Chapter-2

Field Investigations and Remote Sensing

This chapter provides detailed information on the geoarchaeological field investigations carried out in the Jonk River valley. It also gives a brief account on the field observations, the location and contexts of the sites discovered. The chapter further describe about the selected fluvial sections recorded during the fieldwork, settlement pattern and site formation of the Acheulian and Microlithic sites. Lastly, remote sensing and GIS studies are also included in this chapter.

2.1 Field investigations and results

The areas surveyed for understanding geoarchaeology included lower, middle and upper parts of Jonk River and most of its tributaries. Survey was successful as 61 new archaeological sites were discovered and recorded. The discovery includes 15 Acheulian, four Middle Palaeolithic and 39 microlithic sites. Most of these sites were discovered in the Jonk River basin, its tributaries and also along the hill slopes. Among these, the Lower Palaeolithic sites are located on the hill slopes and erosional gullies on the foot hills, whereas a few sites are located in gravels exposed in the river sections. Microlithic sites, on the other hand, are found at the base of the hills spread over the granitic outcrops or near the exposed cliff surfaces of the river. Some artifacts belonging to later periods were also discovered during the course of exploration. One Neolithic celt manufacturing site was discovered at Jagdispur in Raigarh district of Chhattisgarh. Though not the goal of the investigator, three new Early Historic settlements were also discovered. The site distribution map (Map 2.1) of the study area was prepared to broadly understand the site distribution patterns. A list of explored and discovered sites is given (Table 2.1) followed by a brief description of each occurrence.
2.2 Field Methods

2.2.1 Plan of Field investigation

The study area was intensively surveyed for four years. The entire study area was surveyed on motor cycle. All the river basins and tributaries were surveyed that covered a distance of more than 3000 km. The places favourable for the occurrence of Palaeolithic sites were surveyed by walking across the landscape. The author initiated his research from the Lower Jonk to the Upper Jonk. The Survey of India Toposheet nos. 64/k-10, 64/k-11, 64/k-12, 64/k-8, 64/k-6, 64/L-9, 64/L-5, 64/L-6 (in scale of 250,000, 150,000 and 50,000 maps) have been used for the survey. These maps were published in the years 1935, 1975, 1981 and 2009. These toposheets were not only used for finding the routes but also to locate potential localities such as eroded surface land near the present water source, small hillocks and hill ranges and rock outcrops. The Geological Survey of India, district resource map (DRM) were also used for the identification of rocks and mineral sources in the study area.

The first season of exploration (December 2007- January 2008) was designed to get acquainted with the roads all along the river, locating base camps, making local contacts and observing some of the river sections. During the first phase of field work, the investigator had confined his field observations to the Jonk River basin. The initial survey in lower Jonk basin resulted in the discovery of four microlithic sites and no Palaeolithic sites were located during this initial survey. This was followed by the second season of exploration (November 2010-December 2010) which has been conducted along both the river banks. During this second season of exploration, the author surveyed and documented the river sections, collected sediment samples and artefacts found on the river section for a systematic analysis later on. The third and fourth seasons of field investigation were conducted between January 2011- February 2011 and April 2011- May 2011, respectively. These explorations intensively focused on the hill slopes, major and minor tributaries and places located away from the river. These investigations also concentrated to locate the raw material resources in the study area. The last season (January 2012- February 2012) of field visit was conducted with my Ph.D. supervisor to get into the details of different aspects of geoarchaeology, site formation process, and to conduct section scrapping in order to understand the Quaternary stratigraphy of the river.
2.2.2 Field Recording or Sampling

Most of the surveyed sites revealed stone tools very often occurring in clusters of artefacts, denoting the manufacturing areas of the pre-historic people. However, it was very difficult to grid the entire sites and collect the samples from all the grids as the area covered by these sites was large and contained a large amount of cultural material. Therefore, attempts were made to collect all the artefacts from one of the representative clusters (demonstrating higher artefacts density) from every site. This was done with a view to make the collection representative both from technological and typological points of view. The artefacts, thus acquired from various sites, were subjected to a detailed techno-typological analysis. Nevertheless, artefacts were picked up from the site for a detailed study in the laboratory only after proper field documentation.

Different depositional phases in each section were noted along with their characteristic features, sediments, and archaeological material. Additionally confluence points, braided stretches, pool’s island, meander, gorges, palaeochannel and nick point were also recorded during the course of explorations.

Potential cliff section along the river banks of the Jonk and its tributaries were visited and studied. Rocky areas, waste land, bad land, hilly terrain, hill slopes and small hills tops were also surveyed to understand the pre-quaternary geology and provenance of the raw material sources used for tools as of class present in the alluvium.

In order to achieve a better understanding of the quaternary stratigraphy and geomorphology of the basin section, scraping was undertaken at Chikhili and few other river sections were also documented in a systematic manner. Furthermore, to trace the extent of alluvium in the basin, stretches slightly away from the banks were also inspected. Relevant information was also gathered from the local people.

Ethnographic data, present day climatic conditions, land form systems, land use maps, distribution of water resources and raw material sources were studied in order to reconstruct the settlement pattern.
2.2.3 Description of Sites

While describing the sites, several aspects have been taken into account. Each site is recorded along with its geographical coordinates and elevation. The distance of the sites from the nearest reference villages and the associated directions were also recorded. In addition, the location, distance and position of the site in relation to the river, streams and the banks on which the sites are located were mentioned. The size of each site is indicated in square meters. The measurements were also taken into consideration along with the provenance of lithic raw material as the Jonk Riverbed is one of the principal sources of raw material.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Site</th>
<th>Period</th>
<th>Context</th>
<th>Latitude / Longitude</th>
<th>District</th>
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<tr>
<td>1.</td>
<td>Banka- BNK</td>
<td>Acheulian</td>
<td>Nala Section</td>
<td>20°49'41.36&quot;N; 82°29'21.29&quot;E</td>
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<td>Bherha Loc-1-BHR</td>
<td>Acheulian</td>
<td>River section</td>
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<td>Girna Ghat -GRN</td>
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<td>11.</td>
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<td>Feature/Environment</td>
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<td>Exposed sediment near river</td>
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<td>Granite Outcrop</td>
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<td>Near Karmel Nala</td>
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Table: 2.1 List of Discovered Sites during the Field Study
Map: 2.1 Site Distribution Map of River Jonk
2.3 Archaeological Site Descriptions

2.3.1 Acheulian Sites

2.3.1.1 Bhajipalla Acheulian Locality -1

20°49'41.36"N; 82°29'21.29"E

Elevation 336 meters

The site is situated at a distance of 15 km from Nuwapada district headquarters. The site lies one km away towards the western side of the village Bhajipalla. It is located at the foot of the Haldi hill. The lateral extent of the site is about 30 x 40 meters. The site is very close to the road connecting Khariar Road and Sarabong talukas and is at a distance of 50 meters from the Talikatta Pond. The artefacts found at the site were made on quartzite, which in most of the cases is coarse grain quartzite. Many of the tools were made from river pebbles. The Jonk River is nearly three km west of the site. The site is located on a pedimented exposed laterite slope. Granite bedrock is underlying the laterite gravel.

2.3.1.2 Bhajipalla Acheulian Locality-II

20°49'52.57"N; 82°29'1.86"E

Elevation- 337 meters

The site lies 300 meters away from the Locality-1 towards the north side. The site is on the foothills of the Haldi hill, connecting between Bhajipala and the village Haldi. The artefacts were found both on the hill slope and foot hill (Plate 2.1). Just below a channel passing through the site, a large number of artefacts were found scattered on the sloped pedimented surface. The artefacts were also recovered from a part of the site which is now an extension of an agricultural field. This site was probably used for habitation. The exposed surface occurs with a high density of artefacts on a 40 x 30 m². The site was evidenced by a variety of artefacts and the author observed the occurrence of different periods of lithic assemblages on the same surface indicating mixed lithic industries.
Most of the artefacts were finished tools although a few utilised cobbles have also been found from the site. It seems that quartzite river cobbles, pebbles were carried to the site from 2-4 km away, for the manufacturing of tools. The site also revealed the presence of some hammers and anvil stones. Secondary retouching and trimming of tool edges was carried out at the site as reflected by the debitage at the site. While quartzite appeared to be the dominating raw material at the site, sporadic use of quartz as a secondary raw material is also visible.

The site of Bhajipala is associated with a regolith and the artefacts were found on the quartzite pebbles mostly transported from the rivers. The site is associated with large cutting tools and little evidence of manufacturing evidence is noticed at the sites. Preliminary manufacture of large flake blanks or initial flaking from the cobble might have been carried out within a 2-3 km radius of the sites. This site has very little evidence of secondary retouching, attested by very few debitage specimens.

2.3.1.3 Bherha River section Acheulian Locality- I

20°46'54.61"N; 82°26'16.51"E

Elevation: 329 meters

The site is located in the fluvial section on the right bank of the river. The modern village Bherha is situated 1.5 km towards eastern side of the site. The river section is 1.5 meter high having a 70 cm horizon of cobbly-pebbly gravel deposits indicating high energy deposition. The artefacts were found within these cobbly-pebbly fluvial deposits. All of the artefacts were made on quartzite and few were seen embedded within the river gravel and some found in the colluvium. The assemblage at the site was dominated by pebble tools and the artefacts appear to be quite abraded and rolled. The river pebble-cobbles and boulders were well rounded and poorly sorted. The fluvial deposits found in the section show episodes of torrential flood in the past and the shifting of the river channel towards the eastern side of the river.
2.3.1.4 Bherha Hill slope Acheulian Locality- II

20°46'25.72"N; 82°27'58.57"E

Elevation -354 meters

The site is located on the Jamarkhol Dungir hills’ slope, which falls within the Lodra Reserve Forest, and lies at a distance of 1.5 km toward southern side from the village Bherha and just 30 meters from the Upper Jonk irrigation Project Cannel. Artefacts were found on the exposed hill slope gravel bed and most were recovered from the rain gullies (Plate 2.6). The site extends over an area of 300 m². The material at the site includes handaxes, cleavers, choppers and few pieces of large flakes and cores. Most of the artefacts were made on quartzite. A section is exposed on the eroding nala which shows the surface covered with 3-5 cm thick alluvium probably of hillslope wash in origin. It is followed by a small layer of loose sand occurring with microliths and cobbly-pebbly gravel lying on the weathered granite bedrock. The site has revealed the presence of microliths in addition to some Acheulian artefacts. The microliths were mostly made on the dark brown chert.

