Continuation of a Tradition over Five Thousand Years: Lithic Assemblage from Loteshwar, North Gujarat, Western India

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Received: 19 August 2014; Accepted: 14 September 2014; Revised: 10 October 2014
Heritage: Journal of Multidisciplinary Studies in Archaeology 2 (2014): 283-304

***Abstract**: Loteshwar (23°36′ 1.8″ N; 71°50′ 11.8″ E) is situated in the Sami Taluka of Patan District in North Gujarat, Western India. First excavated in 1990's the site was re-excavated by the North Gujarat Archaeological Project during November/December 2009. The 2009 excavation unearthed two cultural periods namely Mesolithic (dated between the end of the eighth millennium cal BC and the middle of sixth millennium cal BCE) and Chalcolithic (dated to around 3600-3000 BC). The comparative analysis of the lithic assemblages associated with these periods is the main objective of the current study. Other artefacts and ecofacts recovered during the excavations suggest a changing economy at the site from hunting and gathering to agro-pastoralisam. However, the analysis of the lithic assemblage, in particular the cores show continuity in term of a tool technology (quartering technique of stone tool manufacturing) for over five thousand years. This technological continuity is associated to continuity in settlement patterns, characterized by the occupation of dune tops and the uninterrupted transmission of technological knowledge from one generation to another.*

Keywords: Loteshwar, North Gujarat, Mesolithic, Chalcolithic, Lithic Assemblage, Microliths, Anarta Pottery

Introduction

The site of Loteshwar (Fig. 1) (23° 36' 1.8" N; 71° 50' 11.8" E), locally known as Khari no

Timbo is located on top of a stabilised dune about 500m from the Khari River. It was first excavated by the Department of Archaeology and Ancient History, The Maharaja Sayajirao University of Baroda during 1990-91 (IAR 1991-92). The site was re-excavated in December 2009 jointly by the Department of Archaeology and Ancient History, The M. S. University of Baroda, Vadodara and the Department of Archaeology and Anthropology, Institució Milà i Fontanals, Spanish National Research Council (IMF-CSIC), Spain. The excavation revealed two cultural periods namely the Mesolithic and Chalcolithic. The cultural sequence at the site comprised 4 layers. Layers 1 and 2 represented Anarta Chalcolithic period habitation while layers 3 and 4 belonged to the Mesolithic period occupation (Ajithprasad et al. 2009). The Mesolithic level found from the site is one of the earliest of its kind going as early as the beginning of the 8th millennium BCE (Patel 2008). The Mesolithic deposits provided geometric and non-geometric microliths, faunal remains and grinding tools. The Chalcolithic period was characterised by shallow deposits not more than 0.9m below the current surface and rather conspicuous pits with Anarta pottery; terracotta objects (including an anthropomorphic figurine); steatite micro-beads; terracotta, faience, shell and amazonite beads; terracotta and shell bangle fragments; clay lumps with reed impressions; grinding stones; charred wood and animal bones; a copper punch, a small bangle fragment and a small unidentified copper fragment (Madella et al. 2010).

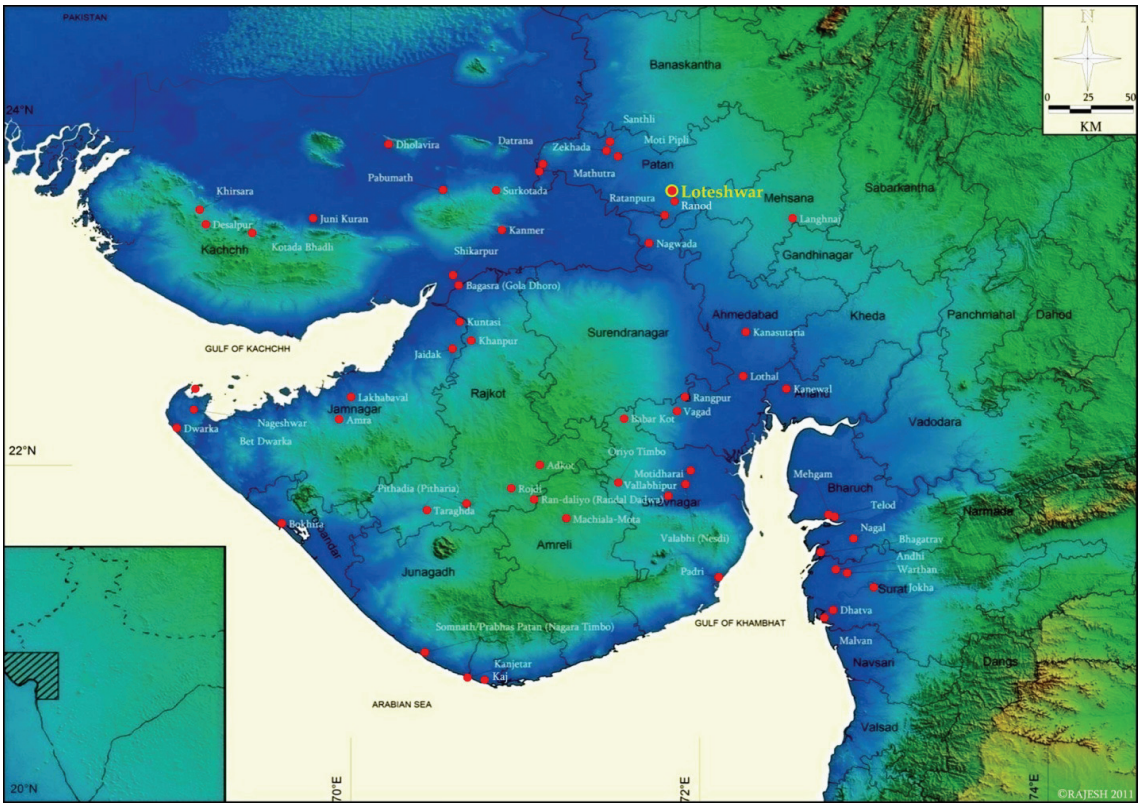


Figure 1: Loteshwar along with other major excavated sites of Gujarat

The analysis of grinding stones from both the cultural periods of the site have shown that they were probably used to grind both food and non-food plant materials.

Phytolith and starch analysis indicated the presence of grasses and non-grasses including small millets, pulses, sedges and a single banana leaf phytolith (García-Granero et al. In press).

Analysis of skeletal remains of cattle from the Mesolithic and Chalcolithic levels has shown that North Gujarat had the potential for being one of the probable centres for local domestication of zebu cattle (*Bos indicus*) (Patel 2009). The author further states that the absence of wild sheep and goat from both levels and the presence of domestic sheep and goat from Chalcolithic levels at Loteshwar suggest that they were probably brought to the site from areas of Northwest South Asia. She concluded that the long span of Chalcolithic phase at Loteshwar and the ephemeral nature of the settlement can be interpreted as representing periodic visits by mobile pastoralists who travelled to the area seasonally (Patel 2008).

