Dichotomous Early Bronze Age Chipped Stone Industry: Statistical Assessment of Congruence among Chert and Obsidian Chipped Stone Assemblages from Kohne Tepesi, East Azerbaijan, Iran

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Abstract: Kohne Tepesi, an Early Bronze Age and Parthian site in East Azerbaijan Province, Northwestern Iran, was excavated under the rescue project of Khoda Afarin Dam Basin in 2007 and 2008. The chipped stone industry from the Early Bronze Age is mostly made from two different raw materials: chert and obsidian. Typo-technological analyses indicates that the chert assemblage is different from the obsidian assemblage in being more specialized and producing formal tools. Bifacial sickle elements are exclusively made from chert, whereas the assemblage from obsidian consists mostly of tiny chips from modification of irregular bifacial core-tools. In this research Mann-Whitney and chi-square tests are applied for assessing of congruence among chert and obsidian assemblages. The results clearly indicate that there is an economic pattern in raw material selection in Early Bronze Age chipped stone industry of Kohne Tepesi.

Keywords: Bronze Age, Kura-Araxes Culture, Chipped Stone Industry, Obsidian, Statistics.

Introduction

Applying statistical methods in archaeological research provides a reliable basis to test theories and hypotheses. Although simple statistical methods leading to identification of preliminary patterns in the structure of archaeological findings, either in field planning or in post-field studies of artifacts, has always been used by archaeologists, advanced statistical methods have rarely been applied in Iranian archaeological research.

Chipped stone assemblages are among the archaeological finds which require the application of both preliminary and advanced statistical methods in order to be interpreted properly. Since the process of producing chipped stone artifacts through removal of flakes always reduces the volume of the original size of the cobble of raw material, naturally, one goes initially from more volume of raw material to less volume in the end products. This reduction sequence could be reconstructed and interpreted if proper statistical methods are applied (e.g. Andrefsky 2001, Binford and Binford 1966; Braun *et al*. 2008). In this research the results from typo-technological classification

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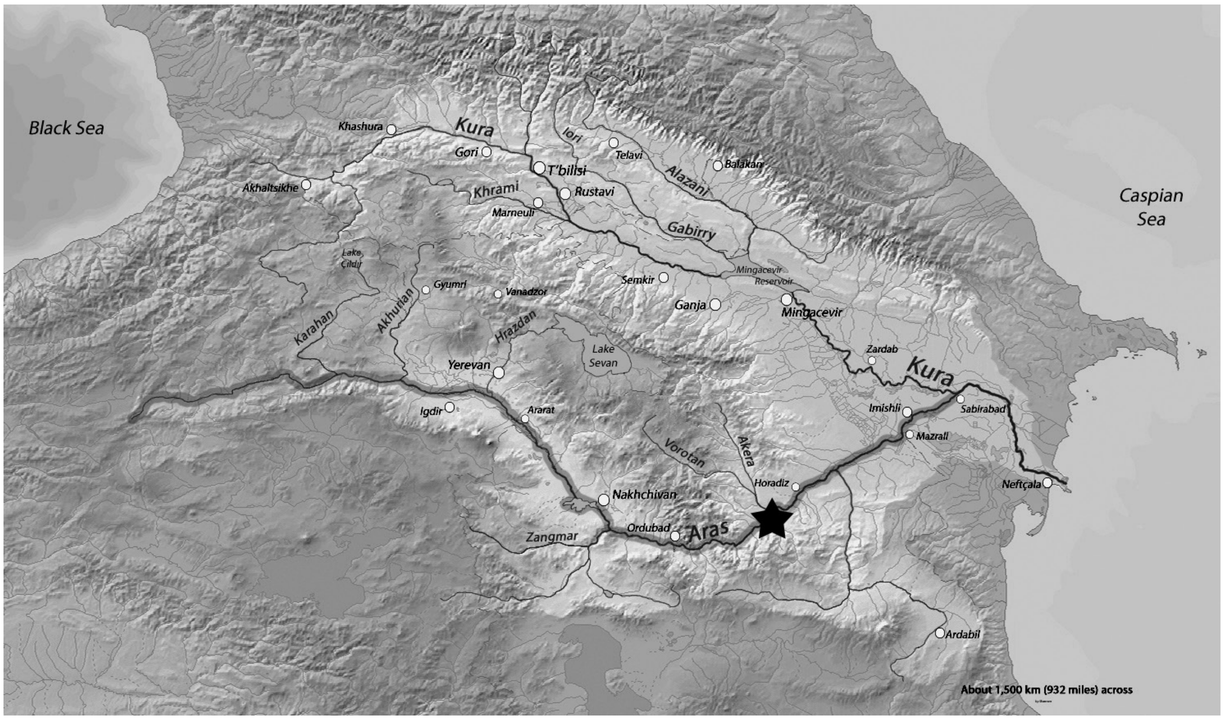