2.3.1.5 Bherha Hill slope Acheulian Locality-III

20°45'52.24"N; 82°26'50.33"E

Elevation- 343 meters

The site is located on the hill slope which is locally known as the Badkhadongar. This hill also falls under the Bherha village which is very near to the village Patora. Artefacts in the form of scatters were found both on the hillslope and the scrub forest land below the upper Jonk irrigation canal. The artefacts were found on the exposed eroded surface of the area and were spread over an area of about 300 m². Artefacts from the site were made on quartzite and sandstone and were very weathered and have developed cracks.
2.3.1.6 Girna Acheulian Locality – I

21°11'59.81"N; 82°37'21.11"E

Elevation -293 meters

The site is situated at a distance of 2.5 km from the Girna village. The site is located on the left bank of the river and lies at a distance of 3 km away from the river. The site is very close to the newly constructed *murum* road, and 20 meters from the road joining the village Girna- Palsani. The extension of the site is over 300 x 100 meters. The artefacts were found over the pedimented surface. The raw material used on the site was locally available coarse pegmatite. It was very difficult to distinguish the natural stone pieces from archaeological flakes as they were similar in colour and patination. Three handaxes and a few flakes were found on the site, in addition to two large cores. Just at a distance of nearly 300 meters from the site, a fragment of fine grain quartzite core and one handaxe were recovered.

2.3.1.7 Girna Ghat- Acheulian Locality – II

21°12'24.15"N; 82°38'28.80"E

Elevation-279 meters

The site is located near the left bank of Jonk River and situated at a distance of 3.5 km towards the north-western side of the village Girna. Five artefacts on fine-grained quartz were found in the quarried pit dug out by the local municipality for a construction of a temporary bridge on river Jonk. Out of these, two are radial cores and three are radial flakes. The artefacts were found within the cemented whitish cobbly-pebbly gravel layer lying below the blackish clay. The black clay formation could be the weathered basalt bedrock, or possibly an earlier alluvial deposit.

2.3.1.8 Banka Acheulian

20°49'41.36"N; 82°29'21.29"E

Elevation- 315 meters

The site comes under the Banka village falling in the Kariar road Taluka in Nuwapada district. The site lies on the right bank of the river near the meeting point of the Banka
Nala. On the exposed eroded surface, two handaxes and four flakes were recovered and are made on quartzite river pebbles. The artefacts were also abraded and probably transported by the Banka nala.

2.3.1.9 Muragaon Acheulian

20°53'15.27"N; 82°29'30.49"E

Elevation-314 meters

The site is situated at a distance of 700 meters south-west of the Muragaon village and lies on the right bank of the river Jonk. The artefacts were found on the eroded surface of a small streambed. The site was exposed on an area of over 30 x 20 m² Yellowish silty calcrite nodules are seen on the surface. Five flakes made on quartzite were found and the artefacts are rolled and patinated with calcritic encrustation on the surface of the artefacts.

2.3.1.10 Senbhata Acheulian

20°50'56.64"N; 82°26'49.86"E

Elevation-339 meters

The site is located on the hills slope of the Badadongar and lies on the western side of the Senbhata village, which comes under the Pausdli Panchyat in the Mahasamund District of Chhattisgarh. The hill is located on the western side of the village and artefacts were found on the sloped erosional surface (Plate: 2.3). The site has yielded a large number of artefacts such as handaxes, cleavers, choppers, scrapers, flakes and many cores. The site extends over 500 m² near the hill slope. The artefacts were found over the exposed lateritic gravels and mixed with small pieces of weathered granite stone. The site also revealed the evidence of microliths found lying on the same erosional surface with the Acheulian artefacts. The latter were made on quartzite, while the microliths were made on black and greenish chert, and quartz. Near the site, a large numbers of granite boulders can be seen. The Badadongar also contain a rock shelter at the top, but no rock art was observed. Near this hill, there are a few more hills where the same exposed erosional surface can be seen but none of these places yielded any artefacts.
2.3.1.11 Chipajhar Acheulian Locality-I

20°46'51.92"N; 82°28'11.87"E

Elevation-353 meters

The site is located on the hill slope of the Chipajhar Pahad and lies 500 meters away from the south-western side of the village (Plate 2.4). The site has clusters of artefacts that include handaxes, cleavers, large flakes, polyhedrons and few cores. The artefacts can be seen on the erosional sloped surface of the hills. Large amount of sandy-silty deposit is accumulated on the hillslope and the seasonal monsoon rains are also cutting all the alluvium, forming rain gullies and resulting in the exposure of the artefacts on the hill slopes. Some artefacts have also been found at the foot of these hills but they were seen embedded in the soil. Large areas of exposures can be seen in and around the hill, but artefacts were found only on the hillslope facing the village.

2.3.1.12 Chipajhar Acheulian Locality-II

20°46'57.76"N; 82°28'39.92"E

Elevation-347

The Chipajhar Locality-II is extended over an area of 60x30 meters and lies at a distance of 2 km from Locality-I. The site touches a channel wall from one of the sites (Plate 2.5). The sediment is recently getting exposed due to rain water. The surface is covered with a 5-7cm thick fine sandy-silty deposit of light yellow colour. This is most probably aeolian in origin (personal communication S.N. Rajguru). The calcretic bearing gravel mixed with pellets and laterite gravel is occasionally found with a few Middle Palaeolithic artefacts made on dark brown chert. The calcritic gravel was found to be overlying the quartzite boulderly-cobbly-and pebbly gravel which bears large numbers of Acheulian cores, flakes and cleaver artefacts. The site has yielded a total of 13 artefacts.
2.3.1.13 Devsoral Acheulian

21°18'11.49"N; 82°38'53.09"E

Elevation- 266

The site lies on the right bank of Jonk River and comes under the area of Devsoral village which falls in SankraTaluka in Mahasamund district of Chhattisgarh. The site lies on the north side of the Sanka town 1.2 km away downstream. The site appears to be in primary or semi-primary context and the associated river section is 2.90 meter high. The artefacts were coming out most probably from the silty unit. Two Acheulian cleavers made on banded chert and one quartz handaxe were found in the eroded cliff section of the river.

2.3.1.14 Patharpunji Acheulian

20°46'8.99"N; 82°26'1.03"E

Elevation- 349 meters

This site is situated within the scrub forested land situated between the Patora and Patharpunji village and the area comes under the Dharmabandha Panchayat in Nuwapada district of Odisha. The site is 2 km away from the right bank of the Jonk River and the Patharpunji village is located about 1.5 away from the site. The site was found with many flakes and only one bifacial tool and some of these specimens were found within paddy fields. Large scatters of quartzite pebbles and cobbles were noticed at the site, which most probably were gathered by local farmers. The site is spread over an area of half a square kilometre and artefact scatters are found within this scrub bushy land. None of Acheulian artefacts were found below the small hillock close to the river where a large numbers of microliths were found on the hilltop and its slope.
2.3.1.15 Bhaismundi Acheulian

20°49'9.36"N; 82°29'25.85"E

Elevation- 351 meters

The site is located on the foot hills of the Bhaismundi hill and lies on the northern side of the village. The village comes under the Sarabong Taluka in Nuwapada district. The site is placed on the southern side of the Bhajipala Locality-1. Only five quartzite artefacts were recovered from the surface at this location. All the artefacts were made on river cobbles. The artefacts were associated with the granitic rubbles. The southern side of the hills has good exposed erosional surface but does not yielded any artefacts.
1. General view of the site Bhajipala -2

2. Close-up of the artefacts found on surface

Plate 2.1 Site Photos Bhajipala locality-2
1. General view of the Girna site

2. Exposed section near the site

3, 4. Close up of a handaxe and a core

Plate 2.2 Site Photos of Girna locality-1
1. Location of the Senbhata site foot hill

2. Panoramic view of the Senbhata Site

3. Close up of the artefact scatter

4. Close up of a Handaxe

2.3. Site Photos Senbhata
1. General view of the site Chipajhar-2

2. Close up a cleaver

3. Chert artefact with calcrete

Plate 2.5 Site Photos Chipajhar locality-2
1. General view of the Bherha -2

2. Lithic scatters at the site

Plate 2.6 Site photos of Bherha locality -2
2.3.2 Middle Palaeolithic Sites

2.3.2.1 Chikhli

21°14'15.48"N; 82°38'0.10"E

Elevation: 272 meters

The site is located on the left side of the river Jonk, situated 1.5 km north of the village Chikhli. The exposed river banks are locally known as Saral in Chattisgardi language. Satpahadi hills are located at a distance of 3 km from the site. The Middle Palaeolithic flakes were found on the recently exposed cliff surface of the river. The extent of the site is over 30 x 20 meters. The erosional surface of the river transforms into small gullies where six Middle Palaeolithic flakes were found. On the basis of technology of the flakes found in the sites and the associated sediments were classified as middle Palaeolithic.

The flakes have developed a thick greyish colour patination, which indicates that the artefacts were buried rapidly. The associated Quaternary alluvium is light yellow and a gravel of about a meter thick was found on the river bank sealed by 3 m thick reddish yellow silt. The gravel yielded a scraper with Middle Palaeolithic technology affinity. The site can help us understand valuable information regarding the Middle Palaeolithic chronology and its succeeding period in the region.

2.3.2.2 Haldi

20°50'18.02"N; 82°28'5.14"E

Elevation-317 meters

The site is located on the right side of the river Jonk. The site comes under the village Haldi lying on western side of the village. The site is closed to the Microlithic locality HLD-2. While documenting the river section, only two Middle Palaeolithic retouched flakes were found. The artefacts were made on black colour chert. The artefacts were found within the sandy-pebbly fluvial deposits within the lower part of the river section (Plate: 2.8)
1. Panoramic view of the Chipajhar -1

2. Artefacts scatters

3, & 4 Close up of two handaxe

Plate 2.4. Site photos Chipajhar locality -1
2.3.2.3 Bherha Middle Palaeolithic

20°47'21.88"N; 82°27'53.30"E

Elevation 346

The site falls under the area of Bhaira village and lies at the foot hill of the Lodra Reserved Forest. The artefacts were found near the Bhaira locality-III and are made on dark brown chert. The number of artefacts is only 12. The artefacts are flakes and out of them one each is scrapers and Levallois flake.

2.3.2.4 Chipajhar-2 Middle Palaeolithic

The artefacts were found along with Acheulian. For site description see the Chipajhar Acheulian locality-II
2.3.3 Microlithic Sites

2.3.3.1 Dharmabandha- DMB

20°43'34.83"N; 82°25'38.69"E

Elevation: 352 meters

This microlithic site is located towards the eastern side of the small town Dharmabandha, on the left bank of Jonk and the dam bridge over it. Artefacts were found on the north-western side of Telijharan Dungri. Artefacts were noticed around the hills but major concentrations are found at two spots. The first spot (Latitude: 20°43'46.80"N Longitude: 82°25'53.28"E) is about 50 meters away from the dam, where artefacts were found over an area of 20 x 15 meters. The second spot (20°43'34.83"N; 82°25'38.69"E) lies at a distance of 1.3 km from the dam. The extension of the second spot is more than 50 x 40 meters, located on the western side of the hill slope. The artefacts were found on the immediate hill slope. The colour of the sediment at the site is reddish because of the clay mixed with some laterite pellets. Brown and dark brown coloured chert is extensively used for manufacturing of the tools. Microliths in the sites is not associated with microliths. By looking at the assemblage, it appears to be belonging to the earliest phase of microlithic culture. A total of 467 artefacts were collected from the site and the source of raw material as nodules lies near to the hills on slopes. The artefacts are in fresh condition; however, some artefacts had developed a reddish colour patina and laterite encrustation.