Thus it can be seen that Loteshwar has capability to answer various types of questions related to small scale settlements having long span of habitational deposits, social contacts, resource use, early food production as well as early domestication of plants and animals.

The lithic assemblages- stone tools and associated debris- are one of the few artefacts related with humans which have the capacity to survive for thousands of years. They can be used to relate to time depth, prehistoric exchange, relative sedentism, function and prehistoric economy (Andrefsky 2005). Like other technologies, many aspects of lithic production are complex skills that must be taught and learned (Raczek 2007). Raczek (2007) further states that lithic assemblages are created and shaped by a social context which include factors such as mobility, subsistence practices, craft activities and other aspects of daily life, although assemblages are also affected by environmental factors such as proximity of stone raw materials and quality of local stone.

Blade production is a technological tradition and an acquired skill. A lot of training and practice has to be put to learn blade core preparation even if one knows basic knapping skills. However with practice the skill can be easily mastered by new learners. There are many ways to manufacture blades but blade removal techniques are frequently shared by members of a community and tend to be passed down between generations (Raczek 2010).

The lithic assemblage analysed in this paper was recovered during 2009 excavations. It comprises of 1374 blades, 256 geometric and non-geometric tools and 4,227 fragments of lithic debitage including exhausted cores (figure 2).

One of the most interesting observations was about the comparative scale of the lithic assemblage belonging to these two different cultural periods. The Mesolithic lithic assemblage comprised of blades (28.8%), geometric tools (4.4%), non-geometric tools (1%) and lithic debitage (65.8%) while the Chalcolithic lithic assemblage comprised of

blades (25.9%), geometric tools (3.7%), non-geometric tools (1%) and lithic debitage (69.2%). As will be seen in detail later these two assemblages despite belonging to two different cultural traditions and showing a few differences are more or less similar to each other in nature. This similarity most probably is due to repeated occupation of the region by hunter-gatherers and early agro-pastoralists exploiting similar food resources on a seasonal basis for a prolonged period of time. It probably suggests that the significance of micro-blade based tools in subsistence did not diminish much even as the agro-pastoral way of life was gaining momentum at the site. It is also noteworthy that the lithic assemblage does not demonstrate any significant technological innovation or adoption of crested ridge technique during the early stages of the Chalcolithic period at the site.

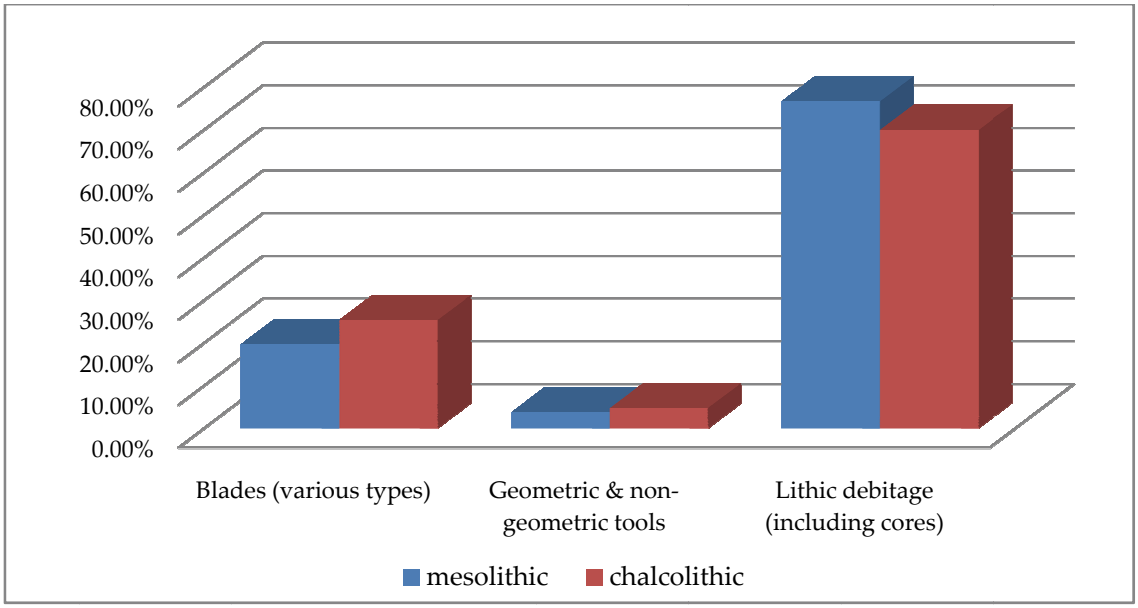


Figure 2: Representation of lithic assemblage according to cultural periods at Loteshwar

Materials and Methods

The lithic assemblage from Loteshwar was analyzed through typological and technological methods.The lithic assemblage recovered from Loteshwar was classified into blades, geometric and non-geometric tools and lithic debitage.

Blades have been classified as simple blades (blades without any retouch but with edge damage on their lateral edges), backed blades (blades having retouch along one longitudinal side), blade flakes (a flake with characteristics of a blade but more thicker and broader) and retouched blades (Blades with minimal and irregular retouch). The non-geometric tools include points (have a pointed end which is achieved by retouching the surface all around), various types of scrapers (secondary retouching classifies them into side and end scrapers, side scrapers and concave scrapers). Lithic debitage includes flakes (primary as well as secondary), nodules, cores and waste fragments/shatter.

Measurements of tools and debitage were taken by Schlenker digital caliper (SEL-SV-03-150). Attributes recorded for all the tools, broken as well as intact, are the same. These include condition (intact, broken-proximal, mesial, distal), cortex percentages (absent, present - <10%, 10-50%, >50%) edge attributes such as retouches, backings and utilization marks (for both ventral and dorsal side edges separately), description of platforms (proximal end characteristics such as type and shape, adapted from Endo 2010), condition of distal ends (feathered, plunging, hinged, retouched, snapped, used etc) and number of dorsal ridges. All the measurements were taken by placing the tools with dorsal side facing the researcher and the proximal end facing up. The length corresponds to a line perpendicular to the striking platform width; tool widths/breadths were taken at the mid- point of the length, thicknesses were measured by rotating the artefact 90^0 from the width point. The lateral edges of all the blades were examined macroscopically.

The raw materials were classified into cryptocrystalline silicates and non cryptocrystalline silicates. Cryptocrystalline silicates include chert, chalcedony, banded agate, moss agate, Rohri chert, bloodstone, quartz and carnelian. The non cryptocrystalline silicate includes quartzite.

Results and Discussions: The Lithic Assemblage from Loteshwar

Blades

A total of 402 blades during Mesolithic period and 973 blades during Chalcolithic period were recovered from the site which included blade types such as simple blades, backed blades, blade flakes, retouched blades and obliquely blunted blades (Figs. 3 and 4). The most common type of blades found amongst the Mesolithic period are the blade flakes (n=184 or 45.7%) while simple blades (n=501 or 51.5%) are most common during Chalcolithic period. Blade flakes are generally sturdier than simple blades and thus could have been used on their own. Even amongst the Chalcolithic period blades the second most favoured type is found to be the blade flakes (n=347 or 35.7%). Retouched blades all together are 55(13.5%) during Mesolithic period and 124(13.2%) during Chalcolithic period. It should also be kept in mind that tools which were intentionally manufactured as hunting and butchering gear might be ill represented in the assemblage as they were meant for tasks carried out away from the site.