Fig. 1. Kura-Araxes River basin and location of Kohne Tepesi in northwest Iran

Fig. 2. The site of Kohne Tepesi during excavation.

of a chipped stone assemblage from Early Bronze Age site of Kohne Tepesi are tested by statistical methods in order to achieve a more reliable portrait of prehistoric chipped stone industry of northwest Iran.

Archaeological research in northwestern Iran is primarily limited to the Urmia Lake basin, much of which was carried out several decades ago. Recent research in the area has included field programs such as the rescue project associated with the construction of the Khoda Afarin Dam in the Araxes River basin, which led to the excavations at a number of important Bronze Age sites along the southern terraces of the Araxes River (see Maziar 2010 and references therein). Kohne Tepesi was one of these sites excavated during two seasons in 2007 and 2008 (Figs. 1 and 2; Zalaghi 2008). The earliest cultural deposits in Kohne Tepesi contain seven stratigraphic phases of the Early Bronze Age, and the site also has upper components pertaining to the Parthian and Islamic periods.

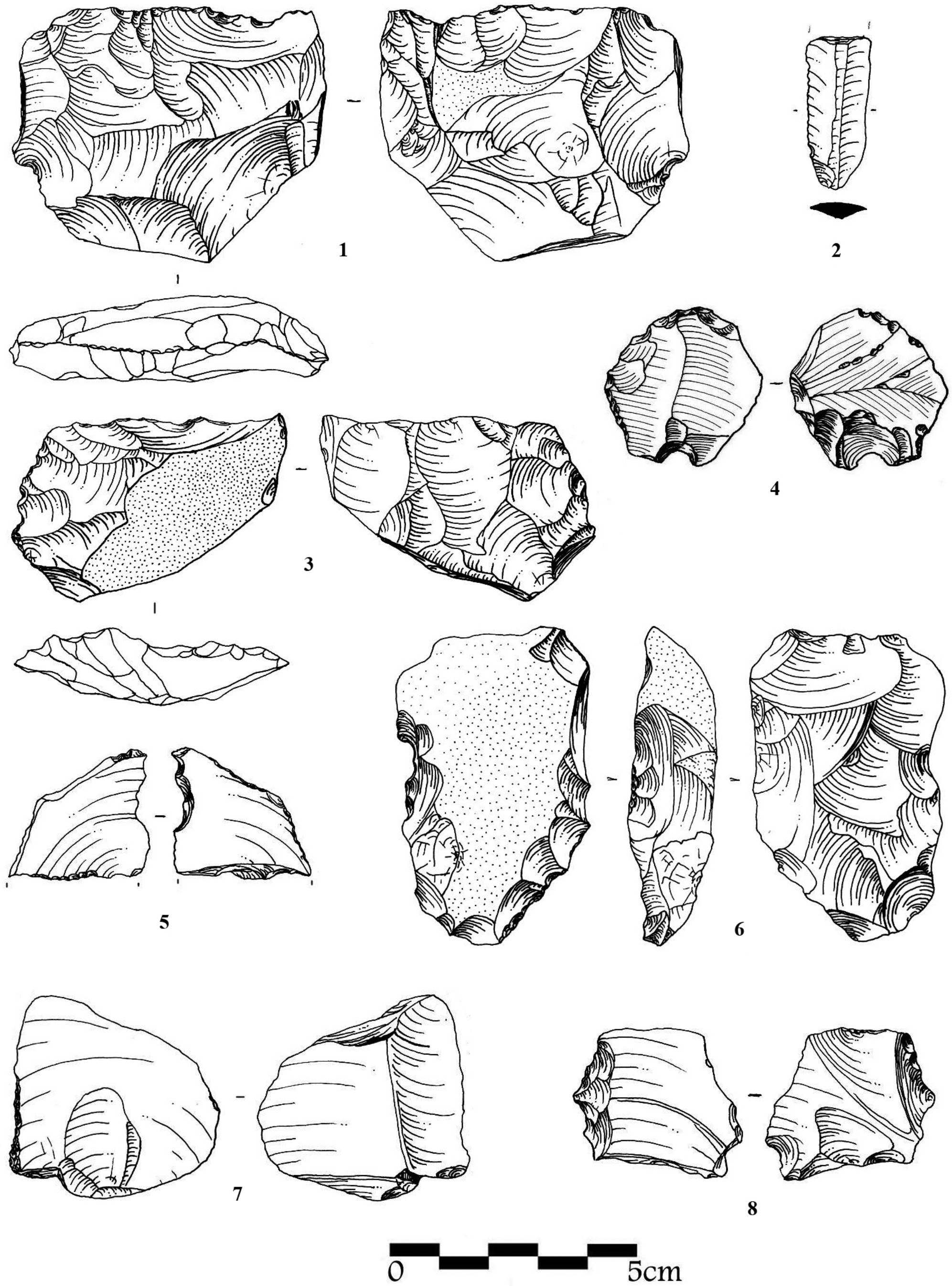

Fig. 3. Obsidian chipped stones in Kohne Tepesi assemblage (1, 3, 6. Bifacial flake core-tools; 2. Proximal end of pressure blade; 4, 5. Notched; 7. Hinged flake with prominent bulb of percussion and errailure scar; 8. Side scraper), drawing by M. Jayez.