2.3.3.2 Patharpunji -PPN

20°46'8.99"N; 82°26'1.03"E

Elevation-332 meters

The Patharpunji site is situated on the top of a small hillock on the right bank of the Jonk River. Patharpunji village is located about one km away from the site. The site is a factory-cum-camp site, with thousands of artefacts lying on the sloping erosional surface of the hillock. The site is spread over an area of half a square kilometre and artefacts were found scattered all over the hillock and hillslope, occurring in the form of small and large clusters. The site revealed many trimmed nodule cores, flakes, blades, and some finished and unfinished tools and debitage. Artefacts were collected
from 5 x 3 meters area of the site. The microliths were found lying embedded under a thin soil cover with sparse vegetation on it. Most of the artefacts were made on different colours of chert, but grey colour was dominant in use. It was observed that most of the raw material was exploited immediately from the river channel. The artefacts were also collected from the alluvial deposits on the left bank of the river, opposite to the site. The site is not associated with calcrete. Artefacts were covered with a thin black colour patination on the quartz artefacts where as some artefacts are fresh and some appeared slightly abraded.

The site has yielded the largest collection of artefacts among all sites of the Jonk. It has a dense concentration of 1751 artefacts. Therefore, the site was selected for a detailed study to understand the lithic assemblages.

2.3.3.3 Bherha Microlithic BHR

20°46'25.72"N; 82°27'58.57"E

Elevation 354 meters

This site is located on the hill slope of the BadkhaDangar, located nearly 3 km away from the river Jonk. The site has preserved a 5 cm thick deposit. The artefacts were found scattered on the surface with weathered angular fragments of the granite bedrock, and quartz clasts and the site is close to the Bherha Acheulian locality-3. Some of the microlithic artefacts were found along with Acheulian artefacts at the Bherha hill slopes. However, the site extends over an area of 130 x 60 square meters and at some places artefacts were found in clusters. Greenish chert and blackish chert appear to be the most preferred raw material but quartz has also been used occasionally to produce some flakes and blade tools. The artefacts were found on the exposed lateritic gravels lying over weathered granite bedrock. The site is not associated with calcrete and typo-technologically form part of the earliest microlithic culture.
2.3.3.4 Sarabong Locality-1 SRB

20°48'48.85"N; 82°28'30.20"E

Elevation- 326 meters

The site was discovered on the left bank of the Domuhaninalla situated roughly one km away from the Sarabong village towards western side of this small town. The site is very close to the road where a small bridge is constructed, connecting Sarabong and Nuapada. The site is located on the pedimented surface. The surface has been exposed due to rain where microliths were found scattered over an area of 80 x 60 meters. The artefacts were found associated with calcrete. The site yielded only 56 artefacts made mostly on quartz.

2.3.3.5 Sarabong Locality-2 SRB

20°48'19.09"N; 82°28'42.93"E

Elevation- 325 meters

This site was discovered on the right bank of the river Jonk while documenting the river section near the Sarabong bridge. The site is located towards the eastern side of the small town Sarabong. Only a few artefacts were found over the surface coming from the eroded river section. The surface is thickly covered by vegetation. All the artefacts found at the site are made of chert. Only 31 artefacts were found and collected from the site. The microliths were associated with calcrete. Most of the artefacts appear rolled.

2.3.3.6 Saliha -SLH

20°51'12.17"N; 82°33'33.90"E

Elevation-337 meters

This site is located near the large granitic tors on the hill slope lying close to the state highway connecting Nuapada and the Salia village. The site is situated 750 meters away from the village towards the south western side of the village and lies at a distance of 2 km away from the right bank of the Silda Nala. The site has a large number of microliths scattered over 500 m² in and around the small hills. A total of
1137 microliths were collected from a sampled area of 5 x 2 meters. A large number of microliths are scattered below the foot hills of the Kanaharia reserve forest on the western extension. The site is not associated with calcrete and appears belonging to the late microlithic culture since few geometric tools were found. Quartz is the most commonly used raw material at this site. Quartz river pebbles were quarried from the nearby SildaNala and used at the site.

2.3.3.7 Patparpali -PTP

20°50'48.80"N; 82°33'2.51"E

Elevation 341

The site is located on the north-western side of the village at a distance of 1 km. The site lies at a distance of 20 km away from the main river but it is near to the Silda Nala. The site is found on the foothills of the Kanaharia Reserved Forest. The area comes under the Nuapada district located 16 km away on the north-east direction of the district headquarters. The artefacts were also noticed on a section where work was in progress at one granite stone quarry. The artefacts were scattered over an area of 200 m². The artefacts were not found associated with calcrete. A total number of 136 artefacts were collected from the site.

2.3.3.8 Haldi Locality -1HLD

20°50'17.96"N; 82°28'59.84"E

Elevation -228m

The Haldi Locality 1 site lies on the north-eastern side of the village Haldi. This is an open air microlithic site located 700 meters from the village of Haldi, 450 meters away from the northern side of the Haldi Hills. The site’s extent is over 110 x 30 meters. The microliths artefacts were exposed and found on the murum quarry surface. The site has preserved 5-10 cm thick habitation deposit. The surface layer i.e. reddish coloured clay is followed by lateritic murum. Artefacts were found above the lateritic gravels mixed with greyish coloured clay deposit. A total number of 749 artefacts were collected from the surface. The site was not found associated with calcrete. The site is under threat because murum quarrying was going on already and a part of the site has already been destroyed.
2.3.3.9 Haldi Locality-2 HLD

20°50′21.75″N; 82°28′2.99″E

Elevation -316 meters

This site of Haldi Locality 2 is located on the western side of the Haldi village, 2.5 km away from the HLD-I. The site is located on the right bank of the Jonk River where the lithic assemblages were found on the exposed erosional surface of the river section. Artefacts were observed mixed with white calcretic nodules. Artefacts were found on the surface within a very limited area of 20 x 8 meters. The site is located just near a mango plantation. The microliths in the site was found associated with calcrete. Microliths were not noticed in the river section at this location. At a few spots, microliths were noticed occurring in clusters. One such cluster was collected for detailed study. Several artefacts at the site were partially embedded in the soil and had to be removed with the help of a trowel. This site revealed microliths, some of which could be refitted with each other suggesting minimal post-depositional disturbance at the site. The material lies on the surface of the brown clay and a total of 483 artefacts were collected from the site.

2.3.3.10 Bhajipala Locality-1 BJP

20°50′2.90″N; 82°30′4.92″E

Elevation 330

The Bhajipala Locality 1 site is located on the exposed eroded surface of the Talibhandha Nala. The site lies very close to the locality BJP 2 and the village Bhajipala is located on the southern side of the site. Microliths were found scattered over an area of 20 x 30 m². A total of 196 artefacts were collected from the site.

2.3.3.11 Bhajipala Locality -2 BJP

20°50′32.47″N; 82°29′49.38″E

Elevation-325 meters

The Bhajipala Locality 2 site lies on the right bank of a small stream known as Talibandha, which originates from Sankhotossa and confluences with Jonk near the
Kaloda village. The site is located about one km north from the Bhajipalla village. The site is very close to the road connecting the two small towns Khariar Road and Sarabong. The site’s extent is over 70 x 40 square meters. The artefacts were found on the exposed eroded surface of the rain gullies that run into the nalla. This stream has preserved 1.5 meters thick alluvium section. The surface layer is formed of the recent sandy deposits followed by yellowish-brown clay. The artefacts are associated with calcrite nodules 2-3 cm in size, followed by yellowish coloured compact clay. The sediment might be formed during the late Quaternary period and most of the artefacts were made on chert and quartz. The site was found with a large number of pinkish-red chunks of chert used for manufacturing the microliths.

2.3.3.12 Bhajipala Locality -3 -BJP

20°49'47.75"N; 82°29'2.22"E

Elevation: 347 m

The site of Bhajipala Locality 3 was found on the hillslope of Haldi hill facing towards the east. The site comes under the confines of both Haldi and Bhajipala villages. The artefacts are few in number mostly made on variously coloured chert. The microliths were found around the hills. Few microlithic artefacts were also found with Acheulian artefacts on the surface. Microliths is not associated with calcrite in the site. By looking at the lithic assemblages the site appeared to belong to the earliest phase of microlithic culture and not found with any geometric tool association. A total of 67 artefacts were collected from the site. Chert was the major source of raw material for manufacturing the artefacts.

2.3.3.13 Banka Microlithic-BNK

20°52'57.74"N; 82°29'30.02"E

Elevation: 312 Meters

The Banka Microlithic site lies on the right bank of the Jonk River. It falls within the administrative confines of Khariar Road Taluka, 12 km away from the Nuapada district headquarters and nearly one km from the western side of the village Banka. The microliths were found on the exposed cliff surface of the river bed. Microliths were found scattered over an area of 600 m². Artefacts are found in association with
calcrete. Brown colour chert and quartz has been the most preferred raw material for manufacturing microliths in this site.

2.3.3.14 Muragaon Microlithic MDG

20°53'15.27"N; 82°29'30.49"E

Elevation 312

The Muragaon microlithic site is located on the right bank of the Jonk River. The site lies on the western part of the Muragaon village at a distance of 1.5 km from it. The village falls on the Khariar Road town in Nuapada district of Odisha. The artefacts were found on the exposed river bed. Part of the site is now within the present river channel and the artefacts were found associated with calcrete nodules. Microliths in the site is found associated with calcrete. Chert is the dominant raw material and most of the river pebbles were used as raw material. A total of 34 artefacts were collected from the site.

2.3.3.15 Dumerpani Locality -1 DMP

20°50'21.83"N; 82°30'35.54"E

Elevation- 343 meters

The site is located near the village Dumerpani, 6 km away from the Nuapada district headquarters. The site could easily be accessed from the NH- 217 that connects Khariar Road to Nuapada. An isolated hill can be seen on the western side before approaching Indira Nagar village. The site lies at a distance of 2 km from the Dumerpani village towards the north-eastern side where microliths were found scattered on the hill slope. The local people have been quarrying earth from the immediate hill slope. One of the pits (8x10 m) formed due to quarrying was documented for the present research. Microliths were noticed in the section of the pit. Quartz and chert are mostly used for manufacturing tools. Microliths in the site is not associated with calcrete. From the hill slope 178 artefacts were collected. Most of the microliths found were excessively patinated with blackish colour.
2.3.3.16 Dumerpani Locality -2 -DMP

20°50'26.94"N; 82°30'18.13"E

Elevation 342 meters

The Locality –II is found about 550 m away from Locality I. The site is very close to the road and canal on the western side connecting the Dumerpani and Sarbong town. The artefacts were lying around the periphery of the granitic outcrop. The artefact concentration is very dense at the site; therefore, the artefacts were only collected from 1/1.5 meters area. Quartz is the most dominant raw material. The site has an interesting evidence of few fragments of unidentified shell remains. Microliths in the site is not associated with calcrete. The artefacts at site also have a similar kind of black patination like at locality-I. It is only after proper cleaning with water that it becomes possible to identify their features. A total of 337 artefacts were collected from the site.