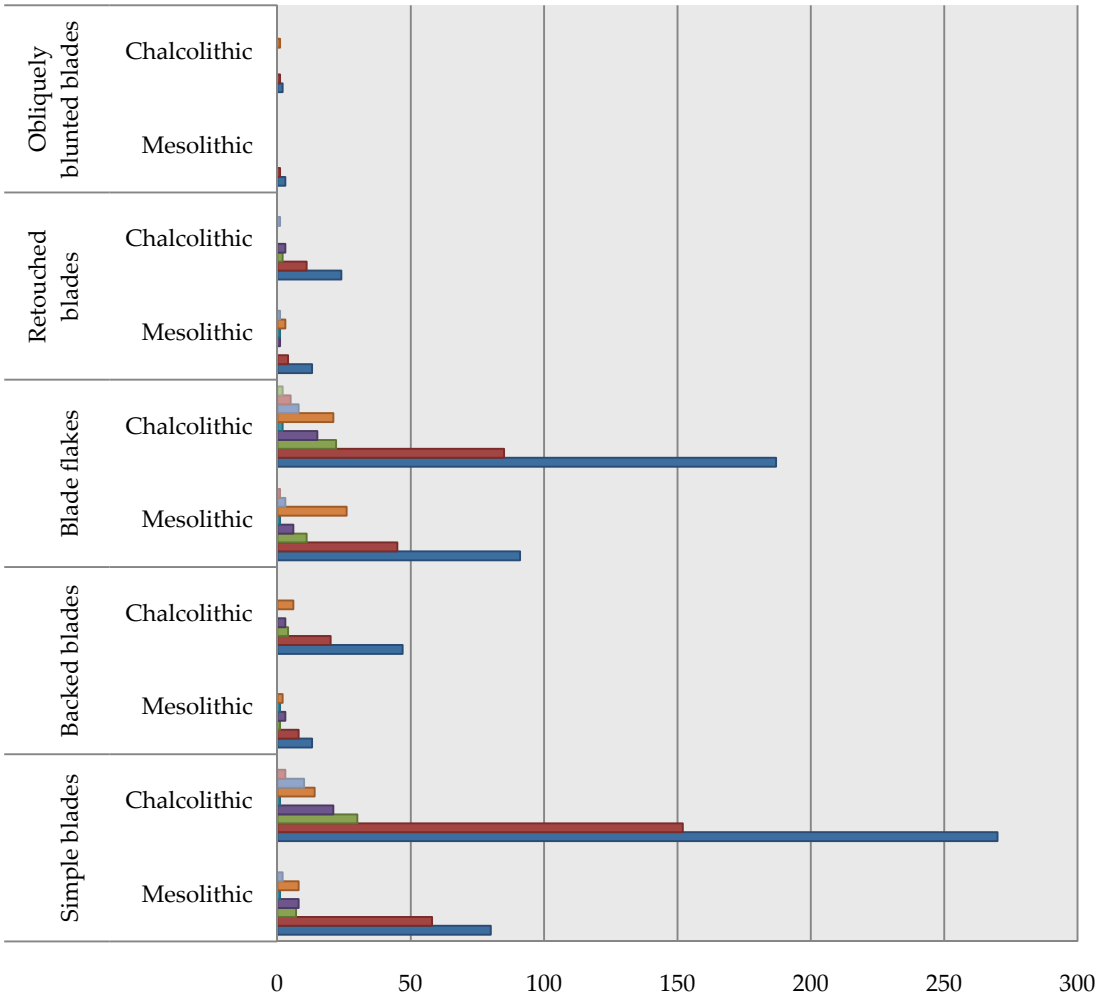
Chipped stone artefacts are produced by tool makers who know how to crack off various sizes and shapes of rock from an objective piece. The best kinds of stones for knapping are those that can be cracked in a reliable and predictable manner; such stones are brittle, homogeneous and isotropic. Cryptocrystalline silicates, including chert, flint or chalcedonies have these necessary properties and thus it is not surprising that these were used to manufacture different types of tools (Harris 2011). Chert (200 tools or 49.6% during Mesolithic period and 530 tools or 54.5% during Chalcolithic period), followed by chalcedony (116 tools or 28.8% during Mesolithic period and 269 tools or 27.6% during Chalcolithic period) were the most favoured raw materials to be exploited during both the cultural phases at Loteshwar (Fig. 4). The two fragments of

Rohri chert blades found from the Chalcolithic period level give evidence of mixing of later materials (later Chalcolithic level) with the materials belonging to an earlier time (early Chalcolithic level).

Figure 3: Blades Recovered from Loteshwar (courtesy: NoGAP)

Condition of Blades: During both the periods, maximum numbers of blades were seen to be of either intact [142 blades (35.3% of blade assemblage) during Mesolithic period and 327 blades (33.6% of blade assemblage) during Chalcolithic period] or proximal condition (158 fragments during Mesolithic period and 370 fragments during Chalcolithic period). Mesial fragments may have been produced during detachment or they may have been produced intentionally by the tool maker. It is not uncommon to find detached pieces, such as blades, that have been snapped into several fragments for insertion into a composite tool. Microliths from Mesolithic period sites are frequently interpreted as intentionally broken or snapped to fit hafting context (Andrefsky 2005). Blade flakes were mostly found in intact condition. Very few blade flakes (15 or 8.15% during Mesolithic period and 19 or 5.48% during Chalcolithic period) were found to have been retouched. Can this be attributed to their being sturdier than normal blades? Maximum proximal fragments belonged to simple blades. Most probably proximal fragments broke while a blade was in use and were discarded or this portion of a blade was intentionally removed for better utility. Mesial or middle portion of blades are maximum in the simple blade category.

Presence of Cortex on Blades: The amount of cortex present on the dorsal surface of flake has been used as an indicator of the reduction stage for tools and non tools



	Simple blades		Backed blades		Blade flakes		Retouched blades		Obliquely blunted blades	
	Mesolithic	Chalcolithic	Mesolithic	Chalcolithic	Mesolithic	Chalcolithic	Mesolithic	Chalcolithic	Mesolithic	Chalcolithic
Rohri chert	0	0	0	0	0	2	0	0	0	0
Quartzite (?)	0	3	0	0	1	5	0	0	0	0
Carnelian	2	10	0	0	3	8	1	1	0	0
Quartz	8	14	2	6	26	21	3	0	0	1
Blood stone	1	1	1	0	1	2	1	0	0	0
Moss agate	8	21	3	3	6	15	1	3	0	0
Banded agate	7	30	1	4	11	22	0	2	0	0
Chalcedony	58	152	8	20	45	85	4	11	1	1
Chert	80	270	13	47	91	187	13	24	3	2

Figure 4: Representation of different types of blades according to their raw materials during Mesolithic and Chalcolithic periods of Loteshwar

(Andrefsky 2005). As all the categories of blades show some amount of cortex, we can say that all the tools were manufactured on the site itself. Though it was also seen that majority of the flakes which were converted into tools or selected as tools were devoid of cortex during both the periods.

