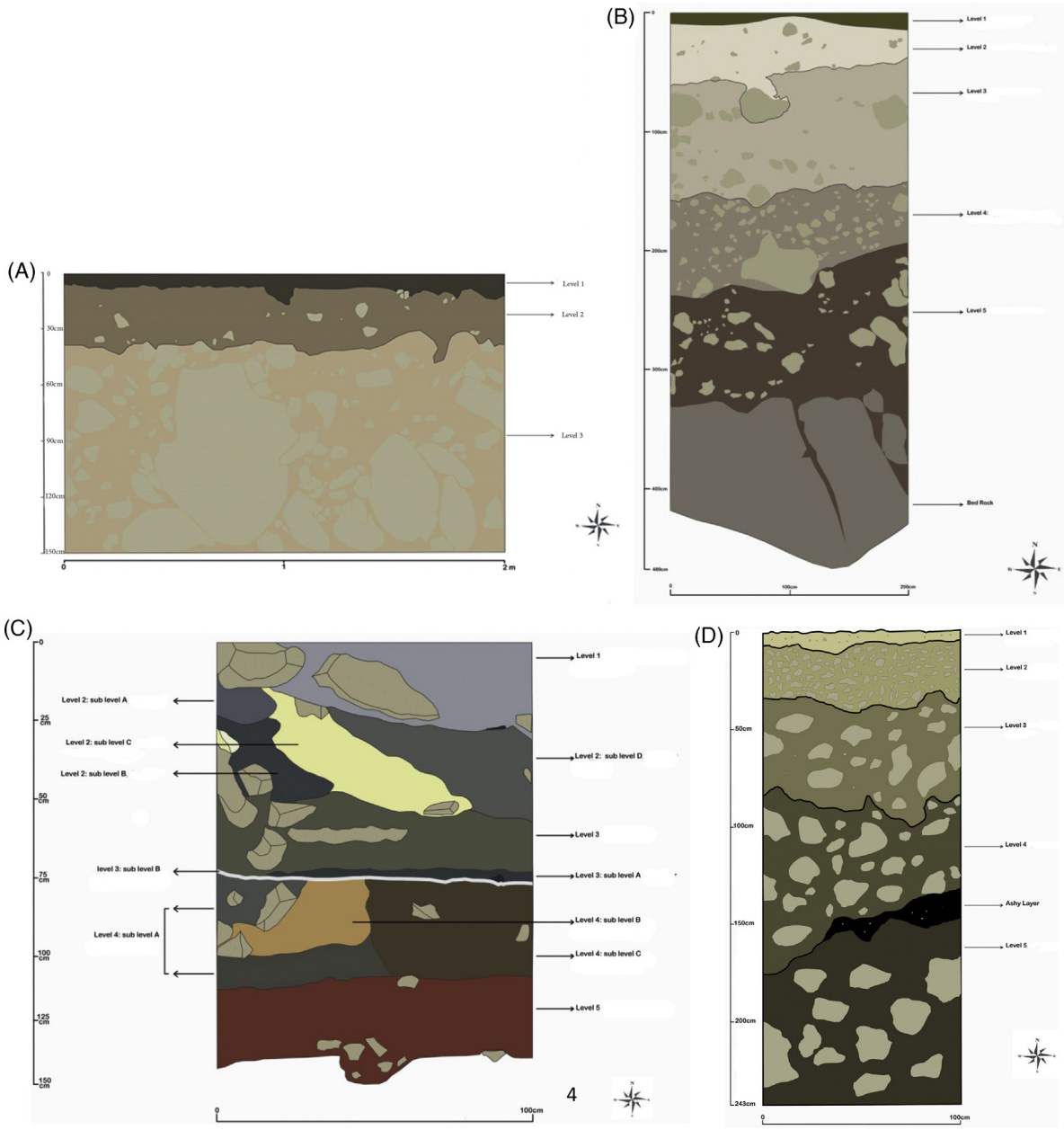


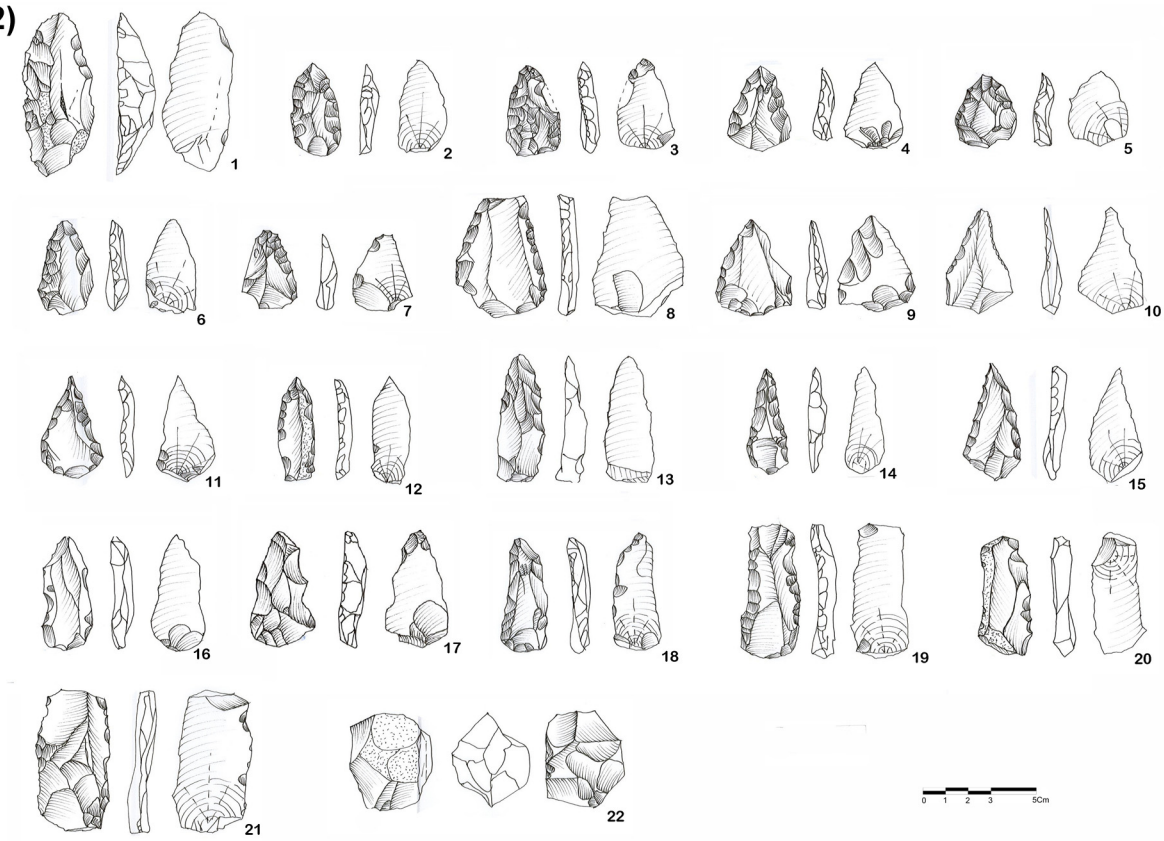
Fig. 3. (Color online). A. Gilvaran = Stratigraphy of the northern section of trench A8. B. Stratigraphy of the northern section of trench AY1. C. Kaldar = northern section of the D4 test-pit and detailed stratigraphy. D. Ghamari = the F2 (detailed stratigraphy).
Fig. 3. (Couleur en ligne). A. Gilvaran = Stratigraphie du côté nord de la tranchée A8. B. Stratigraphie du côté nord de la tranchée AY1. C. Kaldar = section nord du sondage D4 et stratigraphie détaillée. D. Ghamari = sondage F2, stratigraphie détaillée.

thickness varying from 5 to 10 cm and includes a superficial layer with Historical and Islamic materials. Level 2 consists of dark gray sediment with a few limestone blocks and has a thickness from 19 to 30 cm. It includes a unit of mixed Neolithic, Chalcolithic and Bronze Age. Level 3 consists of light gray sediment with a large number of angular limestone blocks and has a thickness from 31 to 150 cm. It contains a unit of mixed Middle and Upper Paleolithic (SOM Fig. 6A1 and A2).

The important assemblage of Mousterian industry from level 5 stands out in this sequence. In the lower part of sub-level 1 in level 5, a variety of Mousterian points and flakes, made with Levallois technique is present in large numbers. By contrast, in sub-level 2, we have observed both the Middle and Early Upper Paleolithic/Baradostian industry that seems to be mixed due to the variation in the depths. The most common retouched tool types in this level are different kind of points, side-scrapers, déjeté

(A1)

(A2)



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scrapers, double-scrapers and other tools that do not fit to any known standard (some of them fractured).

Among the points, a wide variety of types has been identified, including Levallois points, Mousterian, limaces and Tayac points, unmodified and asymmetrical pointed flakes, resulting from unidirectional reduction, with different kinds of platform preparations (retouched, flat, dihedral, faceted, cortical). This variety makes Gilvaran somewhat different from the other localities in the Khorramabad Valley. The side-scrapers are mostly produced on core-edge flakes.