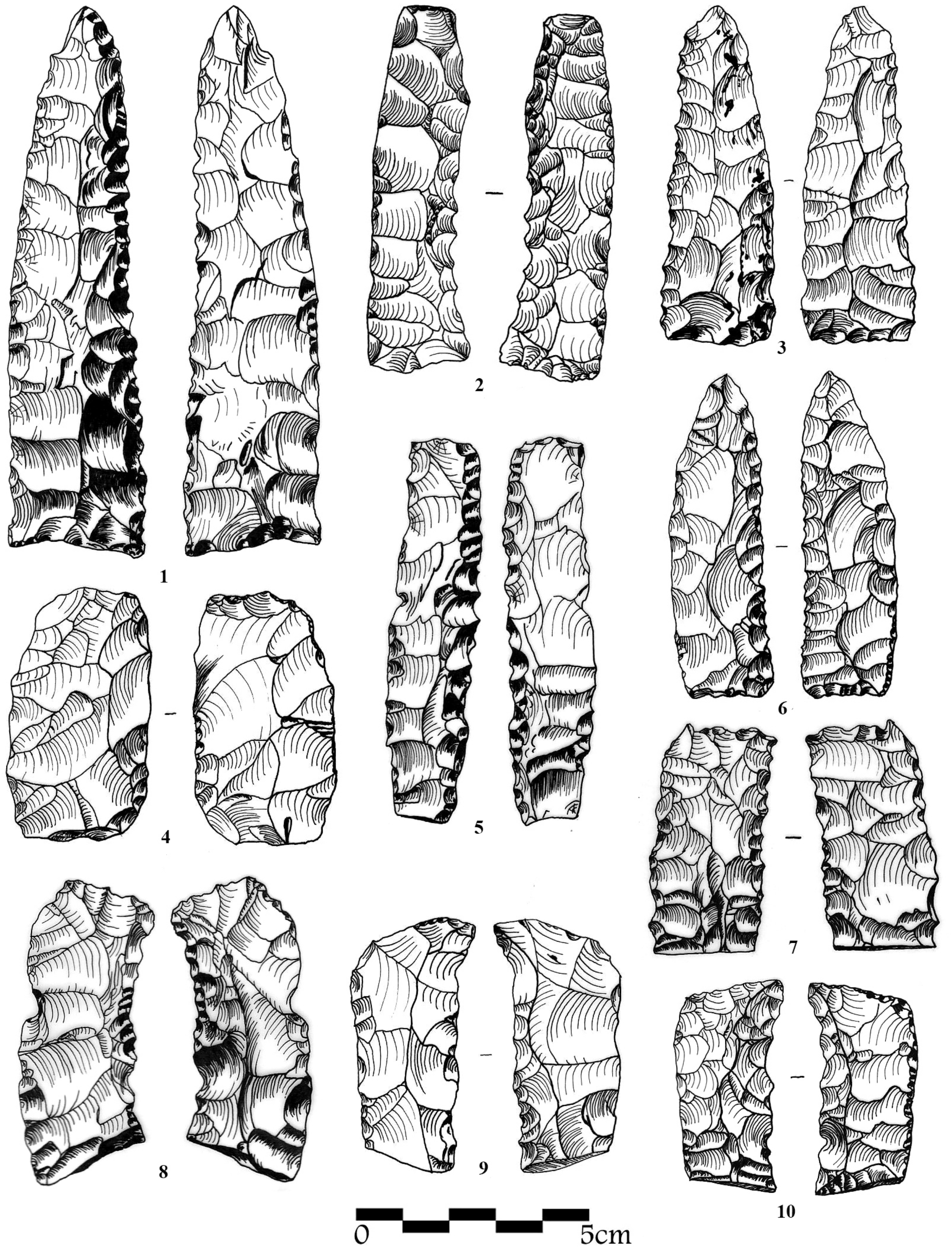

Fig. 4. Chert bifacial sickle elements from Kohne Tepesi, drawing by M. Jayez.