Proximal Condition: Proximal fragments include all the specimens that contain a striking platform (Andrefsky 2005). Thus all the intact blades (142 blades of Mesolithic period and 327 blades of Chalcolithic period) as well as the broken blades containing proximal ends (152 blades of Mesolithic period and 332 blades of Chalcolithic period) have been included in this analysis.

Proximal End Forms: Eleven different types of proximal end forms were noted for all intact as well as proximally broken blades (Fig. 5). Most common end forms were found to have been 'retouched', 'difficult to see' and 'not prepared' respectively. Amongst these 'difficult to see with naked eye' has been represented the most time. A combined percentage of these three was found similar during periods, 41.8% during Mesolithic period and 40.3% during Chalcolithic period. The form 'gull winged' becomes less than half during Chalcolithic period.

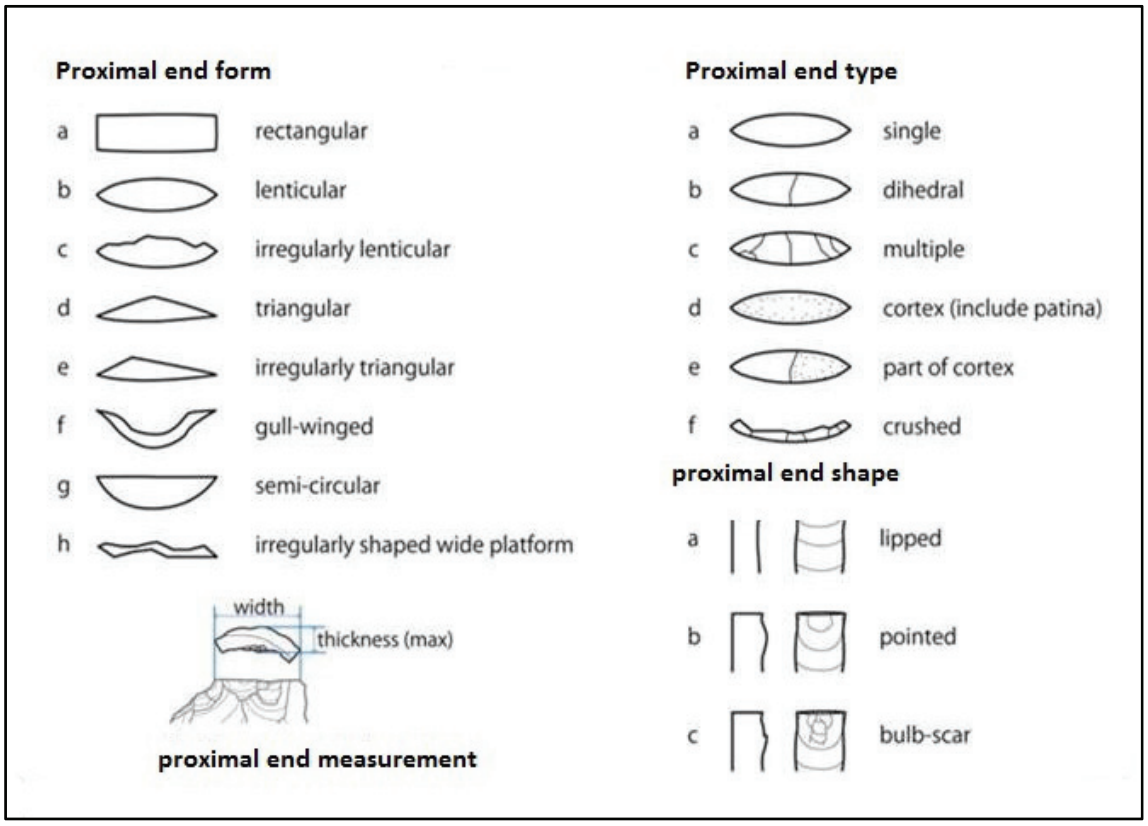


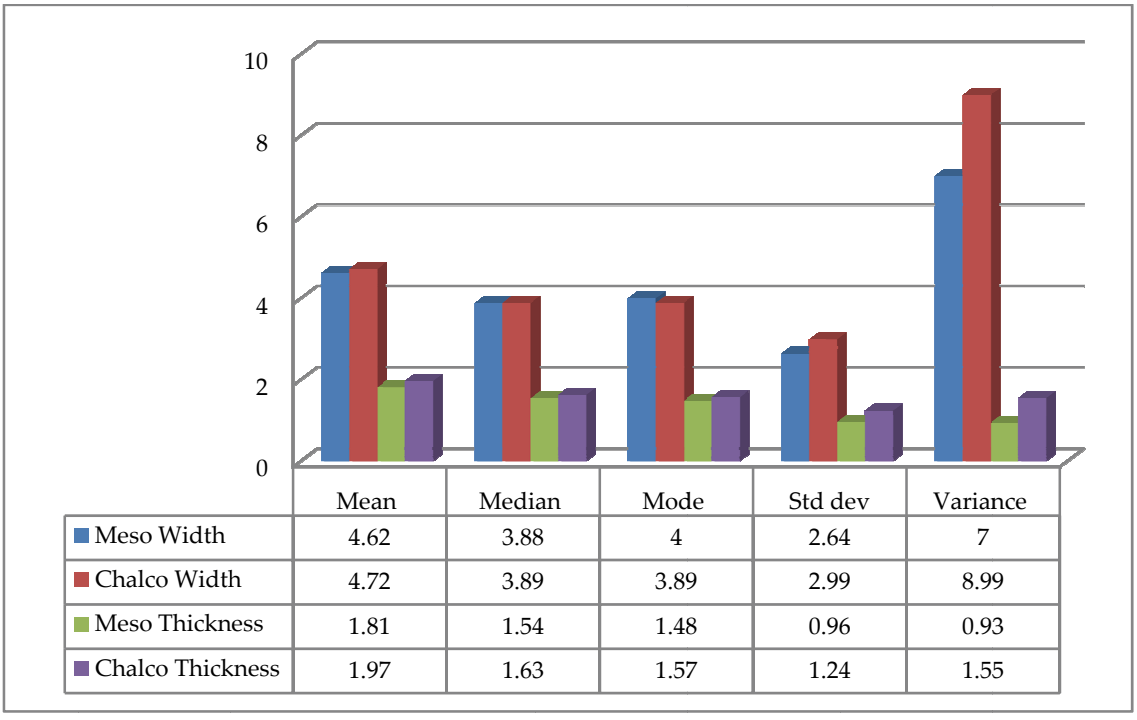
Figure 5: Proximal end attributes (courtesy: Endo 2010)

Proximal End Types: Five different varieties of proximal end types were noted for all intact as well as proximally broken blades (Fig. 5). Type 'single' dominates both cultural assemblages at 84.8% and 82.2%. It has been observed that a flat or single

striking platform is formed when flakes are removed from unidirectional cores (Andrefsky 2005). This fits perfectly with our data from Loteshwar as most of these blades were made out of unidirectional cores.