In the AY1 and A8 trenches, we recovered a total of 23 hammer stones showing discrete patches of pitting and crushing, reflecting that hard hammer percussion took place on the site (SOM Fig. 7). The principal knapping methods identified are Levallois recurrent centripetal and discoid as described by (Boëda, 1993, 1994). Retouched artifacts in the Upper Paleolithic industry in both AY1 (level 4) and A8 (level 3) are dominated by different types of flakes, blades and bladelets.

At the bottom of the Upper Paleolithic levels of both the trenches, tools are found that show some general characteristics of early Upper Paleolithic/Baradostian industry, such as long blades and bladelets, side-scrapers, end-scrapers (mostly fractured) and composite/multifunctional tools with step retouches, different types of pointed flakes along with bladelet cores. Unfortunately, in this level most of the cores are covered with heavy concretion.

As a consequence, in level 5 of Gilvaran cave, two distinct sub-levels have been recognized. The lower one contains many elongated flakes, produced by hard hammer on facetted platform, which subsequently were retouched or pointed. The upper sub-level contains elongated blades obtained with soft hammer, very clearly made with an Upper Paleolithic technology. These blades have been transformed into burins, scrapers with bilateral retouches. Some points made on bladelets are the so-called "Arjeneh" type. Also one carenated scraper was recovered. The upper part of the level 5 belongs to the Zagros Aurignacian, as it has been found in Yafteh and in many other sites in Iran (Otte and Kozlowski, 2007).

Hence, Gilvaran Cave is a promising site located in a suitable part of Khorramabad Valley, in particular for the study of technological variability and its potentiality for Middle to the early Upper Paleolithic transition.

2.2. Kaldar Cave

This cave is situated north of Khorramabad valley at 48°:17′:35″E longitude, 33°:33°:25N latitude and 1290 meters a.s.l (SOM Fig. 2 A, B and C). It is 16 m long, 17 m wide and 7 m high. In 2007, Z. Bakhtiari realized the archaeological importance of this cave. He recorded it with the file number 18796 in the LCHTO archive as an Epipaleolithic site. This site is located in the "Wild Life Century" zone, where it is protected from illegal excavation, which is a common problem in almost all Khorramabad localities. However, the cultural deposit in this case is very well preserved.

