IV.

EARLY MAN

AND HIS

ENVIRONMENT
"Ideally the prehistorian aims at a complete analysis of the available archaeological data and an interpretation of the same for the reconstruction of cultural patterns. Equally important is the need to assign a timescale to the archaeological evidence and to establish the nature of and changes within the palaeoenvironment to assess their effect upon cultural development" (Clark, 1970). This thesis attempts to identify and elucidate the
various environmental factors which would enable a correlation of the ecological data with the Prehistoric cultures. This chapter is divided into two parts, part A: Archaeology and part B: Palaeoenvironment.

A. A R C H A E O L O G Y

PREVIOUS WORK IN THE REGION

"Early Stone Age" tools of Acheulian character were found for the first time by Sankalia in the Saurashtra region during 1962 (Sankalia, 1965) is a pebble conglomerate at Rojadi, now renamed as Shrinathgadh, on the river Bhadar. This conglomerate has been designated by him as Gravel 'I' and the tools as Series 'I' tools. They consist of handaxes, cleavers, flakes, cores and chopping tools.

"Middle Stone Age" or Series 'II' tools comprising scrapers, borers, points and large flakes of agate and chert were collected at Rojadi, Sejakpur and Pala, in districts of Madhya Saurashtra, Jhalawar and Kalar respectively by Pandya (1956 - 1959).

Rao (1959) discovered tools of Series 'I' in the gravel bed at Kotada and Rangpur on the Bhadar and at Thoriali on the Guma. At Rangpur, overlying a limestone bed was a gravel deposit with jasper and occasionally chert pebbles, in turn overlain by calcareous concretions.
Soundara Rajan (1967) identified an "Early Stone Age" tool at Sherdi (Dist. Junagadh). He also collected "Middle Stone Age" tools from the river bank of Kankawati, near Dhrangadhra. An "Early Stone Age" site was discovered by Soundara Rajan (1967) on the banks of Dokamardo nallah, 4.5 km on the Halvad - Dhrangadhra road. The tool assemblage indicated an advanced Acheulian facies, with the presence of a prepared platform technique. The tools made on jasper and chert were collected from this site. Lele (1968-1972) also collected a few "Early Stone Age" tools from Jasdan, Atkot and Dhrangadhra and "Middle Stone Age" tools from Rajadi, Jetpur, Dhoraji, Upleta and Kutiana. The tools were collected from the surface, as well as from stratified fluvial deposits. Recent discoveries include the Palaeolithic sites in the Kalubhar valley (viz. Samadhiala, Rajpipla, Bhojabhadar and Vasadnath) and also at Chotila near Rajkot (Chakrabarty, 1977). Most of these discoveries are surface finds and only a few are in a semi-primary context (e.g., Samadhiala - Chakrabarty, 1977) and in a stratified context at Jetpur (Lele, 1972). These discoveries only proved the existence of early man in the Peninsula since the Lower Palaeolithic times, but the exact chronological framework for Stone Age cultures, particularly for the Lower Palaeolithic, was lacking.
SITES DISCOVERED BY THE WRITER

Field work was carried out in different seasons between 1972 and 1976. The explorations were made, particularly in the Hiran Valley during 1972 and 1974, while during 1975 and 1976 explorations were made in southern Saurashtra.

Archaeological evidence in the Hiran Valley was obtained both for the Lower and Middle Palaeolithic industries. The Lower Palaeolithic sites in the Hiran valley are Unrethi, Kamaleshwar and the Fasa hill ranges (northeast of Sasang Gir). The Middle Palaeolithic sites are Badalpur, Sangodra, Bhorv, Talala and Bhatchel. Most of the collection comprises surface material both of Lower and Middle Palaeolithic periods except for those from Unrethi, Adi Chadi Tao and Badalpur. These sites are of immense importance in understanding the relative chronology, palaeoenvironment and stratigraphy of the Stone Age cultures. Therefore, they have been discussed in greater detail under chronology (part B: 3 of this chapter).

Apart from this, the writer surveyed*, the southern

* The field work was carried out in the company of Prof. R.V. Joshi, Drs. G.G. Mujumdar, S.N. Rajaguru, R.S. Pappu and S.J. Gander. A detailed report is under preparation. However, the relevant views expressed here are exclusively of the writer.
Saurashtra region from the point of studying stratigraphy and chronology of the Palaeolithic cultures. A few Palaeolithic sites were discovered in Bhavnagar district (on the Maleshri river, at Gopnath and at Talaja), Rajkot district (on river Lalpari and at Chatila) and in Junagadh district (in the Hiran valley, on the Saraswati river, Ojat river and on the Sonarkhi river).

Though there are a large number of surface sites (as mentioned above) the writer has taken into consideration, the collection which is important from the point of view of chronology, stratigraphy and environment of the Palaeolithic cultures. The exhaustive study of the surface collection from the related sites have been exclusively avoided as they are not important from the point of main theme of the thesis.

TERMINOLOGY

Stone Age terminology in India, since the first classification scheme of Foote (1916) has, on several occasions, needed revision as a result of new discoveries.

The first classification divided the prehistoric cultures into Palaeolithic, Neolithic, and as Early and Later Iron Age (Foote, 1916). Burkitt and Cammae (1950) later subdivided the pre-Neolithic cultures into Series, I, II, III and IV, corresponding with the Lower, Middle, Upper Palaeolithic and Mesolithic of Europe.
Thirty years later and in keeping with the numerous new discoveries, at the First Asian Archaeological Conference in New Delhi, 1962, a formalised terminology was adopted whereby the pre-Neolithic cultures of the Subcontinent were grouped into the Early, Middle and Late Stone Ages, corresponding broadly with the European Lower and Middle Palaeolithic and the Mesolithic.