Proximal End Shape: Three different types of shapes were noted for all intact as well as proximally broken blades (Fig. 5). Blades/flakes with a diffuse bulb of force and a pronounced lip have been called soft hammer percussion flakes (Crabtree 1972). Hard hammer percussion is believed to produce flakes with pronounced bulbs of force, no lipping, and slightly crushed striking platform areas (Crabtree 1972). Even though soft-hammer and hard hammer flaking techniques produce detached pieces that over-lap in their range of bulb morphology and amount of lipping, these characteristics may be effective discriminators in most cases (Andrefsky 2005). During Chalcolithic period lipping of proximal end had increased. This could be attributed to the use of copper punches in blade production during this period. As mentioned earlier, the site in fact has yielded a small copper punch in the excavation.

Proximal Platform Width and Thickness: As can be clearly seen from figure 6, proximal width varies a lot between blades while the thickness was more or less of standardized size. Both the proximal end platform width and proximal end platform thickness were found to be slightly bigger and thicker during Chalcolithic period.



	Mean	Median	Mode	Std dev	Variance
Meso Width	4.62	3.88	4	2.64	7
Chalco Width	4.72	3.89	3.89	2.99	8.99
Meso Thickness	1.81	1.54	1.48	0.96	0.93
Chalco Thickness	1.97	1.63	1.57	1.24	1.55

Figure 6: Metric analysis of proximal platform width and thickness

Types of Distal End Terminations: The distal end of the flake is where the force of the original point of impact terminates. Distal portion of intact blades and distally broken blades have been classified for different distal end terminations such as feathered,

hinged, stepped, plunging (Fig. 7), retouched, used or both retouched as well as used (specially in the case of end scrapers). Feathered, hinged and plunging terminations indicate that the blade or flake is intact while step terminations indicate a broken blade (Andrefsky 2005). Retouched, used and retouched plus used can be assigned to both intact as well as broken blade categories.

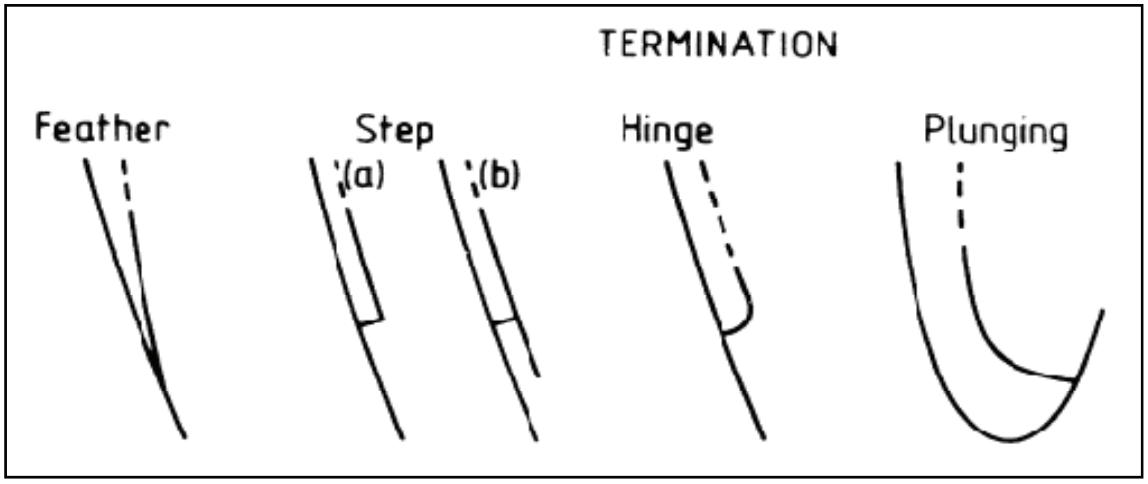


Figure 7: Different distal end terminations (courtesy: Cotterell and Kamminga 1987)

Intact Blades and Distal Blade Fragments: More than half (94 blades or 50.5%) of intact and distal fragment of blades during Mesolithic period seem to have feathered termination. Feathered termination is the proof of a smooth termination that gradually shears the flake from the objective piece (Andrefsky 2005). According to Crabtree (1972) pressure force applied only in a downward direction will cause the flake to be removed tangentially to the direction of the applied force and the flake generated thus will have a feathered termination. Plunging termination has been associated with tool making, especially with blade flaking (Cotteral and Kamminga 1987) thus their presence in 52 blades (24.3%) is not surprising. The most common type of distal end termination during Chalcolithic period was feathered in 156 blades (35.4%), followed by plunging type of termination in 137 blades (31.1%). The only difference during Chalcolithic period is that here both these terminations are almost in equal quantity. Both of these are common terminations for blades and thus their high presence is not surprising. Not many blades falling in this category were either utilised or retouched from their distal ends.

Proximal Blade Fragments and Mesial Blade Fragments: Simple blades seem to have a clean break/snap most of the time during both the periods (95 blades during Mesolithic period and 274 blades during Chalcolithic period show this termination). Since more than 70% of broken blades have edge damage, can it be presumed that they broke while they were in use and thus were discarded? Or were these intentionally broken? Intentional breakage does not seem the plausible answer as these blades are quite small in size (see below). Retouched distal end [23 blades or 10.5% during Mesolithic period and 58 blades (10.9%) during Chalcolithic period] and stepped distal end [22 blades

(10%) during Mesolithic period and 62 (11.7%) during Chalcolithic period) are present almost in equal quantity. Very few blades (9 or 4.1%) during Mesolithic period and 25 (4.7%) during Chalcolithic period] were used by their distal ends.

Edge Damage and Retouches: It was found that 73.9% of the blades show light to heavy edge damage during Mesolithic period while a high proportion of blades (86.1%) show slight to heavy damage during Chalcolithic period leading to the conclusion that they were used for some or the other purpose.

Metric Comparison between Different Types of Intact Blades

Length: Retouched blades and backed blades are the longest blades while obliquely blunted blades appear to be the shortest during Mesolithic period. Amongst the Chalcolithic period blades backed blades are the longest while simple blades are the shortest (Table 1). All the types have high values of standard deviations making their values very diverse. It is puzzling that blades which have been retouched are longer than the blades which do not have retouches. Even blade flakes have a lower value than non-retouched blades. It appears that longer blades were selected for retouching while comparatively smaller blades were utilized on their own.

