Analyzing and Contextualizing the Lithic Assemblage from the Acheulian Site at Bori, Pune District, Maharashtra

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Abstract: The Acheulian site at Bori on the Kukdi River in Pune district, Maharashtra is well known, partly due to the controversial dates of tephra from the site and its association with the Acheulian artefacts. In this communication, the lithic assemblage from the site at Bori has been analyzed. The assemblage consists of artefacts made from basalt and dolerite dyke. The assemblage is dominated by small flakes followed by finished tools like picks and cleavers. Small flakes are a result of rough-out reduction, shaping and biface trimming processes. The technological aspect of these artefacts has been considered for the first time in detail.

Keywords: Acheulian, Bori, Kukdi River, Picks, Small Flakes, Tephra, Chronology

Introduction
Lower Palaeolithic studies in the Deccan volcanic province commenced with the accidental findings of Acheulian artefacts at Gangawadi in early 1950s, almost a century after the discovery of first Lower Palaeolithic tool by Robert Bruce Foote in 1863 at Pallavaram (Sankalia 1952). Further studies were carried out in the Godavari River valley (Sankalia 1952; Joshi et al. 1966; Kumar 1985, 1989; Gohil et al. 2015; Raphael et al. 2015; Deo et al. 2018) and its tributaries like the Pravara (Sankalia 1956;

Though these findings were important, they were confined only to the Godavari basin. An attempt to locate palaeolithic evidence in the upper Krishna basin was made by Pappu (1974), which yielded meager evidence of Acheulian artefacts in the Deccan volcanic province. Interestingly, a significant discovery of an Acheulian site at Yedurwadi in the upper Krishna basin was made in the 1980s by Kale et al. (1986). The site is located on the right bank of a link-channel of the Krishna River. This finding was important due to its location, raw material availability and exploitation pattern, and chronology. Apart from a solitary instance of the use of quartzite, artefacts at this site were made exclusively on basalt (Joglekar et al. 2011). This discovery of Acheulian artefacts for the first time in this region confirmed early hominin presence in this part of the Deccan volcanic province and lead the foundation for further surveys in other river basins apart from the Godavari basin. This led to further explorations in other river valleys. The current paper elaborates the site context, lithic assemblage and a few observations on the various dates of the tephra deposits at the site of Bori in the Kukdi basin, based on recent work by the first author (Jangra 2017).

Figure 1: Location of Bori on Survey of India Toposheet No. 47 I 4 (1:50,000), (Inset: Location of Bori in Maharashtra)
Site Context

Along with the upper Krishna basin, Kale and his team surveyed the Bhima basin in the Pune district in the 1980s (Figure 1). During one of these expeditions, the site at Bori was discovered (Kale et al. 1986). A majority of the artefacts were collected from the cobbly-pebbly conglomerate located on the left bank of River Kukdi, an easterly flowing tributary of the Ghod that eventually joins the River Bhima. These discoveries of Bori and Yedurwadi were a milestone in Lower Palaeolithic studies in the Deccan volcanic province. The bedrock at Bori is covered by varieties of basalt intruded by a few dolerite dykes in the vicinity (Figure 2). River Kukdi is an allochthonous river, tracing its major catchment area to the Western Ghats which receives <2500 mm rainfall annually. It flows through a wide shallow rocky valley with well-developed pediments and inselbergs formed on the basaltic bedrock.

Prior to these findings from the Krishna and Bhima basins, it was suggested that basalt was not a durable raw material and hence, the palaeolithic record had not been preserved properly. At most of the previously studied sites like Gangapur, Laxmina, Nevasa, Chirki-on-Pravara, etc it was observed that many of the artefacts disintegrate once they are removed from their context due to the release of pressure of the later period covering sediments (Mishra 1982), same is not the case with artefacts from Bori. The artefacts at Bori were found to be preserved below the volcanic ash which was dated to 1.4 ma, and were therefore, claimed to be the earliest Indian Lower Palaeolithic artefacts at that time in peninsular India (Korisettar et al. 1989).
Acheulian artefacts are also preserved in the alluvial deposits containing tephra lenses exposed on either bank of River Kukdi. It is to be noted that the cemented gravel from which artefacts were excavated is pebbly gravel. Large sized artefacts are a misfit in this context. Apart from the artefacts, no shaped angular pieces are a part of this cemented gravel.