In the late 1960's, for the first time, distinct blade-and-burin industries were discovered from several regions in India, thereby necessitating terminological revision, because no provision was made in the previous scheme for the Upper Palaeolithic.

Excavations have recently been carried out at a number of sites e.g. Bhimbetka (M.P.), Billasurgam cave (A.P.), Hunsgi (Karnataka) and Samadhiala (Saurashtra) which are believed to contain primary stratified deposits. The precise sequence of Indian Pre-Neolithic cultures has, however, yet to be conclusively established. Furthermore, it is likely that the pattern of cultural development has varied from region to region and it is therefore, both premature and unjustified to draw correlation among the several regions of the Subcontinent.

The writer's discoveries in Saurashtra comprise both stratified and surface material. It is probable (see Discussion ahead) that the stratified artifacts may prove...
to be datable both by relative (e.g. Lower Palaeolithic: Miliolite - I) as well as absolute methods (e.g. Middle Palaeolithic: Oyster shells $^{14}C$ dates).

Since the discovery of the blade-and-burin industry (or industries) from various parts of the country, the terminology adopted for the Indian pre-Neolithic cultures in 1962 needed to be revised once more. Hence, characteristic tool-forms of the Upper Palaeolithic are now known. Indian scholars (Misra, 1962; Sankalia, 1974) now tend to revert to the more or less standardised classification of Lower, Middle and Upper Palaeolithic and Mesolithic. The writer has also adopted this terminology, bearing in mind that although partially this is applicable typologically; stratigraphically or chronologically there is no single site in Saurashtra where the entire sequence has yet been discovered.

THE LOWER PALAEOLITHIC INDUSTRY

The Lower Palaeolithic industry from the Hiran Valley consists of the following components:

- 11 handaxes
- 4 cleavers
- 2 flakes
- 1 core
- 1 chopper

Total: 19
The tools were collected from three different localities, viz. Kamaleshwar, Sasan-Gir and Umrethi. Among these three sites, the collection from Kamaleshwar and Sasan-Gir were obtained as surface collection whereas that of from Umrethi were stratified.

Raw material and state of preservation

The raw-material-wise composition of the industry is as follow:

<table>
<thead>
<tr>
<th>Tool types</th>
<th>Raw material</th>
<th>Acid trap</th>
<th>Basic trap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handaxes</td>
<td></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Cleavers</td>
<td></td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Choppers</td>
<td></td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Core</td>
<td></td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Flakes</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>3</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

Out of 19 specimens, 10 specimens show carbonate concretions on their surfaces. So far as state of preservation is concerned the industry may be categorised in the three groups:

1. Moderately rolled : 3
2. Rolled : 2
3. Fresh : 14
Technique

The assemblage reveals preponderance of the stone-hammer technique i.e. the implements are characterised by irregular, deep and large flake scars. However, a few cleavers show small flake scars, shallow in nature which may be said to be the product of cylinder hammer technique.

Typology

The collection may be broadly grouped as shaped tools and the simple artifacts. The former are represented by handaxes, cleavers and choppers.

HANDAXES

Handaxes form the largest shaped tool group in the collection. Based on the general morphology, the handaxes from the Hiran valley may be grouped as:

I) Handaxes made on flakes : 5
II) Handaxes made on cobbles : 5
III) Core-Handaxe : 1

I) Handaxes made on flakes

The four handaxes are made of basic trap while one is made of acid trap. Generally, these handaxes are heavy and thick in the center. In plan-form these are all triangular and show trimming on both the sides. Flake scars
are irregular, large and small in size, deep and shallow in nature. The working edge extends along the circumference in four specimens while in case of one it extends along a lateral side. Tip ends are either pointed or rounded. The transverse cross sections are biconvex, parallelogrammatic and trapazoidal.

HRN : 4 ( Fig. 44:1; Pl. XVI:1 )

Handaxe made on a flake of basic trap. Cross section approximately parallelogrammatic. Patination brownish gray. Patches of cortex remain in the centre and at the tip of the upper surface. A patch of cortex also to be seen at the bottom of the lower surface. Mainly flaked along one side of both surfaces. Flake scars are generally large and deep. ( 18.0 X 11.0 X 6.0 cm ).

HRN : 5 ( Fig. 44 : 2 ; Pl. XVI : 2 )

Handaxe made on a flake of basic trap. Cross section biconvex, slightly weathered. The lower surface almost fully worked. Flake scars are large. Upper surface showing mid-ridge with stoping sides. Tip pointed, butt rounded and thick at the center ( 13.5 X 7.4 X 6.2 cm ).

HRN : 6 ( Fig. 44:3 ; Pl. XVII:4 )

Handaxe made on a flake of basic trap, narrow elongated in outline. Cross section trapazoidal. Grey
patination. Upper surface showing shallow flaking mainly along one side. Lower surface extensively worked with centrally directed shallow flake scars. Tip short spatulate. Butt pointed (15.0 X 5.5 X 4.0 cm).

HRN : 13 (Fig. 45:10; Pl. XVI:7)
Handaxe made on a flake of acid trap, glossy. Triangular in outline, cross section parallelogrammatic fresh. Upper surface nearly fully worked flake scars are small and shallow in nature. Lower surface is mainly a primary flake surface. Tip is worked and pointed. Butt end is unworked and almost straight (13.0 X 7.0 X 4.2 cm).

HRN : 14 (Fig. 44:4; Pl. XVI:3)
Handaxe made on an obliquely struck flake of a basic trap, oval in outline. Cross section biconvex. Rolled. Upper surface nearly fully worked. Flake scars are both large and small, deep and shallow in nature. Lower surface mainly a primary flake surface with steep flaking along one of the margins. Tip square ended (14.0 X 8.0 X 3.3 cm).