2.3.3.17 Pawartala -PRT

20°48'8.07"N; 82°25'7.11"E

Elevation- 346 meters

The site is located below a granitic rocky hill slope lying on the western side of the village Pawartalain the SarabongTaluka of Nuapada district in Odisha. The site is located on the left bank of the AmaNala. The artefacts were scattered over an area of 50x30 meters. Because of the thick vegetation cover at the site it was very difficult to see the microliths on the surface and most of them were found only after clearing the surface leaves and grass from top. Most of the artefacts are made on chert. Microliths in the site is not confirmed if the site is associated with calcrete. A total of 116 artefacts were collected from the sampled area.
2.3.3.18 Pandripani Para -PRP

20°43'18"N; 82°22'375"E

Elevation-374 meters

The site lies on the left bank of the small stream named Karla Nala. The site is situated at a distance of 2 km south west of the village Pandripani. The village comes under the Dharmabandha block of Nuapada district of Odisha. The site was found after crossing the Nala close to the right side of the road, connecting the Banjipani village. The artefacts were found near the granitic outcrop over an area of 10 square meters. Microliths in the site is not associated with calcrete. A total of 332 artefacts were collected from the site.

2.3.3.19 Khudmudi -KDM

21° 1'15.81"N; 82°36'39.67"E

Elevation-293 meters

The site is located on the left bank of the Jonk River 600 meters west of Khudmudi village in Mahasamund district of Chhattisgarh. The artefact scatters spread over 110x30 meters. A total of 642 artefacts were collected from the site. The site had a very dense concentration of lithic scatters at the site. Microliths in the site is associated with calcrete. Three clusters of artefacts were noticed at this site having more than 150 artefacts in each cluster. Even within the river section large numbers of microliths were observed. Part of the site has already been washed away by the river. Artefacts contained cores, flakes, blades, finished and semi-finished backed blade tools, a good number of trimmed nodules and huge manufacturing debris. Quartz was the dominant raw material for producing microliths at the site.

2.3.3.20 Parsabhadar-PSB

20°56'14.08"N; 82°32'51.76"E

Elevation-303 meters

The site is located on the right bank of the Jonk River lying 200 meters west of the village Parsabhadar, Khariar Road block in Nuapada district of Odisha. The site is
near the confluence of Silda Nala. The artefacts were found on the cliff surface of the river section. The river section where these artefacts were found is 2.5 meters high composed mostly of alluvium deposits succeeded by the yellowish compact clay mixed with the calcritic nodules. Microliths in the site is associated with calcrete. The artefacts were found only with in an area of 8 m² area and 26 artefacts were collected from the site. Quartz and chert were equally utilised for making microliths at the site.

2.3.3.21 Nandapur-NDP

20°51′3.39″N; 82°29′32.87″E

Elevation 323

The site is located just one km south-west of Dumerpani village and on the northeastern side of the Nandapur village. The site falls under the municipal confines of Nuapada district in Odisha and is located near the right bank of an unnamed small stream. A small granitic outcrop is exposed near the site. The nala is eroding the sediment near the outcrop where the artefacts were scattered over an area of 25 x 40 meters area. Microliths in the site is not associated with calcrete. The artefacts were found on the eroded surface of the exposed nala bed. The site is close to the road between the two villages and yielded a large number of quartz artefacts out of which 91 artefacts were collected.

2.3.3.22 Pauntala-PNT

20°48′44.72″N; 82°26′42.13″E

Elevation 325

The site is located on the left bank of river Jonk lying close to a small village Pauntala. A microlitic site has been recorded near the bridge over river Jonk. The village comes under the Sarabong Taluka of Nuapada district. Microlithic artefacts were observed on the eroded river bank. These artefacts were found scattered over an area of 4 m². Microliths in the site is associated with calcrete. The site is under heavy flood threats and already large parts of the site have been deposited with river sand. The site has yielded 44 artefacts.
2.3.3.23 Balangir-BGR Trial Trench

21° 6'42.04"N; 82°38'39.96"E

Elevation 280 meters

The presence of a large number of microliths on the surface in an area of 25 m² at Balangir on the right bank of the Jonk River encouraged the researcher to place a small trial trench at the site. The basic aim was to understand the stratigraphic position of the microliths and also to study the in situ lithic assemblages.

The site is situated 1.5 km east of Balangir village within the Dabha block in Bargarh district of Odisha. The site is located on the right bank of the Jonk River over the alluvial deposits. The exposed section of the river at this place contains gravel deposits of 80-120 cm thickness lying directly on the weathered and undulating surface of the granite bedrock. Artefacts are found on the exposed eroded surface of a thick and brownish colour sandy silty clay layer followed by reddish brown clay mixed with laterite pellets. Microliths in the site is not associated with calcrete. The river bank is extensively eroded and the site is located on one of these surfaces, one was extending over 10 x 7 meters and the other was exposed around 15 x 10 meters. One small test pit of 1.5 x 1 meter size was laid at the site to understand the underlying stratigraphy. The site has a preserved cultural deposit of 20 cm thickness. On site production of microliths is evident by the occurrence of a large number of primary elements and waste products. The details have been discussed ahead under the stratigraphy section in the same chapter ahead. A total of 1505 artefacts were excavated from the trench. The artefacts were made variably on chert, chalcedony, agate, red jasper and quartz.

2.3.3.24 Balangir Locality-2- BGR

21° 6'42.88"N; 82°38'36.30"E

Elevation: 283 meters

The Balangir Locality 2 site is situated 1.5 km away from the Balangir village, 7 km north-west of the Dabha block near a small town in Bargarh district of Odisha. The site is located on the right bank of the Jonk River. The site was found on the alluvial deposits of the river and is just at a distance of 300 meters away from Locality 1. The
exposed section of the river at this place contains alluvium deposits of 80-150 cm thick lying directly on the weathered and undulating surface of the granite bedrock. Artefacts were found on the exposed eroded river section of the thick and brownish coloured sandy silty clay layer. The site has preserved a 10-15 cm cultural deposit where artefacts were found within a layer of the fluvial section. A total of 318 artefacts were collected from the site.

2.3.3.25 Chhuiha-CHA

21° 4'64.15"N; 82°31.39"E

Elevation: 318 meters

The Chhuiha microlithic site is located 4 km away from Bhurkundi town in Mahasamund district of Chhattisgarh. The site is found near a granitic outcrop where a large number of microlithic clusters were noticed. The granitic outcrop is spread over 80 x 30 meters. The Machka River is one km away from the site. Quartz is the most preferred raw material and approximately 70% of the observed tools were manufactured by using this material. However, the use of brown chert is also noticed on this site. Microliths in the site is not associated with calcrete and appeared belonging to the later microlithic culture with a good numbers of microblade and geometric tools. At present the site is under threat as it is being used for quarrying granite by the local people.
Map: 2.2 Site locations of Microlithic sites on the Machka River

2.3.3.26 Jagdala-JDL

21° 6'54.15"N; 82°33'17.46"E

Elevation 303

The Jagdala site is located at the foot of the Mandalpat hills 1.5 km away from the Machka River on its right bank. The site is located near VaisnabideviPahadiwali, a local deity temple. Large scatters of microliths were found over an area of about 300 m². The artefacts were collected from a grid of 5 x 2 meters near the granitic bedrock exposed just on the foothill. Quartz is the dominant raw material used for manufacturing the artefacts here. Microliths in the site is not associated with calcrete. The artefact were covered with black patina produced by chemicals formed by the
decomposition of leaves, bark and wild fruits that bind the surface material very easily and is not quickly washable by water.

**2.3.3.27 Tiprung -TPR**

21°37'49.32"N; 82°30'22.88"E

Elevation-238 meters

The Tiprung site is located on the right bank of the Jonk River lying a half km from the Tiprung village. Microliths were found scattered over about 20 x 30 meters on the erosional slope surface near the river bank. Many blades and scrapers were found at the site and all the artefacts are made on chalcedony, quartz and agate. Association of Microliths with calcrete was not confirmed in the site. A total number of 72 artifacts were collected which were eroding from the erosional surface and gradually falling into the present river channel.

**2.3.3.28 Mahuabhata- MBT**

20°48'8.87"N; 82°25'5.87

Elevation-344 meters

The Mahuabhata site is located on a granitic foot hill near Mahuabhata. The site situated at the western side of the village falling under the SarabongTaluka of Nuapada district. The site lies on the left side of the river nearly 2.5 km away from the river. The site extends over an area of 30 x 40 meters. Microliths in the site is not associated with calcrete. The microliths are scattered on the periphery of the hillslope and the granite bedrock surface is flat. Here some grinding marks on the granite bedrock can be observed, the function of which is unclear. No cupules were observed around the site, which yielded 111 microlithic artefacts.

Microliths are concentrated in a cluster at the base of the granitic outcrop that is totally devoid of soil. The outcrop slopes towards the east and below the slope, the site is heavily destroyed by the impact of modern rice agriculture. Microliths that lie on the top of the outcrop might have been washed down towards the agricultural field.
2.3.3.29 Gauria- GRA

21°15'26.18"N; 82°37'34.28"E

Elevation- 274 meters

The Gauria site is located on the right bank of the river, one km west of the Gauria village. The site is located very near to the confluence of the Bag and Jonk Rivers. The artefacts were found 20 metres along the eroded river section of the river. The site is dominated by the use of quartz and chert for manufacturing the artefacts. Microliths in the site is associated with calcrete. The site is under constant threat of the floods and a part of the site has already been washed away by the river. Every year the river section erodes and the artifacts fall into the riverbed.

2.3.3.30 Kurrubhata -KRB

20°49'7.86"N; 82°28'35.26"E

Elevation 329

The Kurrubhata site is located on the southern side of the Kurrubhta village in the Sarabong block of Nuapada district in Odisha. The site lies on the right bank of DomuhaniNala. The artefacts were found lying scattered on an area of 30 x 50 meters over the granitic outcrop with many microliths present. There is a local playground which lies close to the granitic outcrop that is full of artefacts. The site is badly disturbed because the granitic outcrop is occupied by the present day villagers. The site yielded a large number of core blanks which were dressed but no blades were removed from them. A total numbers of 375 artefacts were collected from the periphery of the granitic outcrop. On the surface of the granitic rock at the site, a large number of ‘post holes’ were observed as well. It is not clear if these ‘postholes’ are contemporary with the archaeological evidence or post date considerably.
2.3.3.31 Panchampur-PCM

20°47'37.00"N  82°27'54.21"E

Elevation 347

The Panchampur site is located on the foothills of the twin hills lying on the southern side at a distance of 1.5 km from the present village Panchampur. The artefacts are scattered over an area of nearly 500 m² and some artefacts were observed in a buried context just underlying the surface. Microliths in the site is not associated with calcrete and lithic assemblage appeared belongs to the early microlithic phase. A thin cover of soil is formed on the hillslope wash origin or may be weathered granitic sand mixed with soil.