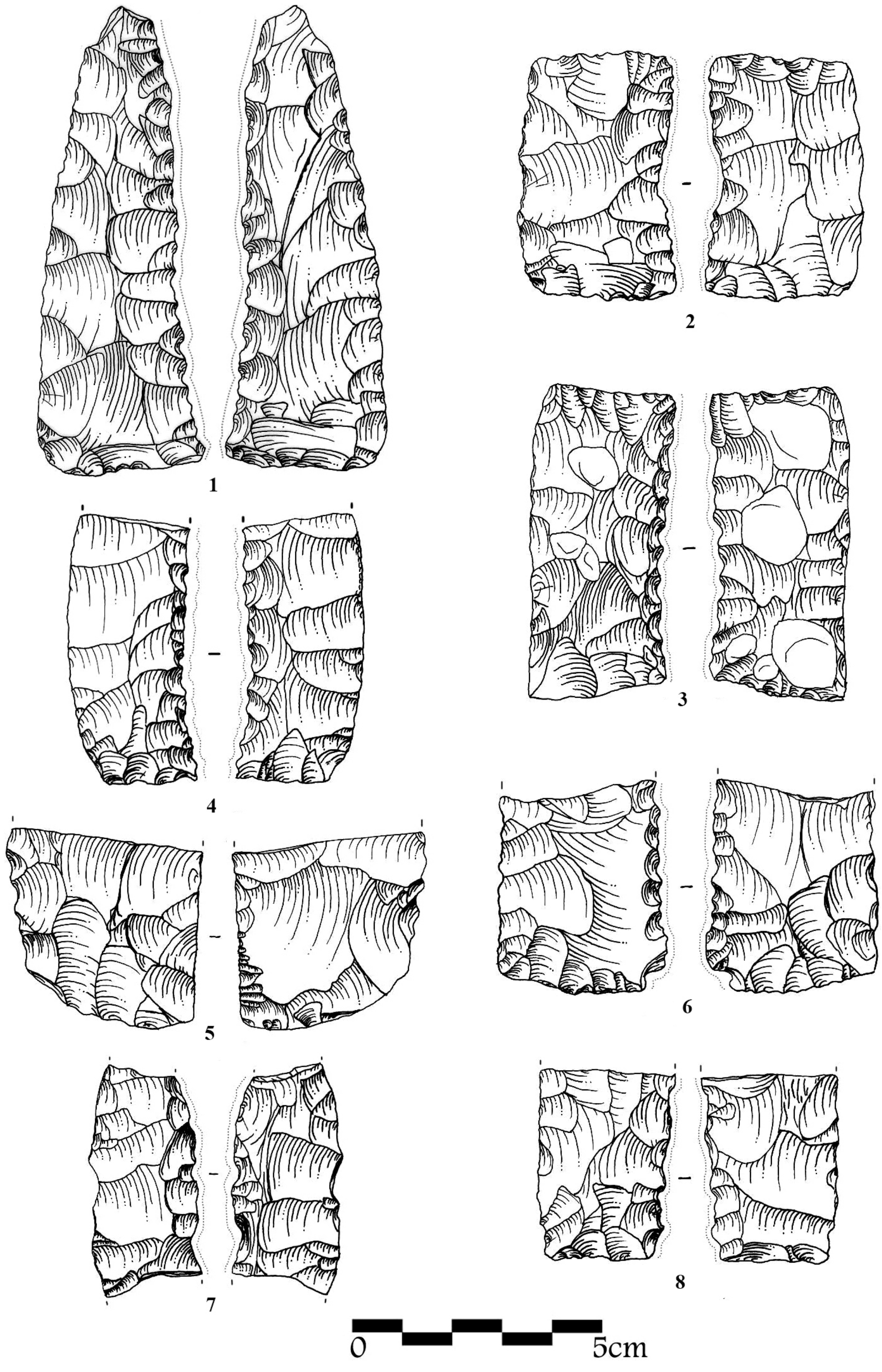

Fig. 5. Chert bifacial sickle elements from Kohne Tepesi, drawing by M. Jayez.

Material and Method

A total number of 940 chipped stones were collected during two seasons of excavations at Kohne Tepesi. 97% of the chipped stones are made of either chert or obsidian. Although obsidian artifacts are more abundant in number, if we take the weight of the artifacts into account, most of the assemblage is made of chert. The technological structure of obsidian assemblage contains a high quantity of small flakes and chips (i.e. small flakes approximately 1 cm in dimension) and a few cores and core fragments. It is obviously a technological structure associated with core preparation, flake removal and tool production at the site. Most obsidian tools, on the other hand, are thick flakes or cores from two faces of which small flakes had been removed irregularly and invasively, finally turning into irregular unstandardized bifaces. Regular retouch and tools are rare and most of flake tools are informal, except for a number of notched pieces which are almost exclusively of the simplest type of product (Fig. 3, no. 4,5).

The assemblage made of chert indicates a different structure of production. Most of the tools in this assemblage are bifacial sickle elements made by regular invasive retouch on both faces. Many of them have one denticulate edge with heavy sickle gloss (Figs. 4-6), while the other edge might have been inserted into hafts likely made from organic materials, although the remains of such hafts have not been found during excavations. Other tools in this assemblage are a few formal tools like scrapers and multiple tools which are much more regular in shape than the obsidian tools.