II) Handaxes made on cobbles
Handaxes of this group are on basic trap except one specimen. In the plan form three are oval shaped while two are triangular. Most of these handaxes are heavy, thick in centre and retains cortex on major part of the surface.
The upper half of the tool from both the sides have been flaked in case of some specimens. Working edge extends around either half or three-fourth of the circumference. The tip ends are either spatulate or square ended and in case of one specimen the tip is broken. The transverse cross sections.

HRN : 1 ( Fig. 45:5 , Pl. XVI:6 )

Elongated handaxe made on a cobbble of basic trap. Cross section roughly trapezoidal. Slightly rolled. Both surfaces nearly fully worked. Flake scars are large, small and tiny both deep and shallow in nature. Patches of cortex remain in the centre and at the side (14.7 X 9.0 X 6.0 cm).

HRN : 2 ( Fig. 44:6 ; Pl. XVI:9 )

Handaxe made on a cobbble of basic trap. Cross section planoconvex. Both surfaces from the butt to about 2/3rd the length of the implement retain cortex. Large, deep flake scars removed alternately from the sides. Tip end is spatulate and also retains small patch of cortex. The cortex covered, butt is rounded (20.0 X 13.5 X 8.0 cm).

HRN : 6 ( Fig. 45:7 ; Pl. XVI:10 )

Handaxe made on a cobbble of acid trap, oval shape in outline. Cross section approximately parallelogrammatic.
From the upper surface large and deep flake scars have been removed while remaining part of the upper surface retains cortex. 2 - 3 large flake scars removed from the lower surface. Patches of cortex also on lower surface. Tip broad spatulate. Butt rounded and retains cortex (13.2 X 11.0 X 7.0 cm).

HRN : 16 (Fig. 45:8 ; Pl. XVI:ll)

Handaxe made on a cobble of basic trap. Cross section planoconvex. White gray patination. A large flake scar removed from the upper surface. Lower surface is unworked excepting one of the sides which is step flaked. Tip squarish. Butt rounded (13.0 X 9.0 X 5.3 cm).

HRN : 9 (Fig. 45:9 ; Pl. XVI:6)

Handaxe made on a cobble of basic trap. Cross section biconvex. Grayish white patination. Both surfaces worked. Flake scars are large and deep. Tip is broken. Butt rounded and retains cortex.

III) Handaxe made on a core

HRN : 3 (Fig. 45:ll ; Pl. XVI:5)

This is the only example of a core handaxe, made on basic trap. Subtriangular in plan form. Cross section irregular. Several flakes were struck off the original core. Flake scars are generally deep and bold. Major part of both surfaces, however retain cortex. Tip somewhat damaged. (14.0 X 9.0 X 8.2 cm).
CLEAVERS

Cleavers form the second largest group of shaped tools in the collection. They may be classified into the following groups:

I) Divergent cleaver : 1
II) Convergent cleavers : 2
III) Parallel sided cleaver : 1

I) Divergent cleaver

HRN: 17 (Fig. 46:12; Pl. XVII:13)

Cleaver made on a flake of basic trap. Coated with calcium carbonate. Cross section biconvex. Both upper and lower surfaces are worked. Flake scars are medium to small and shallow. The bit of the cleaver edge has been formed by the intersecting flake scars from both the surfaces. The bit is slightly convex and butt is rounded. Flaking on bilateral sides near the butt and suggest that the specimen might have been hafted (13.7 X 9.0 X 4.0 cm).

II) Convergent cleavers

HRN: 7 (Fig. 46:13; Pl. XVII:14)

Cleaver made on a flake of basic trap. Coating of carbonate present. Cross section plano-convex. Working on the upper surface only, with fine step flaking. Tip end oblique. Butt end rounded. Cleaver bit shows sign of use (13.0 X 9.0 X 3.5 cm).
HRN : 11 ( Fig. 46:16 ; Pl. XVII:15 )

Cleaver made on an elongated cobble of basic trap. Light gray patination. Cross section biconvex. Both surfaces partly worked and retain patches of cortex. Flake triangular in shape. Sharp cleaver edge, possibly not used. Rounded butt (12.5 X 7.0 X 5.0 cm).

III) Parallel sided cleaver

HRN : 12 ( Fig. 46:15 ; Pl. XVII:12 )

Cleaver made on a side flake of basic trap. Gray patination. Cross section plano-convex. Upper surface partly worked. Flake scars are both large and small. A small patch of cortex in the centre which in fact is the thickest portion of the implement. Lower surface is a primary flake surface but bulb has been removed. Cleaver edge is more or less straight, does not show use-marks (14.5 X 9.0 X 5.5 cm).

C H O P P E R

HRN : 18 ( Fig. 47:16 ; Pl. XVII:18 )

There is only one chopper in the collection. It is made on a cobble of basic trap. The chopping edge at one side is unifacially worked. The edge is concave and shows signs of use (12.6 X 8.0 X 6.6 cm).
SIMPLE ARTIFACTS

These consist of two end flakes and a waste product i.e. a amorphous core.

FLAKES

ADC : 20 ( Fig. 47:17 Pl. XVII:17 )

An end flake made from basic trap. Slightly encrusted with calcium carbonate. Two sloping surfaces meet at the centre divided by a straight mid-ridge. One side retains cortex, the other side is primary flake surface. Lower surface is primary flake surface with diffused bulb. Striking platform is plain with two flake scars have been removed. Shows some battering marks along one side which may be due to rolling, although the specimen is quite fresh.

HRN : 10 ( Fig. 47:18 Pl. XVII:16 )

An end flake made on a basic trap. Light gray patination. Major part of the upper surface is covered by a large patch of cortex. The lower surface is a primary flake surface with a bulb. Striking platform is unworked.