Table 1: Metrics of length of various types of intact blades (measurement in mm) of Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	21	13.47	13.7	6.59	4.92	24.2
Backed blades	3	17.04	17.45	9.19	7.65	58.57
Blade flakes	112	15.29	14.08	10.85	5.70	32.55
Retouched blades	4	17.05	16.85	10.78	6.21	38.62
Obliquely blunted blades	2	12.39	12.39	10.52	2.65	7.03
Chalcolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	77	11.25	10.87	8.95	4.43	19.70
Backed blades	18	16.59	15.73	7.06	6.63	44.01
Blade flakes	224	14.02	13.07	15.5	5.78	33.46
Retouched blades	8	14.69	14.03	8.2	4.29	18.48

Breadth: Standard deviations of breadth values are not very large, showing that there was no significant difference of breadths in different types of blades, except amongst blade flakes of both periods (Table 2). Blade flakes are also the broadest blades amongst all the different types. Since there is not a significant difference in the breadth of backed blades versus simple blades, it appears that only broad blades were being chosen for retouches during both the periods.

Thickness: Thicknesses of different blades seem not to differ too much although simple blades do show lower values than others types of blades. Blade flakes are the

thickest while simple blades are found to be the thinnest blades amongst both periods (Table 3). Backed blades, retouched blades and obliquely blunted blades show more or less similar values during Mesolithic period while backed blades and retouched blades show similar values during Chalcolithic period.

Table 2: Metrics of breadth of various intact blades (measurements in mm) of Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	21	5.71	5.49	3.37	1.42	2.02
Backed blades	3	6.2	5.8	4.84	1.61	2.58
Blade flakes	112	9.99	8.84	6.09	4.75	22.63
Retouched blades	4	5.71	5.56	4.39	1.3	1.68
Obliquely blunted blades	2	5.98	5.98	4.7	1.81	3.30
Chalcolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	21	5.71	5.49	3.37	1.42	2.02
Backed blades	3	6.2	5.8	4.84	1.61	2.58
Blade flakes	112	9.99	8.84	6.09	4.75	22.63
Retouched blades	4	5.71	5.56	4.39	1.3	1.68
Obliquely blunted blades	2	5.98	5.98	4.7	1.81	3.30

Table 3: Metrics of thickness of various intact blades (measurements in mm) of Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	21	1.64	1.28	0.79	0.76	0.58
Backed blades	3	1.98	1.96	1.81	0.19	0.04
Blade flakes	112	2.89	2.42	2.75	1.62	2.64
Retouched blades	4	2.05	1.87	0.97	1.16	1.34
Obliquely blunted blades	2	1.91	1.91	1.10	1.14	1.31
Chalcolithic Period						
Blade Types	**No**	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Simple blades	21	1.64	1.28	0.79	0.76	0.58
Backed blades	3	1.98	1.96	1.81	0.19	0.04
Blade flakes	112	2.89	2.42	2.75	1.62	2.64
Retouched blades	4	2.05	1.87	0.97	1.16	1.34
Obliquely blunted blades	2	1.91	1.91	1.10	1.14	1.31

Geometric and Non-geometric Tools

Geometric tools such as isosceles triangles, scalene triangles, lunates and trapeziums and non-geometric tools such as points (Fig. 8) and various types of scrapers were discovered from Mesolithic period as well as Chalcolithic period level. Amongst

Figure 8: Geometric and non-geometric tools from Loteshwar (courtesy: NoGAP)

the geometric variety of tools, lunates are the most common during both the periods (45 during Mesolithic period and 84 during Chalcolithic period). Lunates have been associated with projectile points as well as cutting tools, thus giving them a larger functional territory. Since Loteshwar is primarily a hunting-gathering settlement this could precisely be their function. Trapeziums, triangles and points are associated with

hunting gear too. One of the surprising elements is the almost complete absence of scrapers during Mesolithic period. Different types of scrapers have been generally reported from a Mesolithic period lithic assemblage. The scarcity of these at this level of Loteshwar is puzzling. Chert (41 tools, 53.9% during Mesolithic period and 99 tools 55% during Chalcolithic period), followed by Chalcedony (22 tools, 28.9% during Mesolithic period and 49 tools 27.2% during Chalcolithic period) was the favoured raw material to make different tools during both the periods. Carnelian gives proof of heat treatment given to raw materials to facilitate in knapping which seems to be practiced at Loteshwar. Banded agate (5 tools, 6.6% during Mesolithic period and 12 tools 6.7% during Chalcolithic period) and moss agate (1 tool, 1.3% during Mesolithic period and 4 tools 2.2% during Chalcolithic period) show their presence but are rare. Both were exploited to make geometric tools. Quartz is very rare too and was utilised exclusively for the manufacturing of geometric tools in both periods.

Lithic debitage

Lithic debitage was divided into flakes [primary (with cortex), secondary (without cortex) and core rejuvenation], nodules, cores and waste/shatter (undiagnostic broken fragments or tiny debitage pieces without any specific shape or form). A total of 506 primary and 690 secondary flakes of different raw materials have been recovered from Mesolithic period while 637 primary and 1090 secondary flakes of different raw materials have been recovered from Chalcolithic period. Not many nodules (16 from Mesolithic period and 22 from Chalcolithic period) were found in either period. 6 core rejuvenation flakes from Mesolithic period while 4 core rejuvenation flakes from Chalcolithic period were identified from the lithic assemblage. A total of 289 fragments of waste/shatter belonging to different raw materials were identified from the Mesolithic period lithic debitage whereas 838 fragments of waste/shatter belonging to different raw materials were identified from the Chalcolithic period lithic debitage.

Cores

A core (Figs. 9 and 10) is a mass homogenous lithic material that has had flakes removed from its surface. The primary purpose of a core is to supply flakes that can be used for the production of various tools. As flakes are removed from the core it gets progressively smaller until it is finished or exhausted (Andrefsky 2005). Exhausted cores, if studied properly, can give a lot of information regarding preparation, blade removal techniques and sharing/continuation of technology.

Core Type: Primarily a core was classified as blade cores or flake cores. A single core was found to have been used as a scraper and thus was classified under a different category of core cum scraper. Almost 84% (46) cores belonged to blade core category during Mesolithic period, which increased during Chalcolithic period where 93% (77) blade cores were identified. This preponderance of blade cores confirmed the findings of formal tools such as blades and geometric tools made out of blades during both the periods. Most of the cores belong to the raw material chert (22 cores during Mesolithic period and 39 cores during Chalcolithic period), followed by chalcedony (17 during

Mesolithic period and 15 during Chalcolithic period) and banded agate (9 during Mesolithic period and 14 during Chalcolithic period). The only difference between Chalcolithic and Mesolithic being the presence of blood stone blade cores (2) during Chalcolithic period. These findings support the distribution of raw material found amongst various tools as well as other lithic debitage.