The fill of the cave was investigated with a test-pit of $1 \times 1\,m^2$ at the center inside the cave very close to the drip and reveals in 1.5 m a stratigraphic succession of five levels and six sub-levels (Fig. 3C). Level 1 consists of fine light gray sediment with large angular limestone blocks. This level has a thickness varying from 12 to 28 cm and it contains mixed Islamic, Historical and Chalcolithic materials. Level 2 consists of 4 sub-levels varying from colors (white, gray, bluish gray and dark bluish gray) with several angular blocks and a thickness from 37 to 42 cm. The cultural remains in this level includes: Sub-level A and B ashy layer, sub-level C Neolithic with typical potteries, sub-level D Pre-pottery Neolithic. Level 3: Contain three sub-levels resulting from fire activities with some flat and irregular limestone blocks with a thick ashy color and very thin bluish gray and lime color and soft sediment varying in a thickness from 19 to 24 cm with presence of different fractured flints showing Epipaleolithic characteristics.

Level 4 consists of 3 sub-levels in dark brown, cream and bluish gray tense sediments, angular blocks. Its thickness varies from 30 to 35 cm. Its archaeological content shows Upper Paleolithic features. Level 5 consists of hard sandy reddish brown sediment with few small irregular blocks and has a thickness that varies from 30 to 35 cm. It contains a Middle Paleolithic assemblage, but at the top some blade technology appears, which might correspond to an early Upper Paleolithic phase.

Fig. 4. (Color on line). A1 and A2. Selected artifacts from Gilvaran GLV-AY1 trench, level 5 and 4: (same as picture above). 1: Limace, 2: Mousterian point with retouched platform, 3: Mousterian point with retouched platform and a fracture on its distal portion, 4: Mousterian point on Levallois flake with two convergent negatives and faceted platform, 5: déjeté scraper or Mousterian point, 6: Mousterian point with dihedral platform, 7: fragmented Mousterian point on Levallois flake, 8: point with direct flat retouches on the left side and three inverse notches on the right side, 9: Levallois point, concretion covers the platform, 10: déjeté scraper, 11: elongated Mousterian point with cortical platform, 12: elongated Mousterian point with flat platform, 13: elongated Mousterian point with dihedral platform, 14: déjeté scraper, 15: Mousterian point with retouched platform, 16 and 17: Tayac points, 18: double scraper on Levallois recurrent unidirectional blank, 19: déjeté scraper, 20: side-scraper with cortical platform on semi-cortical natural core-edge flake, 21: Levallois recurrent unidirectional blade with flat platform and pseudo-retouches on both sides, 22: polyhedral core.

Fig. 4. (Couleur en ligne). A1 et A2. Artefacts sélectionnés de la tranchée de Gilvaran GLV-AY1, niveau 5 et 4 (les mêmes que sur la planche précédente). 1 : « Limace », 2 : pointe moustérienne avec talon retouché, 3 : pointe moustérienne avec talon retouché et partie distale fracturée, 4 : pointe moustérienne sur éclat Levallois avec deux négatifs convergents et talon facetté, 5 : racloir déjeté ou pointe moustérienne, 6 : pointe moustérienne avec talon dièdre, 7 : fragment de pointe moustérienne sur éclat Levallois, 8 : pointe avec retouches plates directes latérales et reprise inverse, 9 : pointe Levallois, talon concrétionné, 10 : racloir déjeté, 11 : pointe moustérienne allongée avec talon cortical, 12 : pointe moustérienne allongée avec talon lisse, 13 : pointe moustérienne allongée avec talon dièdre, 14 : racloir déjeté, 15 : pointe moustérienne avec plateforme retouchée, 16 et 17 : pointes de Tayac, 18 : racloir double sur éclat Levallois, 19: déjeté *scraper*, 20 : racloir latéral avec talon cortical, 21 : lame Levallois à talon lisse et pseudo-retouches sur les deux bords, 22 : nucléus polyédrique.

Drawings by Laxmi Tumung.

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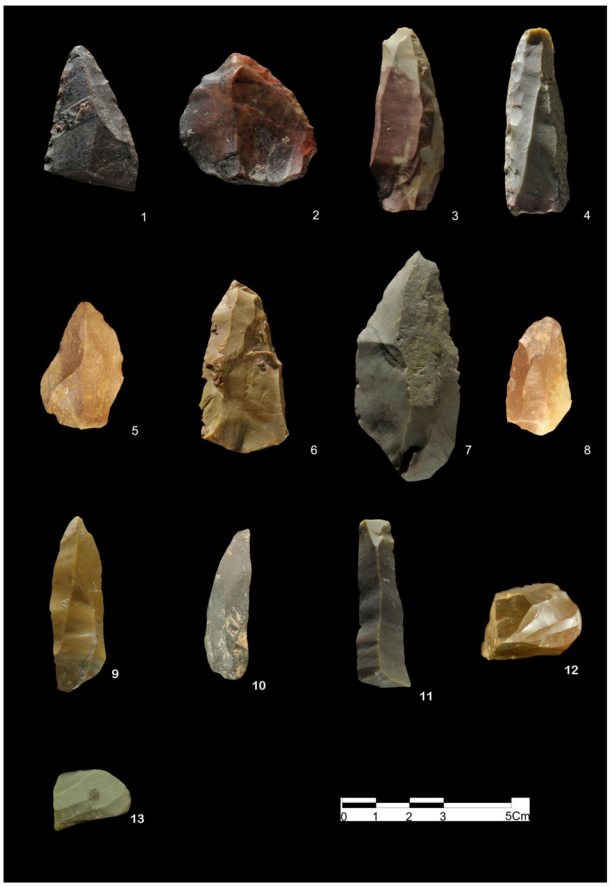

(A2)

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As in Gilvaran Cave, tools were made from different kinds of pebbles, easily available from the Robat River, which is very close to the site. In level 5, there are different types of points (mostly Mousterian and Levallois) along with pointed blades (with early Upper Paleolithic characteristics) and pointed flakes are the dominant tools, followed by side-scrapers. In level 4, flakes, blades and bladelets, polyhedral and bladelet cores along with twisted bladelets are present. As mentioned above, it was believed that the site was occupied only during the Epipaleolithic. However, the recovery in our excavation in levels 4 and 5 of many Mousterian and Upper Paleolithic tools such as points (Fig. 5A1 and A2), side- scrapers and many retouched flakes, indicates that the site was also occupied in Upper and Middle Paleolithic times.