CORE

HRN : 19 ( Fig. 47:19 Pl. XVII:19 )

A formless core made from basic trap. Brownish gray patination and partly encrusted with carbonate. Ovalish, triangular and irregular scars both large and small, deep and shallow from all sides of the specimen.
PLATE XVI. LOWER PALAEOLITHIC TOOLS
Lower Palaeolithic tools, Cleavers.

Lower Palaeolithic flakes and cores.
THE MIDDLE PALAEOLITHIC INDUSTRY

The Middle Palaeolithic collection from the Hiran valley were obtained from the following four sites Sangodra, Talala, Borvav and Virpur. The total collection consists of 61 specimens.

The industry includes the following components.

- 43 Scrapers
- 2 Borers
- 1 Notch
- 1 Point
- 8 Flakes
- 6 Cores

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61 Total

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Raw material and state of preservation

The raw material wise composition of the industry is as follows:

- Acid trap : 17
- Basic trap : 08
- Siliceous material : 36

These specimens are mostly fresh, some of them, however, show calcareous encrustation.
Technique

The Middle Palaeolithic industry of the Hiran valley is basically the product of the light stone hammer technique. There are few implements showing a Levalloisian technique. The edge retouching was done either by pressure technique or by indirect percussion method.

Typology

Typologically the collection is divided into shaped tools and other artifacts. The shaped tools are consisting of:

1. Scrapers
2. Borers
3. Notch
4. Point

SCRAPERS

The most representative type of the Middle Palaeolithic component is the scraper. The scrapers may be grouped / subgrouped as under:

a. Side Scrapers
b. End Scrapers
c. Two-sided Scrapers
d. End-and side Scrapers
e. Round Scrapers
f. Core Scrapers.
a) Side Scrapers

Out of 34 examples 29 made on flake and 5 made on nodule of acid trap, or of siliceous material. The following four sub-types are recognised.

- Side scraper convex : 20
- Side scraper concave : 6
- Side scraper straight : 4
- Side scraper irregular : 4

**Side Scraper Convex**

**HRN : 103 (Fig. 48:1 ; Pl. XVIII:5 )**

Side scraper convex made on a side flake of acid trap. Upper surface shows one large flake scar and a few scars on the margin. Lower surface is primary flake surface with a diffused bulb. Convex working edge on one of the sides shows uneven retouching (5.2 X 5.0 X 1.9 cm).

**HRN : 29 (Fig. 48:2 ; Pl. XVIII:18 )**

Side scraper convex made on a side flake of acid trap. Upper surface retains context. Lower surface is a primary flake surface with a moderately develop bulb. Convex working edge. Retouch along one of the margins and shows signs of use (4.6 X 3.6 X 1.4 cm).
MIDDLE PALAEOLITHIC TOOLS.
HRN : 105 (Fig. 48:3; Pl. XVIII:27)

Side scraper convex made on siliceous material of brownish colour. Major part of the upper surface is unworked. Lower surface is primary flake surface with partly removed bulb. Slightly convex edge shows serrated marks resulted from use (10.5 X 5.5 X 2.5 cm).

Side Scraper Concave

HRN : 7 (Fig. 48:7; Pl. XVIII:22)

Side scraper on an end struck flake of basic trap. Retaining patches of carbonate concretions on both the surfaces. Concave working edge. Retouch from the lower surface, straight and shows shallow retouching from the upper surface (9.5 X 6.5 X 3.0 cm).

Side Scraper Irregular

HRN : 15 (Fig. 48:5; Pl. XVIII:23)

Side scraper made on a nodule of acid trap. Major part of the both surfaces are original flake surface. Irregular working edge shows notch-like indentations (8.5 X 5.0 X 2.5 cm).

HRN : 11 (Fig. 48:6; Pl. XVIII:16)

Side scraper on a nodule of an acid trap. Major part of both the surfaces retained cortex. Irregular working edge is situated on one side of the implement and shows shallow retouching (4.6 X 2.6 X 1.5 cm).
b) End Scraper

End scraper on a flake of a chert. Upper surface showing an oval, large scar. Lower surface shows a prominent bulb with a bulbar scar. Convex working edge, shallow retouching (4.8 X 4.7 X 1.4 cm).

c) Two-Sided Scraper

HRN : 30 (Fig. 48:8; Pl. XVIII:15)

Two-sided scraper on an end flake of acid trap. Major part of the upper surface showing cortex and a thin, shallow flake has been removed with a moderately developed bulb. Working edges on both lateral sides-convex. Blunt retouch (3.5 X 3.2 X 0.6 cm).

HRN : 9 (Fig. 48:9; Pl. XVIII:2)

Two-sided scraper made on an end flake of chert. Triangular in shape, retaining small patch of cortex on upper surface. Lower surface-primary flake surface. Bulb partially removed. Working edges shows both shallow and blunt retouching (4.7 X 4.0 X 1.2 cm).

HRN : 114 (Fig. 48:10, Pl. XVIII:7)

Two-sided scraper on a quadrilateral flake of a chert. Both surfaces-primary flake surfaces. Lower surface showing a moderately big bulbar scar. Convex working edges the right edge is worked from the lower surface while the
left from the lower surface showing signs of use (5.7 X 5.3 X 1.5 cm).

HRN: 47 (Fig. 48:11; Pl. XVIII:17)
Two sided scraper on a blade-form flake of chert. Minor working on the upper surface. A small scar retained at the lower surface. Working edge on both sides, showing shallow retouch (4.0 X 2.2 X 0.6 cm).

HRN: 132 (Fig. 49:12; Pl. XVIII:26)
Two sided scraper made on a chunk of chert. Both surfaces retain cortex. From one side two small flakes were removed. Working edge on two sides. Left showing shallow retouch and right edge is blunted due to use (7.3 X

d) End-and-Side Scrapers
HRN: 16 (Fig. 49:13; Pl. XVIII:12)
End-and side scraper made on a levallois flake of chert. Right lateral working edge is convex and shows shallow retouching from the upper surface but the convex working edge on the top is retouched from both the sides (5.1 X 3.6 X 1.4 cm).
End-and-side scraper on a blade-form flake of acid trap. Upper surface retains a patch of cortex on one side; the side working edge is bluntly retouched from both surfaces. The end convex edge is achieved by removing a parallel flake from the lower surface and shallow retouching from the upper surface (6.8 X 2.1 X 1.6 cm).  