2.3.3.32 Lukupali-LKP

20°59'29.02"N; 82°35'21.70"E

Elevation 301

The Lukupali site is located on the right bank of the Jonk River. It is situated on the left bank of the SemeriaNala close to the Jonk-Semeria confluence point. The site lies 1 km away on the west of the Lukupali village. The artefacts were collected from 30 x 40 meter area. The site has a very dense concentration of artefacts which are mostly made on quartz. Microliths in the site is not associated with calcrete.

2.3.3.33 Arjuni-AJN

21°30'22.61"N; 82°36'51.92"E

Elevation -259 meters

The Arjuni site is located on the right bank of the lower Jonk River. The site is 1.5 km away on the southern side of the Arjuni village. The site was found close to the road connecting Arjuni and Saraipali. The area falls under the Raipur district of Chhattisgarh. The site is found near an unnamed Nala and yielded a large number of finished tools and some debitage. Chalcedony is the dominant raw material used for the manufacturing of tools here. Association of calcrete with Microliths in the site is not confirmed.
2.3.3.34 Beltukri- BLT

21° 2'45.28"N; 82°37'47.40"E

Elevation- 289 meters

The Beltukri site is on the right bank of Jonk River where artefacts were found in the eroded river section. Beltukri is a small town under the Nuapada district of Odisha. The site lies at a distance of 2.5 km from Beltukri village on the western side of the village foot path road connecting Dungaripali. Quartz is the dominant raw material used here for the manufacture of artefacts. Microliths in the site is associated with calcrete. Quartz was the dominating raw material along with chert.

2.3.3.35 Senbhata- SNB

20°50'56.64"N; 82°26'49.86"E

Elevation 335

At Senbhata, the microlithic artefacts were found in the same locality where Acheulian artefacts occur on the surface. The Acheulian artefacts are only confined to the hillslopes, whereas the microliths are widely scattered around the hills. Microliths in the site is not associated with calcrete.

2.3.3.36 Beheradih

20°56'2.58"N; 82°32'41.09"E

Elevation- 309 meters

The Beheradih site is located on the right bank of the Jonk River, 700 meters north-west of the village. The artefacts were found on the pediment surface eroding out due to the badland topography. The artefacts were found associated with calcrete nodules.
1. Panoromic view of Dharmabandha site

2. General view of the Dharmabandha site

3. Microlithic scatter

Plate 2.7 Site photos Dharmabandha site
Plate 2.8 General view of the Haldi - 1 with Microliths in exposed section

Plate 2.9 General view of the Dumerpani-1 with microliths within exposed section

Plate 2.10 General view of the Patarpali site with microliths within exposed section
Plate 2.11 Microlithic site: Bhajipala-2 associated with calcite

Plate 2.12 Microlithic site: Sarabong-1 associated with calcite
Plate 2.17 Microlithic site Chuhhia near granitic outcrop

Plate 2.18 Microlithic site Jagdala foot hill
2.3.4 Post Microlithic, Neolithic and Early Historic Cultures

In the present research, emphasis has been given to the studies of the geoarchaeology and Palaeolithic cultures of the Jonk River basin/valley. In order to present a complete picture of the archaeology of the river, it is also necessary to understand the post-microlithic archaeological potential of the River Valley. Therefore, other archaeological sites that were encountered were also documented and included in this thesis. During our exploration, a Neolithic celt manufacturing site was discovered at Jagdispur in Raigarh district of Chhattisgarh. In addition, two polished Neolithic celts were found on the Jonk River bank - one near Parkom and the other at Muragao near the Khariar Road. Another broken fragment of semi-finished Neolithic specimen is also attested from Muragaon. Additionally, three Early Historical sites have also been discovered during this investigation. These sites are Khatton the left bank of the upper Jonk, Narega on the left bank of Karmel Nala and Kadgion the right bank of the lower Jonk near the NH-200.

2.3.4.1 Neolithic Site

2.3.4.1.1 Jagdispur

21°20'21.40"N; 82°45'6.57"E

Elevation 317 meters

The site was evidenced by large number of flakes and debris shows Neolithic Celt manufacturing activity. The Jagdispur site lies on the western side of the Jagdispur village on the foothills of the Burodihi, two km away from the village. This is the only site which has produced evidence of quarry based celt production in the entire Jonk River valley. This shows continuous sequence of technological transition from the microlithic to Neolithic stages.

Banded chert is locally available in the form of outcrops and chert slabs are commonly found exposed on the Burodihi foothills. The artefacts found on the surface are thickly patinated and are whitish or olive in colour. The exposed dykes formed the major source of raw materials for manufacturing celts in the area. The celt production activities in the area spread over an area of 150 x 170 meters on the foot
hills of the Burodihi. It appears that Neolithic people of the region were exploiting the locally available chert slabs.

2.3.4.2 Early Historic Sites

The plateau contains remains of fortification and was probably the last stronghold of the Bhunjas. Maraguda is a village in Nuapadadistrict situated on the Jonk River at the foothill about 16 km south west of Nuapada. The village is surrounded with remains of some broken images and other ancient relics. Near the village is a large old tank, probably for water storage.

A few km south-west of Maraguda are the ruins of an ancient fortification. The place is called Manikgarh. Manikgarh is an old hill fort in ruins situated at an almost inaccessible location at the top of a hill. On the hilltop are the ruins of a small reservoir of water probably for rainwater harvesting. Foundations of some buildings and a few other relics can be observed around the area. Near Manikgarh were observed bricks that had fallen off from the ruins of the building with damaged Buddhist images. The fort is believed to have been designed for defence. At the foothill is a shallow large tank considered to be one of the largest in the subdivision of Maraguda Tehsil. Its bottom is now partly utilized for paddy cultivation but the northern portion is still deep. There is no clear history about the past of this fort. Some kilometers away from Manikgarh is another ruined fort called Jumlagarh which may have a similar history and be contemporaneous to it?

2.3.4.2.1 Katgi

21°39'43.70"N; 82°31'48.32"E

Elevation -226m

The site is located on the right bank of the Jonk on the National Highway No. 200 near the Katgi Bridge. The site’s extent is over 60 x 50 meters. Habitation deposits are clearly seen on the river section measured about 1.5 meters in thickness. A few brick pieces also occur. One intact bowl and few potsherds of red ware, grey ware and red slipped ware, some unidentified terracotta fragments and one arecanut shaped bead were collected from the site. The site is getting destroyed as it is located on the river bank as the floods in every season are eroding parts of the mound.
2.3.4.2.2 Khatti

20°50'15.45"N; 82°27'56.17"E

Elevation- 320 m

The Khatti site is located on the left bank of the Jonk River lying one km away from the village Khatti. The habitation mound, much of which is already washed away by the flood water is partially preserved. The site yields mostly pottery sherds of red ware, red slipped ware and grey ware lying with fragments of bricks.

2.3.4.2.3 Narega

21°27'27.18"N; 82°39'29.81"E

Elevation -272

The Narega site is located on the left bank of the Karmel Nala. The site lies on the northern side of the village at a distance of a half km from the site. The site has a circular fortification which is bounded by a small moat. The radius of the fort is 500 meters and the site yielded a few pottery fragments which were covered thickly by vegetation across the site.
Map: 2.3 Google Earth Image of the Narega with overlapped Digital Elevation Model with 1 meter of contour interval
2.4 Settlement Patterns of the Prehistoric Hunter gatherers along the Jonk River

The concept of Settlement pattern studies in archaeology was introduced by Gordon Willey (1953) during his work on Viru Valley. Willey (1953) defines Settlement pattern as the way in which man disposed himself over the landscape. It thus refers to dwellings, their arrangements and to the nature and disposition of other buildings pertaining to community life. In archaeology, Settlement pattern studies range from intensive investigations of individual sites to systematic regional surveys. The research on Settlement pattern has developed over time and reviews have acquired theoretical and methodological sophistication (Willey 1953; Chang 1968; Rouse 1972; Trigger 1978; Bettinger 1980; Trigger 1967; Parsons 1972; Ucko et al. 1972; Binford 1966, 1980).

2.4.1 Palaeolithic Settlement Pattern Studies in India

Several studies of early Palaeolithic settlement patterns have been conducted in India, among which Hunsgi-Baichbal are the most well known sites. In the last four decades, several possible studies were conducted by (Paddayya 1979, 1982a, 2006) to understand the food habits, habitation patterns, seasonal behaviours, migrations and landscapes inhabited by pre-historic men. The work on settlement and subsistence pattern along with mortuary practices was conducted by Pal (1994) and Chattopadhyaya (1996) in Ganga valley. In order to understand the settlement pattern of the Kaladgi basin in north Karnataka geomorphological approaches were used by (Pappu and Deo 1994; Deo 1991). Scholars like Rao (2002), Pandey (1982), Corvinus (1983), Ray (1987), Raju (1988), Pant and Jayaswal (1991) have also undertaken settlement pattern studies in India.

In order to understand the late Palaeolithic groups those of microlithic period and some scholar have carried out both the ethnoarchaeology and ethnography to understand their life pattern i.e. Nanda(1985) in Koraput, Mohanty (1989) in Keonjhar, Cooper (1983) in around Bastal Fall, Pappu (1996, 2001) in Kortallayer river, and Selvakumar (2001) in Gundar Basin Tamil Nadu, ,Pal (1994, 2005) in Ganga valley in addition subsistence pattern and mortuary practices were also conducted in Ganga valley (Chattopadhyaya 1996). Above scholars have revealed that the scrub jungle and deciduous vegetation tracts of Peninsular India are extremely rich
in wild plant foods of various kinds like fruits, berries, tubers, roots, nuts, seeds and greens.

2.4.2 Settlement pattern of Acheulian sites

The Acheulian sites found are either within the river section or situated near the hill slopes beside a natural lake. None of the sites were found on any of the small or big streams of the river. This is probably because of heavy siltation where all the small streams are carrying the weathered granitic sand and depositing it near the river bank or across the landscape.

Each site must have served different functions such as exploitation of raw materials, strategic locations for hunting or fishing. The sites found near the river were certainly very important as they must have served multiple purposes. The sites located on the hill slopes must have been equally important for exploitation of the animal and plant resources. The middle Palaeolithic sites in the river are not well represented and only sparse evidences were found.
Map: 2.4 Distribution of Acheulian sites in the Upper Jonk
### 2.4.3 Settlement Pattern of Microlithic sites

Microlithic sites are mostly situated on the banks of river Jonk; either on river section, eroded river gravel or away from the river bank near the hills or hillock or on the raised granitic surface. But we find very few sites in its tributaries (Silda, Machka and Ama Nala). Each site represents different tasks such as processing, repairing and extracting activities on all types of materials (Cooper 1983).

The small sites may have very few artefacts but their functional attributes to understand the human behaviour cannot be ignored. These sites were probably used for short durations such as hunting, butchering, gathering or manufacturing. Scholars have suggested that these sites served as satellite to larger sites (Foley, 1981:164-166; Paddayya, 1991b:131; Thomas, 1975: 62). The main economic activities of the people certainly changed from season to season due to seasonal variations in the availability of games, fishes, fruits, vegetables, honey and other products. Even today the tribal people exploit the seasonal natural resources and store them for future use.