**Fluvial Sedimentary Units around Bori**

Sediments of different time periods have been observed around the site at Bori (Figures 3-6) over the last 30 years. These have been documented by many scholars at different localities of Bori (Kale et al. 1986; Korisettar et al. 1989; Mishra et al. 1995; Deoet al. 2007). These are briefly described from lowermost to surface as follows:

Reddish-brown calcretised silt is the lower most layer capping the bedrock. This unit has not yielded any artefacts. The silt layer has differential thickness (0.5-2.0 m) at various spots, and at places has preserved a few lenses of rubbly-gravel, rich in angular to sub-angular pieces of basalt.

The silt is capped by dark fissured clay on which rests the Acheulian artefact-bearing cobbly-pebbly gravel at places differentially cemented and loose at some spots. This gravel has yielded Acheulian artefacts and also mammalian fossils. The gravel comprises around 95% of basalt and 5% of siliceous material. The pebbles are sub-rounded to rounded suggesting long distance transport of the gravel in the past. Artefacts are the only angular/sub-angular pieces preserved within this gravel, and are therefore a misfit. Some of these artefacts are made from dolerite dyke, located downstream of the site. As observed earlier by (Mishra et al. 1995 and Deoet al. 2007) the artefact and fossil yielding gravel was deposited during a short duration of time and was sealed by clay and thus preserving the archaeological record. The cobbly-pebbly conglomerate has only three types of lithoclasts i.e. basalt, dyke, and siliceous material. This type of conglomerate consists of only two or three lithoclasts has been classified as an oligomict conglomerate by Nichols (2009).

Black fissured clay and tephra caps the artefact-bearing gravel at a few spots, while at some spots this layer is missing. Occasional Acheulian artefacts have also been reported from this layer.

Calcareous yellow silt caps the underlying black fissured clay unit at many spots. This is a commonly identified Late Pleistocene deposit especially in this part of peninsular India.

The calcareous yellow silt is capped by black fissured clay at most places.

The black fissured clay is capped by microlith-bearing calcite rich sandy-pebbly gravel. Ostrich egg shell from this horizon was dated to 30,000 BP along with a few microliths made on siliceous material (Possehl 1994).
This gravel is capped by clay of the Holocene period which has yielded cultural material of the early Historic period (Jangra 2017).

Previously, ten tephra-bearing localities within a stretch of 8 km were reported (see figure 1 of Mishra et al. 1995). A composite stratigraphy of all these litho-units observed at a number of localities was prepared earlier (see figure 3.2 Deo et al. 2017).

Figure 3: Brownish Silt and Tephra, Right Bank of River Kukdi, Bori
The Assemblage