Like Gilvaran, Kaldar Cave also is a promising site for studying the possible transition from the Middle to the early Upper Paleolithic.

2.3. Ghamari Cave

This site is located in 48°:20′:56″E longitude, 33°:29°:31N latitude and 1305 m a.s.l (SOM Fig. 3A to 3C). The fill of the cave was explored with a test-pit $1 \times 1\,m^2$ and five levels were recognized in the 2.45 m of sedimentary sequence (Fig. 3D). Level 1 consists of superficial fine cream-colored sediment with a few Islamic potsherds and a thickness varying from 4 to 9 cm. Level 2 consists of yellowish grey sediment, containing a large number of historical and Bronze Age potsherds and has a thickness varying from 25 to 40 cm. Level 3 consists of a soft and light grey color sediment with limestone blocks of different sizes varying from 45 to 70 cm and a mixed Chalcolithic and Neolithic assemblage with a few flint remains. Level 4 consists of sandy sediment with mixed grey ashy and lime color in the upper part and a black color in the lower part, which clearly results from fire activities. This level contains several limestone blocks of different sizes and is covered by concretions with a kind of heavy lime color. It contains Upper Paleolithic industry, and has a thickness from 50 to 85 cm. Level 5 consists of dark grey sediment with several large and heavy limestone blocks. It has a thickness varying from 60 to 94 cm and contains a Middle Paleolithic assemblage.

The excavation did not reach to the bedrock due to difficulties of the lighting system and high elevation. The real extent of the sedimentary sequence will be investigated in the next field work. A large number of faunal remains and some lithics were recovered from the test-pit. As a consequence, we recovered only a small number of lithics. These have the general characteristics of Upper Paleolithic industry. The Middle Paleolithic industry from level 5 stands out notably in this sequence, especially for the presence of Levallois byproducts, *limace* points and side-scrapers (Fig. 6A1 and A2). The low number of cores in Ghamari Cave could be related to the position of the test-pit further inside the cave or due to the small part investigated. In level 4, fractured retouched and not modified blades, pointed flakes, and side-scrapers are present, as well as byproducts of flaking sequences.

2.4. Gar Arjeneh Rock Shelter

It is located in 48°:20′:21″E longitude, 33°:26′:30N latitude and 1205 m a.s.l (SOM Fig. 4 A, B and C). The locality was excavated by Hole and Flannery in 1967 with some problems for tracking the stratigraphy because the deposit was too disturbed. Their notes indicate that the deposit had been badly disturbed by intrusive porcupine burrows and tools were cataloged by type and not by stratigraphic level (Petraglia and Potts, 2004). Although two 1×1 m test-pits were opened in different parts of the site, the deposit shows stratigraphic problems and no clear evidences for cultural interpretations.

Despite these problems, the analysis of the lithic assemblage documented high percentages of side-scrapers and retouched bladelets (Fig. 7A1 and A2), rather than the known Arjeneh points which certainly reflect the high degradation of the deposit. Further fieldwork is needed to give more information about the cultural sequences and the stratigraphy.

3. Paleontology

A small collection of the fossils from the excavations in the Khorramabad Valley was taken to Tarragona and has been studied in detail. Some of these specimens are illustrated in Fig. 8. Detailed descriptions, comparisons and taxonomic discussions are given as Supplementary Online Materials. The list of identified animal species is given below:

Crustacea indet.: Kaldar Cave
Erinaceidae indet.: Ghamari Cave
Chiroptera indet.: Ghamari Cave
Leporidae? indet.: Kaldar Cave

Fig. 5. (Color on line). A1 and A2. Selected artifacts from Kaldar KLD level 5 and 4. 1: Distal portion of a fragmented Mousterian point on a Levallois blank, 2: point on a Levallois flake with dihedral platform, 3: Levallois point with flat platform, recurrent unidirectional convergent, 4: side-scraper on cortical blade with faceted platform and unidirectional convergent negatives, 5: predetermining Levallois flake with four convergent negatives, flat platform, 6: Levallois point on core-edge flake with flat platform, 7: semi-cortical flake with flat platform and presence of unidirectional negatives, 8: Levallois point with dihedral platform obtained by the recurrent unidirectional modality, 9: pointed flake on Levallois core, 10: twisted bladelet with flat platform, 11: flake of re-shaping the knapping surface, 12: bladelet core, 13: fragmented bladelet core with four negatives.

Fig. 5. (Couleur en ligne). A1 et A2. Sélection d'artefacts de la grotte KLD, niveau 5 et 4. 1 : partie distale d'une pointe moustérienne sur éclat Levallois, 2 : pointe sur éclat Levallois â talon dièdre, 3 : pointe Levallois à talon lisse, récurrent unidirectionnel convergent, 4 : racloir sur lame corticale avec talon facetté et négatifs unidirectionnels convergents, 5 : éclat Levallois prédéterminé avec quatre négatifs convergents, talon lisse, 6 : pointe Levallois sur éclat débordant avec talon lisse, 7 : éclat semi-cortical avec talon lisse et négatifs unidirectionnels, 8 : pointe Levallois à talon dièdre obtenu par la modalité récurrente unidirectionnelle, 9 : pointe Levallois, 10 : lamelle torse avec talon lisse, 11 : éclat de réaménagement, 12 : nucléus à lamelles, 13 : nucléus à lamelles fragmenté, avec quatre négatifs.