### 2.4.4 General discussion

Most sites in the area are found on right bank of the Jonk River with concentration being on the upper region within a radius of 20 km². Thus it is quite possible that the hilly terrain and densely forested areas were avoided as none of the sites were found in such ecological setups.

The open air sites located near small lakes, streams and the presence of forest nearby must have offered large variety of game animals and plant foods. These places were certainly used for habitational purposes (Issac1972; Clark 1975; Paddayya 2006). The study area has very few rock shelters or caves which do not provide for any evidence of human occupation. Among the visited cave shelters none contain any rock art. Based on the observations of present day tribal nomads such as Birhors it can be said that pre-historic people mobilised in groups and settled in places where food resources were available. However, once the food resources finished they shifted to a new area.

The riverside was continuously populated from the Acheulian times but there was increase in population during Microlithic period because of successful advancement in hunting gathering techniques. Even now days the river valley supports a large
number of tribal populations, whose main source of subsistence are agriculture, gathering, fishing and occasional hunting.

The area has different variety of flora and fauna and their exploitation need some skills and labour to collect or make them eatable. The variety of tools found, must have had multiple purposes or specialised functions. The change in tool technology, their sizes, shapes and forms suggest possibility of change in subsistence pattern with a developed stone tool technology and wider choice of exploitation of larger variety of flora and fauna and other eatables.

To date hardly any Palaeolithic site has been excavated in the area of study and most of the studies from surface scatters and stratified contexts are confining to only typotechnological aspects. No evidence of human skeletal remains has been recovered from any reported sites; similar in case with most Indian sites.

2.5 Site Formation Process

The study of site formation process provides nature, character, physical conditions and composition of a site or an area. It helps in inferring data related to site formation processes. Site formation process gives a basis for interpreting the duration of human occupation, the continuity of occupation, intensity of occupation, rate of deposit formation, post-depositional alterations and the effects of erosion on the preservation of cultural remains. It provides clues to understand the period of occupation of a site after studying patterns of erosional, depositional and post dispositional history; physical and chemical weathering; accumulation and transportation of materials that may affect preservation of the cultural remains; and the landscapes that result in reorganization of the distribution patterns of the archaeological remains (Ahsan 1993). In Indian context such studies has been conducted by Paddayya 1987; Paddayya and Petraglia 1993, 1995; Ahsan 1993; Pappu 1996; Jhaldiyal 1997, 2007; Mishra et al 2009; Agrawal 2012, have studied the site formation processes in regional context.

In order to understand post-depositional process of lithic assemblage, several attributes like assemblage composition, artefact density, artefact size vis-a-vis natural clasts, raw materials present, degree and type of weathering, rounding, patination, breakage and damage patterns were observed to understand the depositional context of the artefacts (Binford 1980, 1983, 2001, Potts 1984; Jhaldiyal 1997, 2006). So past
human activities, past natural processes and present day natural processes along with modern human activities interact to create complexities at the archaeological site, (Ascher 1968, Collins 1975, Cogill 1970, Schiffer 1976, 1983, 1987, Binford 1980). Past natural processes and human activities contribute to the formation of an archaeological site. The study of the diverse processes of site formation is one of the most important aspects of modern archaeological research.

The geomorphology of a site, its micro-stratigraphy, chronology and lithology are essential for evaluating the duration of human occupation, intermittency of occupation, rate of site formation, location of activity areas, erosion and the post depositional alterations. The formation processes influence the archaeological site in two ways: cultural formation processes and non-cultural formation processes. The cultural processes start after the discard or loss as surficial exposures. They may be modified and rearranged spatially and formally to some degree by the ongoing cultural system of that period. Material may be added; some may be scavenged and reused, till they get buried. The longer the artefacts are exposed the greater the chance of modification in the artefact petering. Many present land modification processes, like road, building, canal construction, land levelling, ploughing etc may re-expose the buried archaeological record and may contribute to the alteration of the context. These processes are called cultural formation processes (Ahsan 1993: 1-3).

Most of the present day Acheulian sites are still covered with transported regolith. The artefacts could get buried either for a short term or forever. Raw material like rock is resistant and so it gets preserved. During the study of the present area of research, two episodes of regolithic transportation were observed. The first episode is associated with the Acheulian and the second with the Microliths.

2.5.1 Hill slope context

A number of sites were found along the hill slopes and foothills at natural pediment surfaces. Artefacts found on the upper part of the surface were scattered and less in concentration in comparison to the lower part of the surface.

The Acheulian sites are found in two contexts, alluvial and regolithic. Most of the Acheulian sites were coming within the regolithic context. Some of the microlithic sites were also coming from the regolithic context but not from the same horizon. The microliths were associated with calcrete. (For details see discussion Chapter-4). The
middle Palaeolithic assemblages are coming from the alluvial context, however middle Palaeolithic from the regolithic context is very sparse. Keeping in mind the stratigraphy of the site, sedimentology, artefact taphonomy were studied to understand the site formation processes.

The hill slope and foot hill Acheulian sites are located away from the alluvial settings, rivers or major sources of aggradations and degradation. The landscape around the site is marked by undulating topography and dotted by granite tors, inselbergs and low hillocks. Seasonal rivulets dissect the area. The artefacts occurring on the hill slope were found associated with typical hill slope material mixed with angular to sub angular clasts of granite, laterite pellets, pebbles and cobbles of quartzite and angular pieces of quartz. Quartzite cobbles, pebbles appeared to be transported from the Jonk River from a distance of 3-4 km, whereas at some sites the raw material was quarried from the quartzite bedrock. In few sites 3-5cm thick fine sandy-silt was noticed which in origin could be the hill slope wash. Artefacts were found on the surface but neither in situ nor embedded within the sediments. In few hill slope sites even the exposed and redeposit of artefacts were observed due to the rain gullies and erosional activity. The Acheulian artefacts found within the river gravel in the site Bhaira-3, have not been disturbed by high energy fluvial processes but some of them show abrasion and rounding which is indicative of two or more episodes of deposition. In this case archaeology helped to understand the geomorphology of the area.

The high degree of rounding and patina on the artefacts show that the artefacts were exposed on the surface for prolonged period. In the present situation they are coming from the recently exposed sediment. Hence, it shows that the artefacts were exposed to the surface for long time and then buried and recently being exposed to their present condition.

In the Jonk, sites have been observed in different contexts: primary, semi-primary and some are disturbed. The grade of disturbance varies from site to site. The disturbances are caused due to natural factors like surface erosion, gully erosion, flooding, seismic activities, climatic conditions.

The reconstruction of climatic conditions could also indicate the pattern of site formation. The same is valid for the Jonk where climatic conditions could be assessed by the help of lithology of gravel beds. The lower gravel bed seems older than the
upper gravel bed and the formation of the two boulder beds does not seem much different. The arrangement and orientation of boulder and gravel beds helped to confirm the lateral expansion and shrinking of the river, as well as the bed load carried by the high velocity water due to change in climate conditions.

The present day river sand is found more with the feldspar and not much with quartz grains which confirms the prolonged geological history of the river. In the river section the deposits of secondary laterite nodules and pellets were found randomly. Artefacts found in the Jonk may be grouped into two heads (1) artefacts found within the river gravel and silt (in situ) and artefact found on surface.

Part of the site Bhajipala-2 is disturbed. Part of the site is found exposed in the ploughed fields with associated sediments completely separated. The original position of the artefacts were disturbed and moved to other places and some of the artefacts were found discarded outside of the plough field.

The area is covered by the Archaean bedrock, with mica and schist and in some places it is found in form of outcrops in the high grounds. Besides these rocks other kinds of rocks present in the same area are granite and quartz which are found in form of elevated outcrops. Bedrock has been under the exposure which is resulting in faster weathering (Ghosh 1978). At certain places it is covered by younger deposits. In some places the bedrock is decomposed and turned into clay of various colours in range of yellow to black. In lower part it is black very much due to the decomposition of basalt bed.

Generally, due to the elevation near the hills the gradient increases which displays a pattern of site distribution as far as the depositional variability is concerned. The plain land surface is close to the river while other places are undulating. Both these factors were responsible for the transportation of weathered fragments of laterite and granular into the river during floods. This material conglomerate was carried mainly by water as runoff and ultimately deposited in the lower reaches. Preferably more in the depression than the flat surface resulting in variable thickness of the surface.
2.5.2 Disturbance of lithic materials

The sites found in the hill slopes were subjected to exposure and re-disposition for several episodes of such behaviour. The process would cause artefacts from above and below the soil, as it is being washed away, to get mixed up and accumulated in clusters. Perhaps this would give the false impression of the existence of the higher density of material, the cause of which would be almost impossible to determine considering the different types of activities performed in a prehistoric encampment and varying rates of the accumulation of debris (Cooper 1983:143-146). The latter tends to hold the artifacts as if partially embedded in it. (Similar phenomenon with Paddayya 1979:83)

2.6 Description of River Sections

It was observed that the river basin and associated plains formed by the Jonk River are made exclusively of fluvial deposits which are periodically renewed by the capping of silt through seasonal floods. They vary at places and belong either to the older or the younger alluvium. At some places the alluvium is mixed with laterite gravels and other small calcareous nodules such as kankar.

2.6.1 Results of section-scraping at Chikhli

Latitude: 21°14'15.48"N, Longitude 82°38'0.10"E

Elevation 272 amsl

The Chikhli site is located on the left bank of the Jonk River, situated two km away from the Chikhli village (four km away from the NH 6) in the Mahasamund district of Chhattisgarh. Flakes thought to belong to the Middle Palaeolithic were found on the recently exposed cliff surface of the river. The erosional surface of the river has made numerous small gullies where six Middle Palaeolithic flakes were found, all of which have developed a thick greyish colour patination. The dorsal surface of these flakes, which are thin and sharp, have multidirectional/radial scar patterns, suggesting the Levallois technique of reduction. Artefacts are made on black coloured chert and almost all flakes show a well developed patina and are non-abraded.

The site was taken for section-scraping to understand the Quaternary sequence of the river at this location and also to understand the sedimentary context of the Middle
Palaeolithic artefacts. The section scraping was carried out near the present river channel, where a 4.5 meter thick alluvium section (see fig-1) was exposed. The section was divided into different units on the basis of different sedimentary characters. A thin sand cover of ~10-15 cm had been deposited by recent floods, observed at the top of the section. Below this unit there are other 4 sedimentary units, all described individually below.

**Unit - 1** is represented by a cover of light brown compact medium sized sand with ferruginous pellets. This unit resembles the present Jonk channel sand except for being compact. The present Jonk channel sand is a mixture of angular coarse to medium sand with a mixture of ferruginous pellets. These pellets are generally either lateritic or rounded weathered bedrock fragments.

**Unit- 2** This is a distinctive layer with fine white sand without ferruginous pellets. Some mottling was also observed in this unit.

**Unit- 3** shows a noticeable increase in clay content. The sand seen in the upper layers is still present. In the upper part of unit 3 ferruginous mottles are seen and there is a gradation from the pellets to the mottles. In the lower part of Unit 3, the mottling changes from orange to grey in colour and the background clay from grey/brown to yellow brown. Occasional angular stone pieces are also seen in the section.