The lithic assemblage from Bori was mostly excavated during the work undertaken by Kale et al. (1986), and a few artefacts were collected later on during subsequent visits by various scholars. A total of 213 artefacts and a fossilized tusk of Elephas sp. were collected from the cemented gravel at three localities, viz. Jadhavwadi, Ambrai and Shiroli and also occasionally in loose gravel. The lithic assemblage comprises of picks, handaxes, cleavers, cores, hammer stones, worked slabs, nodules, scrapers, choppers and flakes (Table 1). Flakes of varied dimensions dominate the lithic assemblage and are classified as chips, medium-sized flakes and large flakes. All artefacts demonstrate thin yellowish green or greyish patina but have fresh edges. These artefacts are made on basalt and from the closest dolerite source that lies exposed downstream of the Acheulian artefact-bearing gravel, thereby indicating that they are not part of the fluvial gravel. Out of 213, 28 artefacts are made on dolerite (20 finished tools and 8 flakes), while the remaining 185 are made on fine grained, gray to dark gray basalt (23 finished tools, 157 flakes and 5 other artefacts). This composition of artefacts suggests that the majority of the doleritic tools were prepared somewhere else and brought to this spot where they were preserved in the conglomerate. As the Acheulian artefacts are a total misfit in the rounded pebbly conglomerate, they appear to occur in a semi-primary context and not re-deposited as argued by some scholars (Petraglia 2011; Westgate et al. 2014; Westgate and Pearce 2017). In short, our studies clearly demonstrate a close association between the tephra and Acheulian artefacts around Bori. The assemblage is further described here as follows: The finished tools in the assemblage have been primarily divided into core-based tools and flake-based tools (Table 2). The flake-based finished tools are mostly large sized i.e. > 10 cm in length while other small flakes are a part of the reduction sequence suggesting the large flake Acheulian tradition (Sharon 2007).
Figure 5: Calcareous Yellowish Silt Capping the Basal Gravel, Left Bank of River Kukdi, Bori
Figure 6: Microlith-bearing Sandy Pebbly Gravel with Lenses of Pool Clay, Left Bank of River Kukdi, Bori

Table 1: Composition of Lithic Assemblage from Bori

<table>
<thead>
<tr>
<th>Types</th>
<th>Number of Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picks</td>
<td>7</td>
</tr>
<tr>
<td>Handaxes</td>
<td>2</td>
</tr>
<tr>
<td>Cleavers</td>
<td>7</td>
</tr>
<tr>
<td>Cores</td>
<td>15</td>
</tr>
<tr>
<td>Hammer stones</td>
<td>2</td>
</tr>
<tr>
<td>Worked slab</td>
<td>2</td>
</tr>
<tr>
<td>Nodule</td>
<td>1</td>
</tr>
<tr>
<td>Scrapers</td>
<td>8</td>
</tr>
<tr>
<td>Chopper</td>
<td>4</td>
</tr>
<tr>
<td>Flakes</td>
<td>165</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>213</strong></td>
</tr>
</tbody>
</table>

**Cores**

Out of the 15 cores (Figure 7), 14 are made from dolerite dyke nodules, while a single flake core is made from basalt. The mean dimensions of the cores are 7.87 x 6.97 x 5.81 cm with weights ranging from 35 gm to 880 gm. A minimum of 3 and a maximum of 20 flake scars were observed on these cores. It is quite clear from the size of these cores
that none of these was trimmed for detachment of a large flake. The only flake core has two large convex flake scars (12.7 x 7.63 cm and 10.3 x 4.1 cm) present on both surfaces of the core. This flake core is suggestive of Kombewa technique being employed at the site.

Table 2: Distribution of Finished Tools

<table>
<thead>
<tr>
<th>Finished tools</th>
<th>Numbers</th>
<th>Flake-based</th>
<th>Core-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choppers</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Scrapers</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Cleavers</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Handaxes</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Picks</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Cores</td>
<td>15</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>18</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

Figure 7: Cores

Picks
A total of seven trihedral picks (Figure 8) have been recovered from the site. Interestingly, all of them are made on dolerite. Six of them are made on parallelepipedic cobbles, with untrimmed heavy butt and pointed apex except in a single case where all the edges are almost parallel. The mean dimensions are 14.47 x
Figure 8: Picks
8.63 x 6.15 cm and the weights vary from 580 gm to 1290 gm, and average tip length is 4.93 cm. Three of them are slightly abraded and the remaining 4 are fresh. All of them show patination of light gray (10YR 6/1) colour and cortex has light olive brown (2.5 Y 6/4) patination according to the Munsell rock color chart (2009).

Out of seven picks, two are made on flakes, both of which are unifacial. One is notably smaller and does not show any secondary flaking; it was probably detached from a prepared core. Dark grayish brown (2.5 Y 4/2) patina was observed on this pick. The other pick is bigger in size and has a thick cross-section. This pick has shallow flake scars as compared to other core-based picks.