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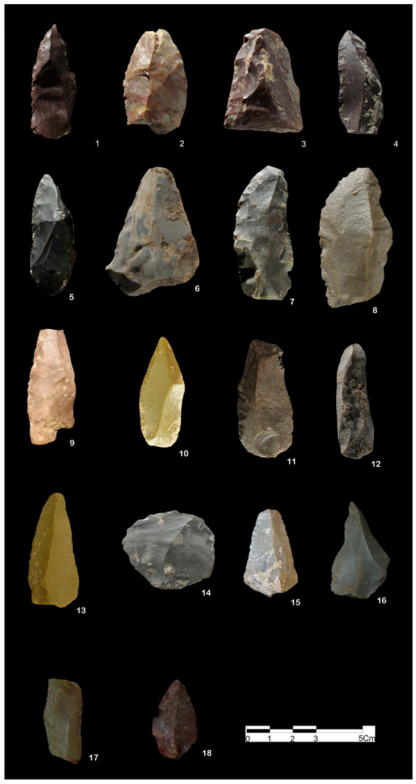
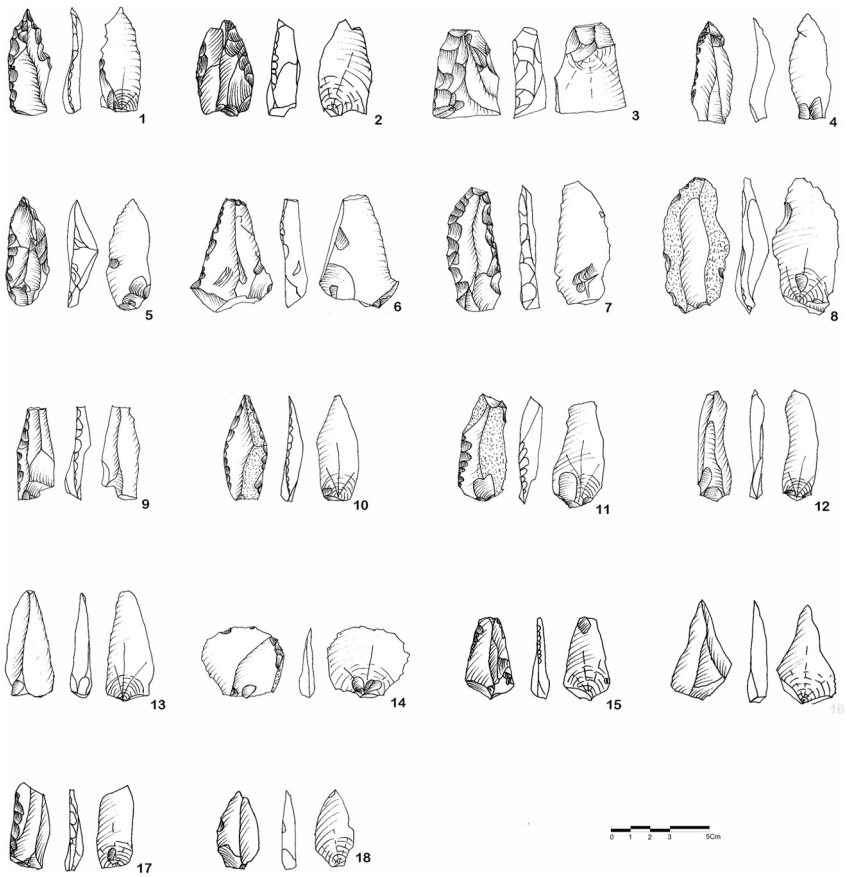
(A1)



(A2)



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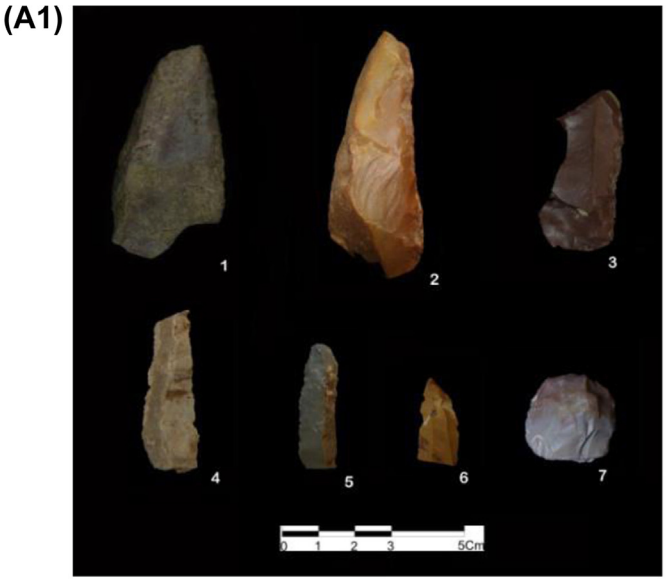