End-and-side scraper on a quadrilateral flake of acid trap. Major part of the upper surface worked. Lower surface primary flake surface with a diffused bulb. The working edge from left lateral side is straight but oblique. Shallow retouch (5.8 X 4.6 X 1.7 cm).  

End-and-side scraper on a side flake of acid trap, roughly rectangular. Half the upper surface retains cortex. Lower surface is smooth, bulbar scar at one of the sides. Working edges on both sides and at one end. Shallow retouch (5.8 X 5.5 X 1.6 cm).  

e) Round Scraper  
Round scraper on a thick flake of jasper. Numerous flake scars removed from the upper surfaces. Flake scars are
both large and small, shallow in nature. Lower surface unworked and retains a tinny bulbar scar. Working edge around the circumference (7.2X2.8 cm).

f) Core Scraper
HRM: 126 (Fig. 49:18; Pl. XVIII:20)
A core scraper made on a thick, side flake of a chert. The major part of the upper surface shows a large rounded scar with several other flake scars removed from all over the surface. A few flake scars are also removed from the lower surface. The working edge has resulted from usage, brushed (10.2 X 7.5 X 3.9 cm).

BORER
HRM: 27 (Fig. 49:19; Pl. XVIII:3)
Borer made on a thin flake of acid trap. None of the surface worked. A thick borer point has been achieved by convergent flaking from both sides of the point. The tip is retouched and also the sides of the implement. (4.9 X 4.1 X 1.6 cm).

NOTCH
HRM: 123 (Fig. 49:20; Pl. XVIII:1)
A notch made on a flake of acid trap. Major part of the upper surface shows cortex. Flat lower surface, unworked and smooth. A notch has made on the left lateral
side of the implement and shows signs of use (5.2 X 2.9 x 1.3 cm).

**POINT**

HRN: 231 (Fig. 49:21; Pl. XVIII:13)

A crude point made on a thin end flake of jasper.
A few shallow flake scars removed from the upper surface.
Sides around the point are retouched (4.2 x 3.6 x 0.6 cm).

**CORE**

HRN: 102 (Fig. 49:22; Pl. XVIII:21)

Discoidal core made on a block of jasper.
Numerous flake scars medium to small size removed from both the surfaces (8.2 x 7.3 x 4.6 cm).

To sum up typo-technologically the Lower Palaeolithic culture in the Hiran valley is Acheulian. The collection as mentioned earlier is not homogeneous. The Palaeolithic tools from the Umrethi dam site, in the Hiran valley and from the Adi Chadi Wao (Junagadh) have been found in the fluvial gravel, one of the earliest rock unit of the Quarternary formations in Saurashtra (see the discussion in part B of this chapter).
Acheulian tools from the Hiran valley are made on Deccan Trap and consist of a few handaxes, cleavers, chopper flakes and cores. The industry seems to be the product of stone hammer technique, although a few cleavers show that final finishing and retouching was done by cylinder hammer technique.

On the basis of manufacturing technique and general characteristics of these tool groups, we may compare them with the Acheulian industries from Saurashtra and other parts of India. It is, however, interesting to note that the collection though small compares very well with Chirki-Nevasa (Maharashtra), Anagawadi and Hunsgi (Karnataka). But technomorphologically they show slight difference from the tool kit composition of Samadhiala (Saurashtra). The Samadhiala industry based on its technomorphology has been assigned to the Upper Acheulian phase in the Lower Palaeolithic tradition of India (S. Chakrabarty, 1977). However, as the tool kit composition of the Hiran valley shows similarity with that of Chirki, Anagawadi and Hunsgi; we are, therefore, tempted to place them in the Lower Acheulian tradition of the Lower Palaeolithic industries of India.

The Middle Palaeolithic tools from the Hiran valley have been collected from the following sites: Sangodra, Talala, Borvav and Virpur. The Middle Palaeolithic industry
is basically scraper-borer complex. Of the total collection (61 artifacts) scrapers amount to 70.49%, borer: 3.28%, notch: 1.64% and point: 1.64%. This shows that scraper is the most dominant type among all other categories of finished tools. The raw material wise distribution shows that the industry employed different type of raw material but mainly consisting of siliceous material.

The Middle Palaeolithic industry from the Miran valley in tool types, manufacturing techniques as well as in the employment of raw material shows close affinity with the Middle Palaeolithic industries known so far from other parts of the country as well as from Saurashtra (Table: 18 and 19).

Finally, the occurrences of the Lower and Middle Palaeolithic tools in the stratified context from the southern parts of Saurashtra are of great importance from the point of view of chronology, palaeoenvironment and man-land relationship. However, these factors have been discussed in detail in the subsequent part of this chapter.
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<th>Sites</th>
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<td>--</td>
<td>16</td>
</tr>
<tr>
<td>Choppers</td>
<td>--</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>Scrapers</td>
<td>4</td>
<td>--</td>
<td>49</td>
<td>20</td>
<td>73</td>
</tr>
<tr>
<td>Flakes</td>
<td>1</td>
<td>2</td>
<td>66</td>
<td>9</td>
<td>80</td>
</tr>
<tr>
<td>Cores</td>
<td>--</td>
<td>1</td>
<td>15</td>
<td>--</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11</td>
<td><strong>19</strong></td>
<td><strong>222</strong></td>
<td><strong>36</strong></td>
<td><strong>290</strong></td>
</tr>
</tbody>
</table>