**Handaxe**
The handaxe is bifacially flaked on a cobble clast of basalt. It has a thick cross-section and radial flake scars. The dimensions are 9.43 x 7.63 x 5.51 cm and it weighs 370 gm.

**Choppers**
There are four choppers in the assemblage; one is bifacial and the other three are unifacial. The mean dimensions of the choppers are 9.1 x 8.3 x 6.2 cm and weights range from 190 gm to 860 gm. The raw material used for one chopper is dolerite while the rest are made of basalt. One of them is highly abraded, two are moderately abraded, and the bifacial chopper is fairly fresh.

**Scrapers**
A total of seven scrapers are present in the assemblage. Apart from two made on pebbles, the rest are made on flakes. The two pebble scrapers have rounded edges and are highly abraded. Patina on these scrapers is light gray (10YR 6/1). The mean dimensions are 6.8 x 5.4 x 2.3 cm, and weights range from 40 gm to 280 gm including the pebble scrapers. These scrapers were made exclusively by using basalt. A majority of them are retouched. There are two side-scrapers and three end-scrapers among the flake tools. One of these flake-based tools is a scraper-cum-awl, retouched on two adjacent sides with observable notches giving it a projecting point (Figure 9). Three of the scrapers have retained 60% - 80% of the cortex on their dorsal face.

**Cleavers**
Six cleavers(Figure 10)and one cleaver flake forming 3% of the assemblage are present. All of them are made of basalt. Three cleavers are made on end-flakes while the remaining three are made on side-flakes. Three of them are highly abraded, two are moderately abraded, and two are fairly fresh. The mean dimensions of cleavers are 11.4 x 8.9 x 4.2 cm, and weights range from 110 gm to 980 gm. A maximum of 11 flake scars have been observed on the surface of one of the cleaver.

**Flakes**
Flakes are the most dominant in the lithic assemblage as shown in the Table 1. They constitute 78% (165) of the assemblage. The mean dimensions of the flakes are 6.85 x
5.4 x 2.6 cm and weights range from 3 gm to 1070 gm. Due to this wide range, flakes are divided into three categories on 3-point scale, namely chips (< 3cm, n 5), medium sized flakes (3-10cm, n 152) and large flakes (> 10cm, n 8). The frequency of chips and large flakes is very low. Large flakes do not show any particular pattern, they were probably produced for making tools. Majority of the flakes come under the medium sized category. Most of the chips must have been washed away or were not collected. Flakes includedebitage, and also those with secondary modifications by anthropogenic activities such as damaged edges/use marks, secondary flaking and retouches. Flakes with secondary modifications consist mostly of minimally trimmed flakes, which show no pattern of shaping and do not fit into any type of the shaped tool classes. These flakes have preserved previous flake scars, sometimes have retouches or utilization marks. Only eight flakes are made from dolerite dyke and rest of them are made on basalt. Majority of the flakes are fresh and rarely abraded. The most common patina on the scars are shades of gray, yellowish brown (10YR5/6) and olive brown (2.5YR 4/4). Whereas the patina on the cortex shows mostly gray, yellowish brown and reddish brown shades. The flakes found at the site are dominated by bifacial reduction products.

![Figure 9: Scraper-cum-awl](image)

Out of 165 flakes, 85 flakes are having normal bulb/point of percussion, 43 flakes with prominent bulb/point of percussion, while and remaining 37 flakes with diffused bulb/point of percussion. This has probably happened due to the variability in the
mineral composition of the raw material, different levels of force applied for detachment of the flakes, purpose for which the flakes were detached, secondary reduction, preservation condition, etc.

Figure 10: Cleavers

Flakes as Lithic Waste/By-products
Lithic waste or debitage is the major and significant component of the assemblage from Bori. These are further classified into few categories as follows:

Bifacial Waste Product: A majority of the flake components are medium sized (3-10 cm) as mentioned earlier and show the characteristics of shaping and thinning of bifacial tools.