The characteristics of the chipped stone assemblage from Kohne Tepesi indicate a dichotomous industry (see Jayez and Zalaghi 2015 for a detailed description of the assemblage). The obsidian assemblage consists of great numbers of tiny flakes and is based on flake production from cores which finally turned into irregular bifaces, most probably used as implements (Fig. 3, no. 1, 3, 6). Irregular retouch and informal tools are mostly observed in obsidian tools. The obsidian assemblage seems to reflect an industry which lacks specialization in production and it could even be the product of unspecialized people producing their informal tools not necessarily in specialized workshops, but probably even in their residential spaces.

The chert assemblage, on the other hand, consists of many flakes larger in size than obsidian ones. Bifacial sickle elements indicate a somewhat specialized industry in which the tools shapes and dimensions were pre-planned (for standardization of measurements in bifacial sickle elements see Jayez and Zalaghi 2015; Mirzai 2016).

Statistical assessment of congruence among chert and obsidian Assemblages

The two assemblages of chert and obsidian from Kohne Tepesi are compared statistically in this research in terms of:

1. Weight
2. Length
3. Width
4. Thickness
5. Technological Structure
6. Tools composition

First, One-Sample Kolmogorov-Smirnov Test was applied to determine normal distribution of values of weight, length, width and thickness. Then Mann-Whitney, which is a nonparametric test, was applied in comparison of those values. We have also applied Chi-Square Test to investigate the relation between qualitative variables, like technological structure and tools typology between the two assemblages, with a significance level of $p<0.05$.

Results

Table 1 indicates that chipped stones of chert are generally larger in dimensions than those from obsidian. They are both larger and heavier than obsidian chipped stones. Hence, different distributions are observed in values regarding metric attributes from the two assemblages which indicate an incongruity based on raw material.