* - Collection from these sites have been incorporated with the kind permission of Shri. S. Chakrabarty.
### TABLE 19

**Middle Palaeolithic tools from Saurashtra**

<table>
<thead>
<tr>
<th>Sites</th>
<th>Bhavnagar*</th>
<th>Rajkot*</th>
<th>Hiran</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrapers</td>
<td>208</td>
<td>102</td>
<td>43</td>
<td>353</td>
</tr>
<tr>
<td>Borers</td>
<td>18</td>
<td>4</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Notches</td>
<td>13</td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Points</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Burine</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Choppers</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Knife</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Handaxes</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Pushplane</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Flakes</td>
<td>128</td>
<td>70</td>
<td>8</td>
<td>206</td>
</tr>
<tr>
<td>Blades</td>
<td>15</td>
<td>3</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Cores</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>410</td>
<td>186</td>
<td>61</td>
<td>657</td>
</tr>
</tbody>
</table>

* - Collection from these sites have been incorporated with the kind permission of Shri. S. Chakrabarty.
B. PALAEOENVIRONMENT

1) ORIGIN OF THE MILIOLITE

The problem of the origin and age of the miliolite of Saurashtra has intrigued a number of workers of various scientific disciplines ever since it was first reported by Carter in 1849. One of the most-discussed aspects of miliolite is its mode of origin. One group of workers maintain that it is composed of marine and coastal deposits which have been transported and reworked by subaerial processes ("aeolian hypothesis") and the other school believes that it represents mostly beach sediments which have formed in varying marine environments ("marine hypothesis").

Pedden (1884) suggested a marine origin but had noted dune sands within miliolite. Evans (1900) opined that the Saurashtra miliolite has been formed in the immediate vicinity of the shore by wind action at some places and elsewhere as a littoral/shallow water deposit. A similar view was expressed by Biswas (1971) who stated that miliolite rocks had been deposited in varying environments. According to him the coastal miliolites were deposited in a beach environment but the inland ones were deposited in an aeolian to fluvio-aeolian environment. Bhatt and Patel (1976) have supported the "marine hypothesis" based on studies in the area between Kodinar and Veraval. Sperling and Goudie (1975) felt that there are sound
arguments in favour of an aeolian origin for the Saurashtra miliolite but they accept the hypothesis that there may be more than one type of limestone of Pleistocene age in this area. Agrawal and Roy (1976) have classified the inland miliolite (viz. from Junagadh, Ghotila) as being of aeolian origin. Verma and Mathur (1976) are of the opinion that the miliolite of Saurashtra consists of both marine and aeolian deposits.

From this brief review it can be seen that most of the workers accept a littoral origin for the miliolite occurring within the coastal fringing area, but do not agree on the mode of formation of the inland miliolite. The controversy regarding the origin of the miliolite has arisen due to the fact that no worker has attempted to study more than one aspect of this deposit and each one has chosen an isolated field of observation to draw his conclusions. The overgeneralisation about the mode of occurrence and the origin of miliolite from limited areas has also resulted in further controversy.

In order to understand the origin and age of the miliolite in the Hiran valley, samples of the miliolite and related sediments were analysed (as mentioned in chapter III). Only the results of the analysis are discussed here.

Chemical analysis of 15 samples was carried out and the percentage of CaO, MgO, Al₂O₃ and SiO₂ were estimated.
No marked difference was observed in these characters between the coastal and inland miliolite samples. Therefore, it is not possible to infer depositional environments only on the basis of chemical properties.

The quartz grains from the inland miliolite were studied with the help of a Scanning Electron Microscope (SEM). On the basis of limited SEM results it is difficult to establish the precise origin of the miliolite. However, the samples from Umrethi and Bhatchel showed subaqueous features and absence of any typical aeolian features. The samples from Bhatchel suggest intermixing of environment (e.g. fluvio-marine).

Petrographic studies show that the majority of the miliolites can be classified as pelmicrite or biopelsperite. The majority of quartz and felspar grains are fresh, subangular to angular along with easily weatherable minerals (hornblende, pyroxene) which are local derivatives contributed as suspension load in the fluvial environment. On the other hand the pellets, pseudoolites in the micritic and sparitic groundmass indicate their deposition under either a littoral shallow water marine environment or an aeolian (mostly, nearshore dune) environment. There is no difference in the degree of sorting (most of them are well sorted). The degree of rounding of silica grains (the majority are subangular) and the nature of abrasion of the
foraminifera and shell fragments (mainly moderately abraded) in the rock samples, which on the basis of field characters have been assigned to a fluvo-marine origin (Umrethi, Bherala) and aeolian origin (Una). Thus, petrological studies are not by themselves useful in differentiating between littoral and aeolian environments.

The dune formed at Adi Chadi Wao, however, must have formed as an obstruction dune at the base of Girnar, in a near-coastal environment. It rests disconformably on the basal fluvial, bouldery pebbly gravel. It is difficult to ascertain whether the dune was formed during a transgressive or regressive phase, but it is certainly contemporary with the first and major marine transgression in this area (as the pre-miliolitic bouldery pebbly gravel is entirely devoid of miliolitic pebbles or even particles).