Rough-out Flakes: These are such flakes (Figure 11) which comprise those arising from the initial stages in the shaping of large flakes. They may/may not contain cortex
depending on the characteristics of the original large flakes. They are generally thick and \( \geq 5 \) cm in length/breadth, and with a plain and cortical striking platform, as per defined by Newcomer (1971). Presence of rough-out flakes in the assemblage indicates that the large flake blanks were brought and shaping was performed at the site.

*Biface Shaping and Thinning Flakes:* After roughing-out of the large flakes, shaping and thinning of the biface blank is done. Three types of bifacial shaping and thinning flakes (Figure 12) are observed. Type A: representing thinning and finishing, having feather like termination. Type B: having previous flake scars, mainly one or two which can occur due to the rehearsing of flaking before actual striking out of a flake. Type C: elongated flakes, reduced while shaping of the bifaces (Newcomer 1971; Sharon 2007).

*Cortical Flakes:* The flakes which have a cortical dorsal face or if some part of the dorsal face has cortex is a cortical flake. Cortex removal is a result of shaping out (in case of cores) and rough-out/thinning (in case of bifacial pieces). Out of 164 flakes, 51 flakes have cortex. Out of these 51 flakes, 17 of them have 0-25% cortex, 11 bear 25-50% cortex, 7 flakes have 50-75% cortex and 16 flakes have 75-100% cortex.

*Large Flakes and Other Non-bifacial Waste:* The non-bifacial waste and some large flakes were detached not for producing tools but were a result of core trimming process or were accidental breakages. Marginal shaping is seen on such flakes and that is why they cannot be considered as finished tools, though they could have been used as a tool. Along with large flakes, three split cobbles are also present. Split cobbles do not have any secondary modification but have use-marks on their edges.
Apart from the above mentioned artefacts, two worked slabs, two hammerstones (?), and 1 nodule is also part of the assemblage. Small/medium sized flakes are most dominant in the assemblage. This suggests that bifaces and other tools were prepared in the surroundings of Bori. These flakes got preserved as the cementation of the gravel had taken place rapidly as suggested by previous scholars (Mishra et al. 1995 and Deo et al. 2007). Large/giant cores are absent in the assemblage which confirms that the initial large flakes were detached elsewhere. Water worn cobbles and pebbles of basalt were exploited where they were easily available as part of the channel gravel. Dolerite dyke which is slightly away from the site was exploited mostly for making finished tools i.e. large cutting tools (LCTs) (picks, handaxes, cleavers, scrapers). Very few small flakes of dolerite dyke are part of the assemblage; on the other hand LCTs are greater in number suggesting that the preparation of the tools of this raw material was done away from the environs of Bori, probably near the source of the raw material. Contrastingly basalt artefacts include LCTs as well as smaller flakes suggesting that this raw material was exploited at the sites itself. It can be inferred that the early hominins occupying this landscape have harnessed different raw materials in varied forms. Core-based finished tools are greater in number. This can be interpreted, that the boulders were not easily
available for detachment of large flakes; hence the cobbles and pebbles of basalt which are available in the vicinity were exploited for making tools. This highlights the cognitive capabilities of the early hominins to adapt strategies according to their requirements. Fragmentary nature of reduction sequence of this assemblage probably is indicative of early phase of the Acheulian.

**Chronology**

Bori is one of the first sites in India where tephra was discovered in association with Acheulian artefacts. Many attempts were made to date the tephra from Bori using various dating methods (Table 3). A total of 10 absolute dates obtained for the tephra ranging from a maximum age of 1.4 Ma (Korisettar et al. 1989) to a minimum age of 23.4 ± 2.4 ka (Horn et al. 1993) i.e. from the Early to the Late Pleistocene period. However, the association with Acheulian artefacts certainly supports the early Middle Pleistocene age.