Table 2 presents a comparison between technological structure of the chert and obsidian assemblages. Although neither of the two assemblages indicates systematic production of blades and bladelets from prismatic cores, they show different technological structures. The high percentage of chips in obsidian assemblage is a likely result of core trimming and bifacial removals which lead to bifacial core-tools. Although bifacial removal is

Table 1. Comparison of the mean and standard deviation among metric attributes of chert and obsidian assemblages

	Thickness mean±SD	Width mean±SD	Length mean±SD	Weight mean±SD
Chert	3.4±47.1	10.7±13.1	13.2±16.6	14.4±28.8
Obsidian	3±47	9.1±13.3	10.2±14.6	4.8±11.1
Test	Mann-Whitney	Mann-Whitney	Mann-Whitney	Mann-Whitney
P-Value	P<0.001	P<0.001	P<0.001	P<0.001

a characteristic of chert sickle elements as well, there is lower percentage of chips in this assemblage, because the distribution of technological components is different (which also probably indicates the chert assemblage is not representative of production workshops of these tools where there should have been many more tiny chips). On the other hand cores and core fragments are fewer in the obsidian assemblage. Application of Chi-Square Test confirms such an incongruity in the technological structure of Kohne Tepesi chipped stone assemblage.

Table 3 presents a comparison of tools composition of chert vs. obsidian chipped stone assemblage of Kohne Tepesi. Application of Chi-Square Test indicates that there is a meaningful difference between these two assemblages in terms of their tool typology and type-frequency. Retouched tools in this table means flakes which have been irregularly retouched and could not be classified into any definite tool category; scrapers are either end scrapers or side scrapers; "other" means tools including borer, backed and burin, so rare that we had no choice but to integrate them into one category for the sake of statistical analysis applicability.

Application of statistical methods clarifies the dichotomy of chipped stone assemblage of Kohne Tepesi based on raw material. Tables 1, 2 and 3 indicate incongruity of chert and obsidian chipped stone assemblages regarding metric characteristics, technological structure and tools composition.

Discussion

The chipped stone assemblage from Kohne Tepesi is the first Bronze Age assemblage from northwestern of Iran which has been classified and analyzed techno-typologically. Although chipped stones are found abundantly at Bronze Age sites of the Kura-Araxes River basin (see for example Abedi *et al*. 2014; Burney 1961; Sagona *et al*. 1995; Gogochuri and Orjonikidze 2007; Lyonnet *et al*. 2012; Marro *et a*l. 2011), archaeologists mostly have focused on the other cultural finds, especially architectural remains and pottery which represent the traditional approaches to archaeological research in prehistory. Limited research on chipped stones from these sites is mostly concentrated on the provenance of obsidian artifacts (see for example Chataigner and Gratuze 2014; Chataigner *et al*. 2003; Francaviglia 1994; Khademi Nadooshan *et al*. 2013).

The application of statistical methods in this research on the chipped stone assemblage of Kohne Tepesi indicates an inner dichotomy based on raw material in this assemblage. Statistical analysis as well as archaeological observations clarify that the assemblage made from chert indicates specialized production of bifacial sickle elements, along with other tools (table 3), to be utilized in agricultural activities, while the assemblage from obsidian indicates a different industry based on the production of irregular bifacial core-tools, the function of which can be clarified by use wear analysis.

From archaeological point of view, it should be investigated as to whether such a dichotomous pattern is characteristic of all chipped stone assemblages from Kura-Araxes sites, or whether it is a pattern exclusive to Kohne Tepesi. Another chipped stone assemblage that has been recently classified is from Tepe Zarnagh in East Azerbaijan, excavated by A. Hozhabri-Nobari (see Hozhabri-Nobari 2012) and it also has cultural deposits dating to the Early Bronze Age. The results of these investigations indicate that the pattern observed in the Kohne Tepesi chipped stone assemblage might not be necessarily the general pattern of Kura-Araxes chipped stone industry; rather in the Zarnagh assemblage, obsidian chipped stones are too rare to be compared with chert chipped stones, although

Table 2. Comparison of the technological structure among chert and obsidian assemblages

	Chert		Obsidian	
	N	%	N	%
Blade Segment	35	10.1	4	0.7
Bladelet	2	0.6	6	1.1
Bladelet Segment	0	0	2	0.4
Chip	30	8.6	133	23.5
Core	10	2.9	11	1.9
Core Fragment	13	3.7	5	0.9
Debris	13	3.7	51	9
Flake	156	45	173	30.5
Flake Fragment	46	13.3	91	16
Tool Preform	1	0.3	0	0
Anonymous	26	7.5	84	14.8
Sum	347	100	567	100
Test	Chi-Square Test			
P-Value	P<0.001			