**Unit-4** shows compact clay with fissuring. Pellets are no longer present.

**Unit 5** is a gravel unit containing cobbles and rubble.

**Unit-6;** is weathered Archaean bedrock breaking at angular planes.

This section is very interesting as a gradual change from sediments resembling the present day Jonk channel deposits to clay is seen. It appears that the original angular sand derived from the weathered Archaean bedrock *in situ* is being weathered into clay. The Middle Palaeolithic flakes were found on the eroded surface of this section. In the area where the artefacts were found, the erosion had reached to Unit 3. The artefacts therefore could have been derived from either Unit 2 or Unit 3. Unfortunately, no artefacts were found during the section scraping.

The absence of calcrete from this section is also interesting, as it is present at many microlithic sites which should belong to a later period. In more arid parts of Peninsular India calcrete is associated with all Pleistocene sites as conditions were
favourable for calcrete formation at all times. In the Jonk River valley, and most probably elsewhere in eastern India generally, calcrete formation only occurred during periods of arid climate, the youngest of which is associated with microliths. None of the Acheulian sites is associated with calcrete either.

Figure: 2.1 River section at Chikhli
2.6.2 Results of the trial trench at Balangir

Balangir is a single culture site that yielded 20 cm deposit with microlithic evidence. The place where the trench was laid has gradient towards the western side of the river. The trench (1 x 1.5 m) was taken to understand the cultural sequence of the site. Few clusters of microliths were found in only one corner of the trench. Therefore, in order to understand the stratigraphy at the site in relation to the discovered mixture of lithic material. But the place where the trench was placed has an eroding slope, hence mixed lithic material was observed. The sediment, after excavation was sieved and all the artefacts were collected from the site.

The site under study was observed to be formed of four distinct layers. The first layer (surface) is composed of loose sand mixed with roots of common grass, pale-yellow in colour and 10 cm in depth. The second layer contained loose sandy-silt which is brown in color having a thickness of 25 cm. In this layer, pellets occurred randomly. The third layer is reddish-brown in color and coarse in nature containing unsorted laterite, small grade gravel mixed with angular unsorted weathered granite. This layer is the cultural layer in which microliths are found. A large number of manufacturing debris with some finished and semi-finished tools were found along with few worked quartz river pebbles. The artefacts appeared fresh without any patination or weathering on them. The layer has a thickness of 10 centimetres. The fourth layer is weathered granite bedrock yellow in colour finally succeeded by Archaean bedrock which can be seen in the river bed.
Figure: 2.2 River Section at Bolangir (step trench)
2.6.3 Bherha River section

20°46'54.61"N; 82°26'16.51"

Elevation-329 m

The Bhera site was discovered on February, 2011 and is located within the river section on the right bank of the Jonk River east of the Bhera village at a distance of about 1.5 km. The river section is 2.2 meter high having a 70 cm of gravel deposit containing pebbles, cobbles and boulders. The artefacts are found within these fluvial gravel deposits. All of the artefacts were made on quartzite and the tool assemblage is dominated by flakes and cores made on river cobbles and boulders. Some of the tools seem to be rolled due to the river action, whereas some of the artefacts look fresh.

At this site, four layers of sedimentation were observed. The surface unit is a loose sandy horizon, light yellow in colour mixed with grass and small herbs. The layer is followed by a light brown sandy-clay deposit. The second unit is the gravel deposit containing boulders, cobbles, pebbles either underlying several artefacts or capping them. Thus the artefacts are trapped in the cobble-pebble gravel. The gravel deposits appear to belong to an older channel which was most probably flowing during a high torrential flood of the then-existing river channel. Two episodes of gravel deposits were observed in the present channel: the first episode was observed with artefacts in a thicker deposit of cobbles and boulders than the second episode. The second episode of gravel deposit was comparatively thinner and does not contain any Acheulean artefacts. The gravel with artefacts is collapsing into the present river channel. When the channel was exposed during prehistoric times, it must have been an ideal place for raw material exploitation, since a variety of different clast sizes were easily available. The site has yielded some cores and some finished artefacts, such as handaxes, cleavers, and flakes.
Figure: 2.3 River Section at Bherha
2.6.4 River Section at Beltukuri

21° 2′35.50"N; 82°37′49.12"E

Elevation 291m

The Beltukuri river section is getting eroded rapidly by the recent floods exposing a high river section of 2.50 meters. Unit-1 is loose, 15-20 cm thick, composed of sandy-silt sediment. Unit-2, having a thickness of 20-100 cm is brown in colour composed of light medium sand that made hands dirty but the wetness could not be felt. The third unit of 100-160 cm was clayey-sand mixed with red calcrete having a dark brown and black loam. Unit four 160-260 cm, was the microlithic horizon, composed of sandy clay found with well-developed calcrete mixed with microlithic artefacts. Unit 5 was found with river gravel followed by the weathered Achaean bedrock. At Beltukuri, few microliths were coming out from the eroded section. But the position of the layer containing the artefacts was not clear and required section scraping to understand its stratigraphy. One piece of fossil wood possibly belonging to the Gondwana period was also found over the weathered Archaean bedrock.

Figure: 2.4 River Section at Beltukuri
Plate: 2.19: River Section at Beltukuri

Beltukri Section further down stream

Further downstream in the Beltukri area is a river section 3.25 meters in height. The first 60 cm is the sandy-silty river alluvium, 60-120 cm found with sandy-clay deposits and the 120-280 cm is the yellow silt with calcrete horizon, but not found with microliths and 280-325 cm are found with an angular gravel followed by Archaean bedrock.

2.6.5 Sarbong Bridge
20°48'44.73"N; 82°26'52.16"E

Elevation 325

The river section here is located on the right bank of the Jonk River just near the Sarabong river bridge connecting two villages Sarbong and Amabhana. The river section is 4.60 meter high and the first layer is black clay; the second layer is black clay mixed with calcrete, followed by red coloured clay as the third layer. The fourth unit was yellow coloured silt is observed at the bottom and bedrock at this place is not visible.
Figure: 2.5 River Section at Sarbong Bridge

Plate: 2.20: River section at Sarabong bridge.
2.6.6 Devsaral

21°18'11.49"N 82°38'53.09"E

This section is located downstream of the Jonk River on its right bank, 1.2 km from the Sankra town towards the north. The river section is 2.90 meters high and four units of sedimentation were observed at the river section.

**Unit-1** is the surface layer formed by sandy-silt deposits, yellowish brown in colour and covered with thick grass.

**Unit-2** is 30 cm thick composed of medium sand-loamy clay without any calcrete present.

**Unit-3** is comprised of compact yellow coloured silt characterised by the formation of high amount of calcrete.

**Unit-4** is the gravel lying on the Archaean bedrock. The calcrete nodules are of 2-6 cm in length. Two Acheulian cleavers prepared on banded chert and one handaxe made of sedimentary rock (possibly marble) were found in the eroded section of the river.
The river section was discovered at the Girna Ghat of the Jonk River lying towards the north-eastern side of the Girna village at distance of three km from the main village. The section is exposed due to soil quarrying for the temporary bridge construction between the Girna and Phalsani. The exposed section was 1.20 meter high and the surface unit-1 was covered by brownish colour silty-clay mixed with few pieces of calcrete. The calcrite found in the section was rounded varying in size from 2 to 4 cm. Unit-2 was composed of calcareous cobble-pebble gravel with a thickness of 20-30 cm. Within the cemented calcareous Layer 5, fine grained quartz artefacts (3 flakes and 2 cores) were found. Techno-morphologically, these artefacts appear to belong to the Acheulian period.
Plate 2.22: River section at Girna.
2.6.8 Dharmabandha

20°43'58.42"N; 82°26'5.41"E

This river section is situated just below the Dharmabandha Dam, lying on the western side of the village Dharmabanda. The river section is nearly 8 meters thick and the dam water is cutting the river section. Four units of sedimentation were observed in this river section. Unit-1 is sandy, mixed with few pieces of angular rocks and unit-2 is compact sandy-silt red in colour. This kind of deposit is typical of the forest soil formation in the area. Unit-3 has a thickness of 20-30 cm and is composed of river silt mixed with rounded river pebbles. Unit-4 is composed of compact silt deposits devoid of any river pebbles or gravel. Unit-5 is cemented angular gravel containing cobbles, pebbles and boulders. Most of the cobbles and pebbles are quartzitic in origin but few are also granitic. The river section was devoid of any artefacts.
Figure: 2.7 River section Dharmabandha
Occurrence of calcrete is common in fluvial sections and sediments in general. The calcrete occurs in the black clays and yellow colour clay silts. The form or shape of calcrete differs from place to place but mostly occur in the nodular form. The calcrete of Beltukri is rounded to sub rounded in form. Calcrete occurs with microliths exposed nala bed at Bhajipala. It has been observed that calcrete is found on the surface because of the erosional activities which has washed away the surface soil leaving behind calcrete nodules on the ground surface. In a few river sections, different episodes of calcrete are observed. None of the sections in the river appear to have a separate calcrete gravel layer indicating the in situ formation. But their concentration varies from high to low in different layers in the section. There are different types of weathering patterns observed on the calcrete. After studying a few calcrete specimens from different river sections, some colour variation has also been recognised in the calcrete depending upon the area. The percentage of carbonate in
soils was recorded as 0-0.2%. The alluvium of the area is dominated by sand particles of various sizes from top to bottom due to which in the sub-humid region of the Mahanadi, where the rainfall is quite high (1300-1600 mm per annum), downward leaching of the carbonate must have taken place from upper part of the profile and it had not precipitated forming *firakankar* bands (Pandey 1987:255-59).

*Kankar* generally occur in the rainfall zone of 550-800 mm per annum and the areas receiving less than 550 mm rainfall develop hardpan calcretes. The areas receiving more than 800 mm rainfall do not form *kankar* at all (Weinert 1976:133-140). The formation of the *kankar* band alone cannot be taken as an indication for a particular type of past environment. In India, *kankar* formations have been reported in the semi-arid and sub-humid regions (Superkar 1968: 423). Detailed understanding of occurrences of different kinds of calcrete and its chemical analysis and weathering pattern is necessary to understand the palaeoclimate of the area. The association of microliths with the calcretic soil formation suggest that these microlithic site may be dated to the terminal phase of the last Ice Age, at around 18000-15000 BP (or Last Glacial Maximum), and the second phase of the microlithic, associated with the brownish coloured sandy-silty deposits, might have had its beginnings in the early Holocene to the mid Holocene period, in parts of Odisha (Prof. S.N. Rajaguru: pers. comm.).

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Table: 2.2 Occurrence of calcrete in the reported sites
2.6.10 Laterite formation

The laterite is an important geological formation and which throws light on many aspects of past environment. The formation of laterite in India took place right from the beginning of the Quaternary and different types of laterites are common throughout peninsular India. The low level laterites have been dated to the Early Pleistocene. Laterite is formed mainly of hydrated iron oxides under hot seasonal condition: in the wet season, rocks are leached and in the dry season, the solution with the leached ions is drawn to the surface by capillary action, where it evaporates, and leaving salts to be washed away in the next season. Thus the whole zone is depleted of the more easily leached elements (e.g. sodium, potassium, calcium and magnesium) and the residuum consist of iron oxides (or aluminium, in the case of bauxites) (Whitten and Brooks 1972:261-262) quoted by Dennell 2009).