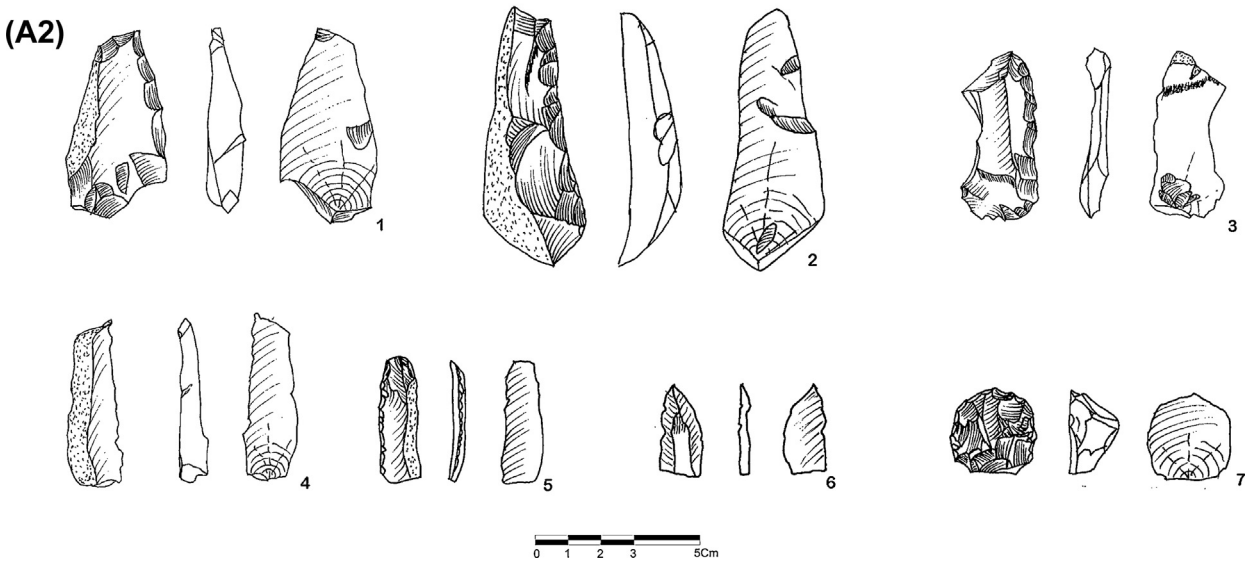

Fig. 7. (Color online). A1 and A2. Selected artifacts from Gar Arjeneh Rock Shelter. 1 and 2: Side-scraper on cortical flake with flat platform, 3: Fractured side-scraper with dihedral platform, 4: cortical blade, 5: fractured retouched bladelet, 6: pointed fractured bladelet, 7: discoid core.
Fig. 7. (Couleur en ligne). A1 et A2. Sélection d'artefacts de l'abri Gar Arjeneh. 1 et 2 : racloir cortical avec talon lisse, 3 : racloir fragmenté avec talon dièdre, 4 : lame corticale, 5 : lamelle retouchée fragmentée, 6 : lamelle appointée, 7 : nucléus discoïde.

Fig. 6. (Color online). A1 and A2. Selected artifacts from Ghamari Cave level 5 and 4: 1: Mousterian point on a Levallois flake with faceted platform, 2: Mousterian point with a flat platform and distal fracture, 3: Mousterian point on a Levallois unidirectional convergent flake, 4: Mousterian point with flat platform and distal fracture, 5: limace, 6: side-scraper on core-edge flake, 7: side-scraper with flat platform, 8: semi- cortical flake with flat platform, pseudo retouch on both sides, three unidirectional negatives, 9: fragmented side-scraper with flat platform, 10: side-scraper on cortical flake with flat platform, one parallel unidirectional extraction and open internal flaking angle, 11: side-scraper on cortical flake with flat platform, 12 and 13: Levallois point with dihedral platform, 14: Levallois flake with faceted platform, 15: fractured pointed flake with dihedral platform and pseudo retouch on the left side, 16: fractured overshot pointed flake, 17: fractured side-scraper with flat platform, 18: fractured pointed flake.
Fig. 6. (Couleur en ligne). A1 et A2. Sélection d'artefacts de la grotte Ghamari, niveaux 5 et 4. 1 : pointe moustérienne à talon facetté, 2 : pointe moustérienne à talon lisse, fracturée, 3 : pointe moustérienne sur éclat Levallois unidirectionnel convergent, 4 : pointe moustérienne à talon lisse, fracturée, 5 : « limace », 6 : racloir sur éclat débordant, 7 : racloir à talon lisse, 8 : éclat cortical à talon lisse avec pseudo-retouches et trois négatifs unidirectionnels, 9 : racloir fragmenté avec talon lisse, 10 : racloir cortical, avec un négatif parallèle unidirectionnel, 11 : racloir cortical à talon lisse, 12 et 13 : pointes Levallois à talon dièdre, 14 : éclat Levallois à talon facetté, 15 : éclat appointé fragmenté à talon dièdre et pseudo-retouches sur le côté gauche, 16 : éclat appointé fragmenté, 17 : racloir fragmenté avec talon lisse, 18 : éclat appointé fragmenté.

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Fig. 8. (Color online). 1: KLD-DS-5 + KLD-1—right lower canine of a male *Sus scrofa* from Kaldar Cave; lingual view; 2: GLV-A1-17-enamel fragment of a cheek tooth of a rhinoceros (?) from Gilvaran Cave; (a) buccal view, and (b) section; 3: KLD-11 – tip of the tine of an antler of Cervidae indet. cf. *Cervus elaphus*; (a) anterior/posterior, (b) lateral/medial, (c) anterior/posterior, and (d) lateral/medial views, and (e) section; 4: GLV-A8-103—fragment of a lumbar vertebra of Cervidae indet. cf. *Cervus elaphus* from Gilvaran Cave; posterior view; 5: KLD-9—fragment of the pincer of a crab from Kaldar Cave; (a) distal section, (b) mesial view, (c) occlusal view, (d) lateral view, (e) inferior (?) view, and (f) proximal section; 6: GHM-F2-8—right P2 of Bovini indet. from Ghamari Cave; (a) occlusal, (b) buccal, and (c) lingual views; 7: KLD-14—first phalanx right of the axis of the hand (?) of *Capreolus* from Kaldar Cave; (a) distal, (b) proximal, (c) axial, (d) dorsal, (e) abaxial, and (f) plantar views. 8: GHM-F2-22 – axis of *Hystrix* from Ghamari; (a) anterior, (b) posterior, (c) right, (d) dorsal, and (e) ventral views; 9: KLD-10 – left M1/2 (M1?) of *Capra* from Kaldar Cave; (a) buccal, (b) occlusal, and (c) lingual views. The scale bars represent 1.5 cm for photographs 2 and 5 and represents 3 cm for the remaining photographs.