On the basis of laboratory studies and field observations it can be seen that the valley fill miliolites in the Hiran valley are essentially of littoral origin. Also, field studies in southern Saurashtra have shown that miliolites of marine or fluvo-marine origin generally occur at an elevation of about 40 m; while those occurring above this height are aeolian in origin with the exception of Umrethi (about 75 m AMSL), the Shingoda dam site (about 104 m AMSL) and Adi Chadi Wao (about 105 m AMSL).
One of the most important aims of Quaternary archaeology is to establish a relative or an absolute date for implementiferous sediments. The Older Alluvium yielding Lower Palaeolithic industries has been dated to the Middle Pleistocene on the basis of palaeontological evidence from a number of sites on several major Peninsular rivers, viz., Narmada (de Terra and Paterson, 1939), Pravara (Sankalia, 1956) and Godavari (Joshi et al., 1966). The faunal remains consist of typical Middle Pleistocene species of *Bos*, *Elephas*, *Equus*, etc. It has also been observed that the alluvium yielding the succeeding Middle Palaeolithic industry is also associated with more or less similar faunal remains. This is because many of the mammalian species have a wide time range and persist both in the Middle and Upper Pleistocene, almost up to the beginning of the Holocene (Khatri, 1966). At present, therefore, faunal evidence has a restricted value in the precise dating of fluvial sediments and associated archaeological remains.

Relative chronology of sediments is often based on the presence of cultural units; however, this is not an accurate method as there can be an overlap of cultures in many areas. e.g. the excavations undertaken by Supekar (1968) at Mahadeo Piparia in the Central Narmada Valley and by Corwinus (1967) at Chirki Nevasa in the Pravara valley have revealed that tools of the Lower and Middle Palaeolithic
industries occur together both in the lowermost bouldery gravel as well as the succeeding rubble gravel formations. It is, therefore, necessary to date a tool-bearing formation independently either by stratigraphical or by geophysical methods.

A few radiocarbon dates have been obtained for the Older Alluvium in Western Maharashtra. These dates range from 39,000 to 19,000 years B.P. (Agrawal and Kusumgar, 1967). Some of the dates are for the lowermost portion of the alluvium. Rajaguru (1970) on the basis of these radiocarbon dates and geomorphic evidence has assigned an Upper Pleistocene age to the alluvium partly exposed and partly buried in the river valleys of Western Maharashtra. According to him the Lower Palaeolithic industry found in the Older Alluvium of Western Maharashtra should broadly be dated to the Upper Pleistocene and there is not much gap between the Lower and the Middle Palaeolithic cultures of this region.

A temporal framework for alluvial stratigraphy based on radiocarbon assays of caliche nodules from the Narmada, Mahi and Sabarmati was attempted by Hegde and Switsur (1973). They concluded that the soil might have begun forming several thousand years earlier than the radiocarbon dates (18,000 to 24,000 B.P.). The caliche nodules from the B/C horizon of the Black Cotton soil in
the Lower Narmada valley have been assayed radiometrically and the soil is dated to 7,000 years B.P. (Rajaguru and Hegde, 1972). It appears that the black soil was formed during the early Holocene times and alluvial deposits lying below this in situ weathered black soil are of the Pleistocene Age. This, therefore, gives an upper age limit to the Older Alluvium exposed in the river valleys.

Nothing is known about the lower limit of the Pleistocene deposits and hence it is difficult to date the related Palaeolithic cultures in Peninsular India. However, the writer's recent discoveries of stratified Palaeolithic artifacts, have proved useful in dating the Lower Palaeolithic culture of the southern Saurashtra. The dating is mainly based on stratigraphic, geomorphic and geophysical data.

The problem of chronology of Palaeolithic artifacts is interlinked with the miliolite and other coastal formations in the area under consideration. There are various opinions regarding the age of the miliolite formations. On the basis of micro-faunal analysis Sastri and Pant (1960) assigned the miliolite to a Pleistocene to sub-recent age. Biswas (1971) dated the coastal miliolite of Saurashtra to the Early Pleistocene and the inland miliolites of Kutch and Saurashtra to the Late Pleistocene. Lele (1973) ascribed an Early Quaternary
age to all the miliolites of Saurashtra on the basis of relative stratigraphical evidence; Sperling and Goudie (1975) and Agrawal and Roy (1976) on the other hand placed the inland miliolites in the late Pleistocene on the basis of archaeological evidence and a few $^{14}C$ dates. The $^{14}C$ dates of miliolite fall between 14,000 to 30,000 B.P. (Agrawal and Pant, 1976). However, the miliolite is not a very suitable material for $^{14}C$ dating, since the exchange possibilities are large and the $^{14}C$ dates represent only the upper limits (Agrawal et al., 1977). The dates of miliolite on the basis of the Ca/Mg ratio (Govindan et al., 1976) are also in conformity with the radiometric dates. The apparent correlation between the ages obtained by the Ca/Mg ratio method and radiometric methods could be fortuitous because this method assumes an open system in which Ca/Mg ratios change with time. On the other hand radiometric methods require a system to remain closed (Gupta S.K. - p.c.). In recent years Ca/Mg ratios have been determined mainly for the calcite component and not for the gross mixture. It has been observed that $Mg^{2+}$ is selectively adsorbed by illite clays, so that the gross ratio may only reflect the total illite content or perhaps the degree of diagenesis (Chilinger et al., 1976). Therefore, the Ca/Mg ratio is only useful for relative dating (Govindan et al., 1976).
3) CHRONOLOGY OF THE PALAEOLITHIC CULTURES IN THE HIRAN VALLEY

A late Harappan (about 4,000 B.P.) occupational mound was found on the terrace surface of an alluvial fill near Prabhas Patan on the right bank of the Hiran.

The conspicuous development of aeolianites and beach rock has been observed all along the southern coastal strip, from Kodinar to Veraval and further west up to Chorwar and Mangrol. They occur for about a distance of 8 km inland from the coast. These littoral formations seem to have been laid down during the regressive phase of the later part of the late Pleistocene (i.e., after 30,000 B.P. - see the discussion ahead). However, they are certainly of the pre-Mesolithic period as a large number of mesolithic artifacts have recently been discovered on the surface of the aeolianites around Una (Verma K.K. - p.c.) and Kodinar (Goudie and Sperling, 1976).