In India, laterites have been found at various places at different levels in western India they are categorised as high level and low level laterites. Red brown laterites on granites, granitic gneisses, clays and shales are generally hard or hardened after drying, whereas laterites on basalts are commonly friable and show an intensive reddish colour. (http://www.laterite.de). “In the upper Mahanadi valley the laterites have developed on the plains and also have been noticed in the vicinity of shale rock of Cuddapah group” (Pandey 1987: 257). In the Jonk River valley, the laterites have developed on the plains and noticed over the granitic bedrock as well. But in the stratigraphical context laterite formation has not been observed at any river section. The laterite gravel was observed away from the river in the Bagbaraha area, Grina, and in the inland area in Lower Jonk during the present field work.
2.7 Remote Sensing

Satellite remote sensing technologies have been modernised and seen several improvements in archaeological research. Remote sensing being helpful in reduction of cost and associated with large scale mapping, for creation of site strategy and conservation and preservation of archaeological heritage. Archaeological remote sensing encompasses a broad range of techniques from conventional aerial photography, passive and active airborne and satellite remote sensing to ground-based geophysical surveys. Remote sensing applications in archaeology have been helpful in archaeological investigations, to understand the topography, river system, environment, vegetation cover, palaeo-ecosystem and geoarchaeology. (Rosa and Nicola 2011). The advent of Google Earth has dramatically democratized access to archaeological landscape information worldwide. In developing countries such as India, freely-available satellite images available through Google Earth, Flesh Earth (Yahoo and Microsoft), Bhuvan (ISRO) has provided the scope for archaeologists at both the student and the professional level to make use of aerial imagery (Thakuria et.al 2012 in press).

2.7.1 Methodology for Remote Sensing and Mapping

Google Earth (Version 6.2) was used for mapping and locating sites which were then traced over the Google Earth satellite imageries.

The sites coordinates were taken with a Garmin Etrex–handheld GPS. However, the site locations were cross-checked on Google Earth keeping in view of the high error exhibited by this type of GPS. After a successful attempt of tracing the sites in Google Earth, place marks were used for getting the geo-coordinates and elevation points.

The Shuttle Remote Topography Mission (SRTM) Data was obtained from the USGS website for a Digital Elevation Model (DEM). The Google Earth Polygons were traced on the SRTM data to view its positions. The Global Mapper (version: 11.02) was used for processing and analysing all the raw data available from the USGS website. Firstly, all the sites were traced on the SRTM Map and then the map of the study area was viewed in the form of different shades (e.g., global shedder, slope shedder, slope direction shedder, atlas shedder, HSV shedder). The same can be seen
in (map 2.5-11). All these geo-reference data universally accepts WGS84 as the datum point.

Extensive uses of open source satellite and aerial imageries provided by Google Earth 6.02, Flashearth (Microsoft Corporation and Yahoo) and Bhuvan (Indian Space Research Organisation), were used for better understanding the study area topography and related hills system. These imageries were, in particular, utilized to find the exposed erosional surfaces, to understand the various kinds of river behaviour, tracing the palaeochannels, understanding the drainage pattern, landscape, vegetation pattern, land use pattern, and geo hydrology and basin elevation cross sections models. In addition, district resource maps prepared by Geological Survey of India were also used for a similar purpose. The satellite imageries were very helpful to understand water resources available in the study area. These satellite imageries were also used for elevation profile, cross section profiling of the river and its tributaries, and hills all along the river valley. For tracing the toposheets and producing the drainage maps and site distribution maps, Adobe Illustrator CS.5, Adobe Photoshop CS 5, Google Earth polygons and Global Mapper software were used.

2.7.2 Digital Elevation Model

The Digital Elevation Model gives information about the elevation of landforms of the earth's surface only. The first release of Shuttle Radar Topography Mission (SRTM) data was provided in 1-degree digital elevation model (DEM) tiles from the USGS ftp server (ftp://e0srp01u.ecs.nasa.gov/srtm/) in 2003. The Shuttle Radar Topography Mission (SRTM), which employed Interferometric Synthetic Aperture Radar (InSAR). Unlike the imaging radar, InSAR used radar interferometry to produce a near-global elevation model. The original SRTM data has been subjected to a number of processing steps to provide seamless and complete elevation surfaces for the globe.

The DEM could be acquired through techniques such as photogrammetric, LiDAR, IfSAR, land surveying, etc. (Li et al. 2005). The original SRTM DEM (finished grade data downloaded from ftp://e0srp01u.ecs.nasa.gov/srtm/version2/SRTM3/ is used to produce contours or points. Processing is made on a void by void basis. The data is projected in a Geographic (Lat/Long) projection, with the WGS84 horizontal datum and the EGM96 vertical datum. For the present work 90 meter resolution SRTM data
was used. SRTM Data can include centimeter-scale changes in topography; have proved to be particularly useful in the study of regional topography and in the assessment of both natural and human-induced hazards (Evans 2003).

Global Mapper software is used for generating digital elevation models which used the remote sensing rather than direct survey data. Shuttle Radar Topographic Mission (SRTM) data 53_08 Source://srtm.csi.cgiar.org has been used with the aid of 65 void filling interpolation methods (Reuter et al. 2007).

Map: 2.5 Digital Elevation Map (DEM) of the Upper and Middle Jonk with distribution sites

Digital elevation model of Upper Jonk, 20 meters contour interval, major concentration of lines showing the hills, Acheulian sites are marked with yellow dot, Middle Palaeolithic sites are shown with orange colour dots and Microlithic sites were spotted with red colour dots.

The Map clearly suggests that most of the sites were found near to the some hills within a distance range of 5 km away from the river. Absence of sites in any of the terrain or within the dense forest can clearly be seen.
Map: 2.6 Generated Digital elevation model, overlapped on a Google Earth image of the Acheulian locality around Haldi Hill.

The Acheulian sites were spotted with yellow color start sign. The overlapping of the contour above the tilted image of the Google Earth images creates a 3D view of the topography of the area. The solid green color in the map is the natural lake, before few years it was converted into a pond.

Map: 2.7 Digital Elevation Model (Atlas Shader) of the study area
The above image is containing contour interval of 50 meter distance. The map shows that the hills are showing slope in the south-east direction. Acheulian sites are marked with yellow dot, Middle Palaeolithic sites are shown with orange colour dots and Microlithic sites were spotted with red colour dots. The map shows that few numbers of site in found in lower Jonk.

Map: 2.8 Digital Contour Map of Lower Jonk (20 meter interval)

The high contour concentration refers to the hills and mountains which have more slope, the plain is shown by the distant contour interval. The river system is shown in black line.
Map: 2.9 Digital elevation model (HSV Shader) of the study area

The HSV Shader maps the elevations onto the HSV (hue saturation value) color space.

Map: 2.10 Digital elevation model (Color Ramp Shader) of the study area

The Color Ramp Shader displays ramps colour from blue for low elevations to red for the highest elevations in the global mapper.
Map: 2.11 Digital elevation model (Slope Shader) of the study area

The Slope Shader colours loaded terrain data by the slope of the terrain rather than the absolute elevation. This shader allows you to identify the portions of the terrain that are relatively flat against those that are relatively steep.

2.8 Longitudinal Profile of the Jonk River

Elevation to distance profile (longitudinal profile) of the Jonk River has been drawn by plotting elevation of riverbed against respective downstream distance using Google Earth and Global mapper. The longitudinal profile of the river (Fig.) shows that the river is flowing from an elevated terrain at an elevation of 697 m with a sharp fall in approximate elevation from 600-300 meter fall within a distance of within 10 km downstream. It shows a change in terrain where it entered into the broad valleys in its
flow. The minimum elevation of the river is 227 meter with an average elevation of 351 meter. Straight line distance of the river is 137.24 km with vertical difference start to finish in 431.1m. Max slope 5.1%-11.1% and average slope is 0.4- 0.5% the river flows up to an area of 207 km.

Figure: 2.8 Longitudinal Profile of the Jonk River(Google Earth)

Figure: 2.9 Longitudinal Profile of the Jonk River(Global Mapper)
2.9 Elevation of Acheulian and Microlitic sites

2.9.1 Acheulian sites

All the Acheulian sites were located with an elevation of 266-354 meter elevation in the area with an average elevation of 327 meter amsl. Most of the sites were found within an elevation of 300-350 meters height. Site found in upper Jonk are placed in the higher altitude.

![Elevation of Acheulian Sites](image)

**Figure 2.10:** Elevation of Acheulian site

2.9.2 Elevation of Microlithic sites

All the Microlithic sites in Jonk are located within 228-375 meter above the sea levels. Eight sites are located within the elevation range of 228-300 meters. However 28 sites are found within the elevation of 300-350 amsl and only 3 sites are found within 350-375amsl elevation range.
2.10 Palaeochannel

The preliminary studies on palaeochannel were conducted with the help of Google earth satellite imageries and ground data. It was observed that the river has been shifting its channel from eastern-western side of the river as numbers of palaeochannels are found on right bank of the rivers. The present day water channel were also observed flowing close to the left river bank and many places during flood cutting the river bank. Large sandbar were also most of the cases were noticed on right side of the river which indicate the same. The palaeochannels are not found in upper Jonk and lower in the Nuwapara hills range are because of terrain and hilly racts. However it is very active in middle Jonk, when it enters into the plain just after the Dharmabandha village it’s got several traces of palaeochannel on its both banks. The middle Jonk has intensive traces of old channel bed and its older channel can be clearly observed. However in the lower middle part of the river channel is not much fluctuating although some traces are noticed close to the river. The channel shifting found a distance range of 50-1200 meter away from the present river bed. Some of the palaeochannel till day’s also swampy and contained water throughout the year. The shifting of palaeochannel shows that the river might been affected and controlled by.
bedrock geology and tectonics activity.

Map: 2.12 Palaeochannels of Jonk River
2.11 Land use/land cover Pattern

The remote sensing maps of Odisha and Chhattisgarh were obtained from ISRO was used to understand the Land use/land cover pattern of the study area (Map: 2.13). Large land mass in the study area are dominating by agricultural land, forested and waste land. In Mahasamund district land with dense scrub is 0.01 (Lha) land with open scrub is 0.03, underutilised or degraded forest with scrub dominated is 0.04, and degraded forest agriculture is 0.08 and barren rocky/stony waste is 0.09 (ha). In Nuapada land with dense scrub is 0.2, land with open scrub is 0.02 underutilised degraded forest with scrub dominated is 0.22, and underutilised/degraded forest with agriculture is 0.06 and barren rocky/ stony waste is 0.02 (ha). In Raipur district riverine sand is 0.01%, and barren rocky/waste land area is 0.13 (ha). The stony waste areas most of the times have observed with the Palaeolithic artefacts in the study region.

Map: 2.13 Land use/land cover map of the study area (Courtesy Bhuvan, ISRO)