Fig. 8. (Couleur en ligne). 1 : KLD-DS-5 + KLD-1, niveau 4–canine inférieure droite d'un mâle *Sus scrofa* de la grotte Kaldar ; vue linguale ; 2 : GLV-AY1-17, niveau 4-fragment d'émail d'une dent de rhinocéros (?) de la grotte Gilvaran ; (a) vue buccale, (b) vue en section ; 3 : KLD-11, niveau 5–point d'andouiller de Cervidae indét. cf. *Cervus elaphus* ; (a) vues antérieure, (b) médiale, (c) postérieure, (d) latérale, (e) section ; 4 : GLV-A8-103, niveau 2–fragment d'une vertèbre lombaire de Cervidae indet. cf. *Cervus elaphus* de la grotte Gilvaran ; vue postérieure ; 5 : KLD-9, niveau 5–fragment de pince de crabe de la grotte Kaldar ; (a) section distale, (b) vue mésiale, (c) vue occlusale, (d) vue latérale, (e) vue inférieure, (f) section proximale ; 6 : GHM-F2-8, niveau 4–P^2 droite de Bovini indet. de la grotte Ghamari ; vues (a) occlusale, (b) buccale, (c) linguale ; 7 : KLD-14–première phalange, droite de l'axis de la main (?) de *Capreolus* de la grotte Kaldar; vues (a) distale, (b) proximale, (c) axiale, (d) dorsale, (e) abaxiale, (f) plantire ; 8 : GHM-F2-22–axis d'*Hystrix* de la grotte Ghamari ; vues (a) antérieure, (b) postérieure, (c) droite, (d) dorsale, (e) ventrale ; 9 : KLD-10–M1/2 (M1?) gauche de *Capra* de la grotte Kaldar ; vues (a) buccale, (b) occlusale, (c) linguale. L'échelle est de 1,5 cm sur les clichés 2 et 5, et 3 cm pour les autres clichés.

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Hystrix sp. cf. *Hystrix indica*: Ghamari Cave
Gliridae indet.: Ghamari Cave
Mustelidae indet.: Kaldar Cave
Rhinocerotidae indet.?: Gilvaran Cave, level 4.
Sus scrofa: Kaldar Cave
Capreolus sp.: Kaldar Cave, Gilvaran Cave
Cervidae indet. cf. *Cervus elaphus* Kaldar Cave, Gilvaran Cave
Bovini indet.: Gilvaran and Ghamari Caves
Caprini indet. cf. *Capra aegagrus*: Gilvaran, Ghamari, Kaldar Caves

The presence of a crab in Kaldar Cave either suggests that water was very near to the cave at the time the deposits were formed, or that it was brought into the cave by a predator or humans.

In large parts of Europe, the fossil record is sufficiently known to allow fairly precise age estimation, often allowing in assigning fossil associations to a particular glacial cycle or oxygen isotope stage. At present this is not possible in Iran. However, the fossil association is interesting from a biogeographical point of view. The Khorramabad Valley is a passageway across the Zagros Mountains and is situated at the border of the Palearctic and Saharan-Arabian biogeographic realms and not very far away from the Oriental realm (Holt et al., 2013). Dealing here with Pleistocene fossils, we might expect species from these different realms. However, the taxa identified here, and those known from the literature (Marean, 1998; Mashkour et al., 2008, 2009, 2012; Trinkaus and Biglari, 2006; Trinkaus et al., 2008), suggest that, the humans in this area lived in a Palearctic and more precisely a West Eurasian biogeographic context. This must have had importance for their geographic distribution, contacts with other populations and gene flow, or for their opportunities of dispersal.

Against this biogeographical background it is interesting to note that the fossils of *Capreolus* are the southern-most records of the genus in western Eurasia. The same may be true of *Cervus*. The possible presence of a rhinoceros at Gilvaran Cave is intriguing. An indeterminate species of "*Dicerorhinus*" was cited from the Wezmeh Cave in Iran (Mashkour et al., 2008). That genus lives today in SE Asia, while the related *Rhinoceros* lives also in the Indian Subcontinent. Both have long records in East Asia and the Indian Subcontinent, respectively. However, these authors may have meant the genus *Stephanorhinus*, which previously was included in *Dicerorhinus*, a practice still followed by some. *Stephanorhinus* and the closely related woolly rhinoceros *Coelodonta* are fossil rhinoceroses from northern Eurasia. The latter was cited also from the Indian Subcontinent (Colbert, 1935), while *S. kirchbergensis* and *S. hemitoechus* are described from Azokh Cave in Nagorno Karabach (Van der Made et al., in press). Biogeographically it would be very interesting to know which of these species were present in Iran.