Figure 9: Cores from Loteshwar (courtesy: NoGAP)

Figure 10: Cores from Loteshwar (courtesy: NoGAP)

Core Shape: It is one of the features that can provide a great deal of information about the production technique employed (Raczek 2007). Conical shape (15 during Mesolithic period and 10 during Chalcolithic period) is formed due to unidirectional removal of blades and thus it is end result of blade technology. Cylindrical cores (3 in Mesolithic and 16 during Chalcolithic period) too are end results of blade technology but here blades have been removed bidirectionally. A wedge shaped core (12 in Mesolithic and 10 during Chalcolithic period) is generally formed when a nodule is broken into four parts and then flaked only from one face, thus having a wedge silhouette when views from a side. Block cores (5 in Mesolithic and 10 in Chalcolithic period) have a cubical look where generally blades are removed from all the sides. Flat cores (7 in Mesolithic and 21 in Chalcolithic period) have a very flat back, most of the time covered in cortex. Quartering technique is known to produce cores of this variety. Semi conical cores (6 in Mesolithic and 13 in Chalcolithic) too are end products of quartering technique, the difference between them and flat cores are that the former will have a conical shape.

Blade Removal Pattern: Cores where blades were removed from only one side have been categorised as sliced, cores on which blades were removed by rotating come under rotated category and cores where flakes have been removed without a particular pattern have been called flexible [adapted from (Raczek 2007)]. Amongst the Mesolithic period blade cores, 31 or 67.4% cores show rotating blade removal, 9 or 19.6% show slicing blade removal and 6 or 13% show flexible removal of blades. This is in stark contrast to the flake cores where 87.5% show flexible removal of blades/flakes. For the Chalcolithic period blade cores it was seen that 21 or 28.38% cores were sliced, 52 or 70.27% were rotated and 1 or 1.35% showed flexible blade removal. All the flake cores showed flexible blade removal during this period.

Core Platform Preparation: Five different types of core platform preparation methods have been noted for the cores. Removal of multiple flakes to make the platform was the most common (16 cores or 34.78%) method for blade cores during Mesolithic period. However during Chalcolithic period, it was seen that single flake removal was more frequent (25 cores or 33.78%). Most probably this is due to the removal of platform rejuvenation flake. It is a common practice in blade cores to remove a flake diagonally from top of the core and rejuvenate the platform. Removal of a single flake to make the platform was the second preferred method (15 cores or 32.61%) during Mesolithic period while removing multiple flakes was the second most frequent method (17 cores or 22.97%) during Chalcolithic period. A few platforms (7 cores or 15.2% during Mesolithic period, 9 cores or 11.7% during Chalcolithic period) were found to be in broken condition. During Mesolithic period 2 or 4.3% cores showed no platform preparation while 12 or 16.22% show no platform preparation during Chalcolithic period. 6 or 13% has shown chipping during Mesolithic period while 11 or 15.6% chipping was seen during Chalcolithic period. Amongst the flake cores, during Mesolithic period 87.5% show no type of platform preparation while 1 was found to be in broken condition. However during Chalcolithic period all flake cores are found to be without any platform preparation.

Core Platform Count: During Mesolithic period, amongst the blade cores, 35 or 81.4% cores showed a single platform, 5 or 11.63% cores showed double platforms and only 3 or 6.98% showed the presence of three different platforms whereas amongst the flake cores, 42.9% showed more than 3 platforms, 28.6% showed double platforms and the rest 28.6% showed three platforms for flake removal. During Chalcolithic period 56 or 81.16% blade cores had a single platform, 11 or 15.94% showed double platform while remaining 2 or 2.9% showed the presence of more than 3 platforms. Amongst the flake cores from this period it was seen that 50% had double platform while the other 50% had 3 or more platforms.

Core Butt Condition: During Mesolithic period, amongst the blade cores, 19 44.19% showed some amount of cortex on their butts. Only one core was found to have been utilized as an end scraper and thus showed regular retouches on its butt end. A total of 62.5% of flake cores showed presence of some amount of cortex on their butt ends. During Chalcolithic period, 13 or 17.57% showed presence of cortex and 20 or 27.03% showed some amount of retouching from the blade cores and amongst the flake cores 75% had cortex at their butt ends.

Cortex: Cores during both the period show the presence of cortex (35 cores or 76.09% during Mesolithic period and 52 or 70.27% during Chalcolithic period) supports local blade removal. Most probably nodules were brought from the raw material sources and the blades were being taken out at the site itself.

Metric Analysis of Cores: Metric analysis showed that cylindrical cores are the shortest, narrowest and thinnest amongst all cores. They were also flaked bifacially and most probably that is the reason they are the smallest cores present.

Length: All the cores, during both periods, have a high standard deviation value which clearly suggests variation in their lengths. However Conical and semi-conical cores of Mesolithic period have comparative low standard deviation values, while block and amorphous cores during Chalcolithic period show low standard deviation values (Table 4). Conical cores appear to be the longest cores while cylindrical cores are the shortest during Mesolithic period. During Chalcolithic period flat cores appear to be the longest while amorphous cores are found to be the shortest.

Breadth: The measurements of blade cores breaths show a very high standard deviation values for semi-conical cores during Mesolithic period while the standard deviation values for amorphous cores during Chalcolithic period are comparatively low. During Mesolithic period semi-conical cores are the broadest of cores while cylindrical cores are the narrowest cores (Table 5) whereas during Chalcolithic period, wedge cores are the broadest and amorphous cores are the narrowest of cores.

Thickness: During Mesolithic period block cores appear to be the thickest cores while cylindrical cores appear to be the thinnest (Table 6). During Chalcolithic period amorphous core are the thickest while conical cores are the thinnest of cores. There is a

Table 4: Metric analysis of lengths (in mm) of blade cores from Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	15	15.19	15.61	10.44	2.25	5.08
Cylindrical	3	11.64	14.22	3.62	7.09	50.28
Wedge	10	13.73	13.29	10.23	3.1	9.64
Block	4	14.71	12.54	12.31	4.49	20.23
Flat	7	14.8	14.33	11.33	3.69	13.65
Semi conical	6	13.28	13.56	9.87	2.76	7.59
Amorphous	1	12.38	12.38	12.38	0.00	0.00
Chalcolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	10	14.79	14.65	9.37	4.4	19.37
Cylindrical	15	14.22	13.61	12.02	3.35	11.24
Wedge	10	15.1	15.35	10.67	2.87	8.24
Block	6	12.01	12.41	8.34	2.13	4.53
Flat	21	15.83	14.86	10.91	3.73	13.90
Semi conical	13	15.34	15.09	9.19	4.67	21.84
Amorphous	2	9.09	9.09	7.27	2.57	6.62

Table 5: Metric analysis of breadths (in mm) of blade cores from Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	15	11.34	10.06	12.28	4.06	16.53
Cylindrical	3	9.29	9.96	2.65	6.33	40.14
Wedge	10	12.12	11.17	7.98	3.45	11.94
Block	4	11.65	9.73	9.24	4.18	17.46
Flat	7	13.5	12.3	7.01	4.10	16.88
Semi conical	6	12.77	12.71	10.87	1.46	2.13
Amorphous	1	13.44	13.44	13.44	0.00	0.00
Chalcolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	10	11.93	12.15	7.66	2.73	7.49
Cylindrical	15	11.1	10.92	6.76	2.95	8.69
Wedge	10	13.68	13.75	10.81	2.06	4.26
Block	6	11.84	12.05	4.95	4.45	19.85
Flat	21	12.65	12.67	7.44	2.91	8.47
Semi conical	13	11.15	11.45	6.5	2.14	4.58
Amorphous	2	10.49	10.49	9.94	0.78	0.62

big difference in their standard deviation values during Mesolithic period which changes during Chalcolithic period where we do not see very high standard deviation values (except for cylindrical and wedge cores).