**Table 3: Absolute Dates for Tephra at Bori**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Date</th>
<th>Dating Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korisettar et al. 1989</td>
<td>1.4 Ma</td>
<td>K-Ar dating method</td>
</tr>
<tr>
<td>Horn et al. (1993)</td>
<td>0.538 ± 0.047 Ma</td>
<td>K-Ar dating</td>
</tr>
<tr>
<td></td>
<td>0.64 ± 0.29 Ma</td>
<td>Fission track</td>
</tr>
<tr>
<td></td>
<td>23.4 ± 2.4 Ka</td>
<td>Thermoluminescence</td>
</tr>
<tr>
<td>Mishra et al. (1995)</td>
<td>0.67 ± 0.03 Ma</td>
<td>Ar-Ar dating</td>
</tr>
<tr>
<td>Chen et al. (2003)</td>
<td>0.8 Ma (Oldest Toba Tephra)</td>
<td>Chemical and isotopic studies</td>
</tr>
<tr>
<td>Sangode et al. (2007)</td>
<td>&gt;0.78 Ma</td>
<td>Paleomagnetic dating</td>
</tr>
<tr>
<td>Westway et al. (2011)</td>
<td>714 ± 62.4 Ka</td>
<td>Ar-Ar dating and geochemical analysis</td>
</tr>
<tr>
<td>Biswas et al. (2013)</td>
<td>27 ± 3 Ka</td>
<td>Thermoluminecence</td>
</tr>
<tr>
<td>Westgate et al. (1998 and 2014)</td>
<td>74 Ka (Youngest Toba Tephra)</td>
<td>Geochemical data of the glass shards, presence of multiple glass populations and Fission-track age determination</td>
</tr>
</tbody>
</table>

Our field observations and typo-technological studies of artefacts strongly demonstrate a semi-primary context of the early Acheulian artefacts and thus raise doubts about the Late Pleistocene ages of tephra and reworking of artefacts as argued by some scholars (Horn et al. 1993; Petraglia 2011; Westgate et al. 2014; Westgate and Pearce 2017).

**Remarks**

After more than three decades of research at the site at Bori, it can certainly be concluded that this site is a unique case where the tephra dating and their connection with the Acheulian artefacts has created redundant controversies. Various groups of scholars have different opinions about the tephra, but none has denied the presence of
Acheulian artefacts. These Acheulian artefacts are certainly made using older technology rather than the technologies used around the YTT event. So if the YTT dates are accepted, then these artefacts will be the latest representation of Acheulian globally, which does not seem to be the case, neither typo-technologically nor geomorphologically. In fact, the dominance of picks in the assemblage suggests that these pointed artefacts were used for digging purpose during/post-ash fall.

A few key points are lucid from the present study, as follows: 1) the artefacts are certainly at least in the semi-primary context, if not primary, otherwise small flakes in such high percentage would not have been present in the assemblage, 2) artefacts are a part of a large flake Acheulian assemblage despite the dominance of the medium sized flakes, 3) the typology of the assemblage at Bori is mostly a site specific demand and hence such a variability, which is visible by the dominance of picks, 4) the assemblage fits into the Early Acheulian category and certainly belongs to at least the early Middle Pleistocene. Recently, Shipton et al. (2014) have elaborated the characteristic features of the Early Acheulian and Late Acheulian in the Indian context comparing assemblages from different sites and suggested that the Early Acheulian tools are usually thick, which is apt for Bori assemblage.

In the Deccan trap region apart from the site at Bori there are only few sites like Morgaon, Yedurwadi, Chirki-on-Pravara, Nevasa, and Ganganpur which has given evidence of small flakes along with large flake bifaces (Mishra 2007). The assemblage is somewhat similar to the assemblage from the site at Yedurwadi, Belgavi district, Karnataka (Joglekar et al. 2011). The assemblage from Yedurwadi also comprises of a majority of medium and small flakes which are a part of the bifacial trimming process, and also consists of a higher percentage of pick-like pointed tools. In both the cases, the initial large flake detachment was done somewhere else and large flakes were brought to the site where these were trimmed and made into finished tools. This suggests the similar cognitive abilities of early hominins surviving in different geographical regions. The Acheulian site at Bori with good number of Acheulian artefacts from cemented gravel and having a close association with tephra still remains a challenging problem for future multi-disciplinary investigators.

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