4. Discussion and conclusions

Thanks to the advances made by pioneering researchers, we were able to expand and test their initial results with modern techniques. Although some of our results confirm previous findings, others enable us to advance new data. For instance, Hole and Flannery reported that: "The technique of the Luristan Mousterian is non-Levallois, like that observed elsewhere in the Zagros" (e.g., Shanidar, Hazar Merd, Warwasi, Bisitun) (Hole and Flannery, 1967: 155; see also Vahdati Nasab, 2010). However, we recovered many Levallois points, pointed flakes, flakes and Levallois cores not only at Gilvaran and Kaldar, but also at Ghamari, where these had not previously been reported. Regardless of these differences, our results are in general agreement with Hole and Flannery's categorization of technologies from these sites.

Parviz recorded Gilvaran as an Upper Paleolithic locality. Roustaei et al. (2004) stated that: "The two large collections from Sorkh-e Lizeh and Gilvaran I exhibit some generic early Upper Paleolithic characteristics (e.g., many flakes, retouched pieces made on flakes, flake cores, denticulates and notches, side-scrapers), but they occur along with lamellar elements and even bullet cores" (Roustaei et al., 2004: 8). However, we recovered a large number of Middle Paleolithic tools in the A8 and AY1 trenches from this site (several types of typical Mousterian, Levallois, *limace*, Tayac and déjeté points, side-scrapers and blades from Levallois cores. According to their report: "Hammer stones and grinding stones were reported by Hole and Flannery (1967) from their tests at Gar Arjeneh and also show up at Gilvaran I but are of uncertain chronological or diagnostic significance" (Roustaei et al., 2004: 9). From this, it is clear that a surface collection does not allow assessment for a reliable chronology and that the recent excavations in the Khorammabad Valley provide new data necessary to fully understand these lithic assemblages.

Apart from documenting two more Middle Paleolithic localities in the Khorramabad Valley, the recognition in our excavations of two distinct but continues levels in level 5 of Gilvaran cave is of vital importance, because it might help in understanding some of the dark angles of the possible interaction between *Homo sapiens* and the Neanderthals and the causes of the extinction of the latter.

Another important issue, which is one of the main objectives of this research, is the beginning of the Middle Paleolithic period in this area. "The true age of the Mousterian in the Zagros is not known, although carbon from Kunji Cave gave a radiocarbon date of greater than 40,000 years" (Hole and Flannery, 1967). However, relying on 1970s dating, we may know, more or less, the end of Middle Paleolithic age of Khorramabad Valley. "An important point is that in case of absolute dating; most of the Paleolithic sites in Iran suffer from the lack of reliable dating techniques (e.g., some of the dates obtained by ^{14}C techniques prior to the 1970 could be drastically changed because of absence of reliable calibration at the time)" (Vahdati Nasab, 2011).

Although new radiometric dating is still in progress, the techno-typological similarities between the sites investigated and the nearby Yafteh Cave permit to associate the radiocarbon dates of the latter (Otte et al., 2011) for timing the appearance of the Upper Paleolithic in the Khorramabad Valley. The Mousterian tradition instead might be older than expected. The preliminary paleontological study

confirms that faunal affinities are predominantly European and adds a new taxon which has its southern-most distribution in the area. When more extensive collections are studied in detail, biostratigraphy has the potential to contribute to dating the different levels and making paleoecological interpretations.

Our preliminary study also shows that modern and systematic excavations may provide information that challenges the classical views on the technology of the stone tools of this area. A brief study of the lithic assemblages of all the sites shows that the raw materials used are mostly pebbles from the Khorramabad River. Field observations indicate that the majority of the caves and rock shelters in the region are close to water sources, mainly the Khorramabad River. The assemblages are dominated by relatively high-quality raw materials procured as pebbles from local gravels.

In the fluvial deposits in the valley, there are pebbles and cobbles of many different colors and quality (dominated by chert stone) easily available. Flint is easy to find and it therefore seems a convenient source for the Paleolithic hunters and gatherers inhabiting this area. As a result, it is not unreasonable to think that the majority of the knapped materials in the sites are of local origin.

Except a single obsidian microlith blade in the AY1 trench in the Gilvaran, chert is the predominant raw material in all the sites (SOM Fig. 8). As far as we know, the nearest obsidian sources are in the Caucasus and Turkey. "The most important sources of obsidian in the Near East are located in Anatolia and Caucasus. There are also smaller sources in southern Yemen, possibly in southwest Arabia and the Red Sea islands (Francaviglia, 1990; Zarins, 1989), and perhaps some localities in Iran, yet to be explored" (Abdi, 2004).

The preliminary technological analyses of the lithic assemblages indicate in the Mousterian the exclusive use of the Levallois recurrent unidirectional methods with the shift to the centripetal modality at the end of the flaking sequence. The dimension of the raw material plays also an important role in the choice of the knapping method, as is the case in small discoid cores. The retouched artifacts are dominated by Mousterian and elongated points, side-scrapers, déjetés and convergent scrapers. These features are common in the other sites of the Zagros regions during the late Middle Paleolithic indicating a certain technological stability. In the lithic assemblages of the Upper Paleolithic instead is documented a technological change towards the production of blades and retouched bladelets. Within the retouched tools it is worth noting the production of Arjeneh points that are exclusive of these territories, suggesting an in situ development of these artifacts in the Baradostian tradition. Recent examinations of the Upper Paleolithic assemblages of Warsawi and Yafteh Caves highlighted the independence of these technological innovations that are not rooted in the Mousterian tradition as was traditionally stated. It is one of the aims of our future research to know more about environmental conditions and constraints in order to better understand technological and behavioral evolution. For this end, we intend to study the lithics by means of microwear and residue analysis to understand the function of the tools and the features of the behavioral changes and transition. We are also studying the fossils remains to better assess the faunal changes between those periods. To obtain all of this knowledge, a wide comparison analysis of assemblages in the area is of vital importance.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.crpv.2014.01.005.

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