Table 6: Metric analysis of thickness (in mm) of blade cores from Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	15	9.65	8.87	5.69	3.34	11.13
Cylindrical	3	8.03	7.01	3.12	5.5	30.21
Wedge	10	8.37	8.25	2.74	2.99	8.94
Block	4	10.24	8.45	7.5	4.23	17.91
Flat	7	8.3	8.2	3.94	3.2	10.18
Semi conical	6	8.97	7.74	6.90	2.57	6.61
Amorphous	1	8.15	8.15	8.15	0.00	0.00
Chalcolithic Period						
Core Shape	**No**	**Mean**	**Median**	**Mode**	**Std Dev**	**Variance**
Conical	10	8.4	8.38	8.64	1.74	3.04
Cylindrical	15	9.6	8.8	5.26	3.09	9.56
Wedge	10	7.7	8.11	1.00	3.35	11.23
Block	6	10.16	9.45	8.05	2.17	4.7
Flat	21	8.59	9.38	4.67	1.95	3.83
Semi conical	13	7.66	7.71	4.33	2.42	5.8564
Amorphous	2	10.51	10.51	9.27	1.76	3.1

Table 7: Metric analysis (in mm) of flake cores from Mesolithic and Chalcolithic period at Loteshwar

Mesolithic Period	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Length	23.60	21.60	16.53	6.35	40.39
Breadth	18.50	16.51	11.95	7.15	51.07
Thickness	15.86	13.62	11.55	4.76	22.71
Chalcolithic Period	**Mean**	**Median**	**Mode**	**Std dev**	**Variance**
Length	21.59	21.12	16.5	4.89	23.96
Breadth	19.66	20.18	13.32	4.91	24.1
Thickness	14.82	14.01	12.4	3.01	9.08

Flake Cores or Multidirectional Cores: Eight flake cores belonging to Mesolithic period were found. Since seven of them belong to amorphous category, analyses of their measurements are taken together. Although they have high standard deviation values, it can be seen from table no 7 that these were much larger, broader and thicker cores than blade cores. Only four flake cores were found from Chalcolithic period levels, three of which are block shaped while one was found to have amorphous shape. Measurements of all are taken together. Looking at the measurements (in mm) it

appears that the cores of Mesolithic period were longer, broader and thicker than the cores of Chalcolithic period.

Conclusions

The lithic assemblages of Mesolithic and Chalcolithic period recovered from the site of Loteshwar are mostly similar to each other. Loteshwar represents one of the earliest Mesolithic cultural developments (dated to 7000 BC) in western India (Patel 2008). The Mesolithic period is followed by the Chalcolithic period at the site which has been dated between 3790calBC-2500 calBC (Ajithprasad and Sonwane 2011). This clearly shows a very long continuation of habitation at one place. As can be expected such a long continuation also shows cultural development/changes. Thus a Mesolithic way of life comprising microlithic tools, grinding stones and bones of wild animals, specially black bucks (Patel 2009) suggesting a hunting and gathering economy changed over time to a Chalcolithic way of life where in addition to above mentioned artefacts, pottery defined as Anarta, semiprecious stone (including lapis lazuli) and steatite beads, shell bangles, copper bangle, spindle whorl as well as clay lumps with reed impressions suggesting wattle and daub structures (Ajithprasad et al. 2009) were found. The animals exploited during this period include, other than the wild ones, domesticated animals and it was found that domesticated cattle was in vogue at the site from the beginning of fourth millennium BC (Patel 2009). The material culture along with the faunal remains would suggest changing economic production with the beginning of settled way of life at the site.

One would think that this change in the economy which resulted in so many material changes should be reflected in the lithic assemblage. This, however, is not what we found at the site. There is hardly any change in the lithic assemblage associated with both the cultural periods, especially as far as the technology is concerned. The numbers of artefacts found during Chalcolithic period are significantly higher than the number of artefacts which are found from the Mesolithic period. The minor differences which were observed between the periods are as following: abundance of blade-flakes, larger number of retouched (irregular retouches/notches, does not imply backing) simple blades and more lunates amongst the geometric tools were identified from the Mesolithic period assemblage. Chalcolithic period, on the other hand, showed a preponderance of simple blades and majority of these blades showed signs of utilisation. The Chalcolithic period showed an increase of triangles and trapezes amongst the geometric tool category as well as an increase of non-geometric tools, especially scrapers. The predominance of blade flakes and retouched blades during Mesolithic period and the increase in geometric and non-geometric tools during the Chalcolithic period are interesting since geometric tools are generally associated with Mesolithic period. Both the periods have a preponderance of blade cores but it was observed that at the Mesolithic level flake cores had a higher presence. The technique of blade removal during both the Mesolithic and Chalcolithic periods was the Quartering technique (Allchin 1966, Ajithprasad 1992) which is reflected in the blade cores found from the site. The most striking feature is the absence of any metrological

and morphological difference between cores found in two different cultural periods. There appears to be only one type of technology involved in the production of microliths throughout almost four thousand years. This observation leads to the conclusion that there is a continuity of tool making tradition as far as the technology is concerned between the Mesolithic and the early Chalcolithic levels at Loteswar. Tool typology and metric analysis, however, shows a few changes between the two cultural periods. These are found to be the presence of more retouched blades during Mesolithic period and thinner and narrower blades during Chalcolithic period. The metric changes which were observed between the blades show that the blades of Chalcolithic period were thinner and narrower than the blades of Mesolithic period. We would like to assume here that metric changes might be due to the knapper's skill which has improved over time or the standardisation of products during later period. The high level of utilisation of blades during Chalcolithic period demands further study as well.

The lithic debitage shows maximum utilization of raw material. A raw material source near the site has not been identified till now but it can be hypothesized that since this was a settlement belonging to hunter-gatherers getting raw materials from sources located far away would most probably not have been impossible. Thus it is possible that the raw material was precious and people wanted to make full use of whatever was available to them.

Acknowledgement

We are very thankful to the Archaeological Survey of India and, Gujarat State Department of Archaeology for granting us permission to excavate at Loteshwar. We are also very thankful to the people of Loteshwar for their hospitality and support. The first author is thankful to the reviewers for their suggestions and comments.

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