Table 3. Comparison of tools composition between chert and obsidian assemblages

Tool Type	Chert		Obsidian	
	N	%	N	%
Bifacial Sickle Element	29	38.7	0	0
Notched	2	2.7	15	11.5
Retouched	32	42.7	105	80.2
Scraper	5	6.7	6	4.6
Other	7	9.3	5	3.8
Sum	75	100	131	100
Test	Chi-Square Test			
P-Value	P<0.001			

Fig. 6. Chert bifacial Sickle elements from Kohne Tepesi.

similar characteristics are observed regarding bifacial sickle elements in Zarnagh assemblage as well (see Mirzai 2016). Altogether, we need more assemblages to be published in order to find out about general patterns in chipped stone industry of the Early Bronze Age in the region; until then any interpretation of incongruity in the assemblage of Kohne Tepesi would be based on inner attributes of the assemblage.

Various explanations could be discussed regarding the inner incongruity of chipped stone assemblage of Kohne Tepesi. Such an incongruity could be simply because of the nature of raw materials used. The reason could be simply the differences between chert stone (as a cryptocrystalline sedimentary rock material composed of silicon dioxide) and obsidian (as a naturally occurring volcanic glass formed as an extrusive igneous rock). Could it be that these two different raw materials naturally lead to different production patterns, hence different end products? The archaeological evidence from the Kura-Araxes River Basin suggests against such an explanation, because nearly identical bifacial sickle elements have been reported from Ovçular Tepesi in Nakhchivan, Azerbaijan, from both flint and obsidian (Marro *et al*. 2011: 81, Pl.XII, 4 & 5). Therefore, it is unreasonable to attribute all the differences to different nature of chert and obsidian as raw material.

Another explanation could be raw material procurement patterns in chipped stone industries. As mentioned previously, obsidian provenance research in the area indicates that obsidian comes mostly from local sources in northwestern Iran, eastern Turkey and Caucasus region (see Abdi 2004), but unfortunately we lack similar evidence regarding chert provenance. There is no certainty whether

both these raw materials were locally extracted or there were different procurement patterns. On the other hand, we have already mentioned that obsidian might not be so abundantly present at other Early Bronze Age sites (see Mirzai 2016). Consequently, this explanation can not be investigated further until more provenance studies would be conducted regarding chert sources and procurement patterns in the region.

Finally, the dichotomy observed in the chipped stone assemblage of Kohne Tepesi could be attributed partially to craft specialization of chipped stone tool production at the site. Specialization is a complicated concept and there are many factors which should be taken into account at different scales in order to explore craft specialization in a given archaeological context (see for example Costin 2001; Flad and Hruby 2007; Tosi 1984). To explain craft specialization, we require theories of social exchange and interaction, production, and the social role of created objects (Clark 1995: 291); in other words we need to have information regarding production equipment and space, interregional exchange and long-distance trade and the standardization of products. We have already mentioned that bifacial sickle elements, as the most important products in Early Bronze Age chipped stone industry of the region, appear as standardized tools in terms of their production and measurements, but other information regarding interregional exchange and production equipment and spaces is not available. Although attributing the chert assemblage to a specialized industry and attributing obsidian assemblage to a domestic one is the most appealing explanation, given the lack of information regarding spatial analysis of residential features and raw material provenance as well as exchange patterns, such an explanation cannot yet be justified.

Conclusion

Typo-technological classification and the application of statistical methods in this research clarifies an inner incongruity of chipped stone assemblage from Kohne Tepesi based on raw material. The chert assemblage indicates a more specialized industry the most important product of which are bifacial sickle elements, almost standard in production and measurement. On the other hand, the obsidian assemblage lacks standardization and regular tool types. Although similar patterns have not been observed in other Early Bronze Age assemblages from the same region, limited information regarding other chipped stone assemblages of Kura-Araxes sites prevents us from the generalization of conclusions. More chipped stone assemblages are needed in order to achieve a more comprehensive image of Kura-Araxes chipped stone industries and investigation of raw material procurement patterns should be considered in future research.

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