A few Middle Palaeolithic tools were recovered from the basal pebbly gravel of this fill which is about 0.5 m thick and 2.3 km in lateral extent. The finer component of the alluvial fill is moderately calcreted, yellowish brown (10 YR 5/4) silty sand. The alluvial fill rests on and against the miliolite formation which is about 40 m thick in this area. An alluvial fill with more or less similar mineralogical characters and dimensions has been capped by a miliolite, 1.5 m thick at the Umrethi dam site,
(Fig. 20) 22.7 km upstream from Prabhas Patan. Both these formations were found to rest against the miliolite formation. At Umrethi three unrolled Lower Palaeolithic tools were discovered by the writer during the 1975 season's fieldwork in a buried channel gravel of the Hiran at a depth of 34 m below the surface. The channel gravel (about 2 m thick) rests unconformably on the Deccan Trap and grades into the miliolite which is 30 m thick. On the basis of field observations (as described in Chapter III) the miliolite formation in the cut-off trench at Umrethi is certainly earlier than the thin stratum of miliolite, capping the alluvial fill at Ghusia. The Umrethi miliolite has been designated as miliolite I and the Ghusia miliolite as miliolite II.

**TABLE 20**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Location</th>
<th>Material</th>
<th>Elevation (m)</th>
<th>Radiometric ages ($\times 10^3$ years B.P.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MHTL 230, 234U/238U</td>
<td>234U/238U</td>
</tr>
<tr>
<td>1.</td>
<td>Okha</td>
<td>Coral</td>
<td>0.8</td>
<td>113 ± 4.0</td>
</tr>
<tr>
<td>2.</td>
<td>Armara</td>
<td>Coral</td>
<td>3.5</td>
<td>34 ± 2.0</td>
</tr>
<tr>
<td>3.</td>
<td>Bhimdana</td>
<td>Coral</td>
<td>3.3</td>
<td>123 ± 9.0</td>
</tr>
<tr>
<td>4.</td>
<td>Salaya</td>
<td>Coral</td>
<td>0.8</td>
<td>6 ± 0.2</td>
</tr>
<tr>
<td>5.</td>
<td>Mithapur</td>
<td>Coral</td>
<td>3.0</td>
<td>33 ± 1.0</td>
</tr>
</tbody>
</table>

Table contd..
<table>
<thead>
<tr>
<th>Sr. Location No.</th>
<th>Material</th>
<th>Elevation above MHTL</th>
<th>Radiometric ages (x10^3 years B.P.) based on</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>230(^{Th})/234(^{U})</td>
</tr>
<tr>
<td>6. Porbandar</td>
<td>Shell</td>
<td>3.5</td>
<td>--</td>
</tr>
<tr>
<td>7. Visavara</td>
<td>Shell</td>
<td>4.3</td>
<td>--</td>
</tr>
<tr>
<td>8. Bardia</td>
<td>Coral</td>
<td>4.7</td>
<td>--</td>
</tr>
<tr>
<td>9. Gadhula</td>
<td>Coral and Shell</td>
<td>3.7</td>
<td>--</td>
</tr>
<tr>
<td>10. Porbandar</td>
<td>Shell</td>
<td>5.8</td>
<td>--</td>
</tr>
<tr>
<td>11. Kuchadi</td>
<td>Shell</td>
<td>3.7</td>
<td>--</td>
</tr>
<tr>
<td>12. Bhimrana</td>
<td>Shell</td>
<td>1.0</td>
<td>--</td>
</tr>
<tr>
<td>13. Badalpur</td>
<td>Shell</td>
<td>6.9</td>
<td>--</td>
</tr>
<tr>
<td>14. Hiran</td>
<td>Shell</td>
<td>7.2</td>
<td>--</td>
</tr>
<tr>
<td>15. Ghotila</td>
<td>Miliolite</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>16. Dungarpur</td>
<td>Miliolite</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>17. Junagadh</td>
<td>Miliolite</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>18. Barda hills</td>
<td>Miliolite</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Calculated using \(t_{\frac{1}{2}}\), \(^{230}\)Th = 7.52 X 10^4 years
\(t_{\frac{1}{2}}\), \(^{234}\)U = 2.48 X 10^5 years.
\(t_{\frac{1}{2}}\), \(^{14}\)C = 5730 ± 40 years.

Dates of Sr. No. 1 to 12 are from Gupta (1972) and Gupta and Amin (1974) and 13 to 18 from Agrawal et al., 1976

MHTL: Mean High Tide Level.
In the Saraswati valley around Badalpur on oyster bed (1 m thick, at a height of 8.3 m AMSL and 6 km inland) was found to be resting on a fluvial gravel (about 1 m thick) which in turn was found to grade laterally into mottled, grayish tidal clays and dark brown carbonaceous clay (about 1 m thick). The fluvial gravel has yielded a few Middle Palaeolithic tools (Govindan et al., 1975). The overlying oyster bed also laterally grades into miliolite (M-II).

There is no absolute date for miliolite-II but there are two 14C dates for the oyster shells from the Hiran (21,430 ± 690) and Saraswati (24,980 ± 1680) valleys. As these dates represent only the upper limit of the true age, they indirectly help to date M-II and the associated artifacts. In the light of the radiometric dates of corals and beach rocks from the western and southern coasts of Saurashtra (Table 20), it appears that there was a largescale marine transgression during the late Quaternary. This is indicated by the occurrence of miliolite resting on the fluvial gravel which has yielded Middle Palaeolithic tools older than 30,000 years, at Jetpur, Rajkot and at Badalpur.

The tentative correlation of the basal fluvial gravel at Umrethi and from the well-sections between Palala and Veraval, showed that the pre-miliolite (M-I) buried channel of the Hiran was graded to a base level which was at that time 15 m below the present one (Fig. 50). Based on
field observations at the Ummrethi and Shingoda dam sites and in the Hiran, Saraswati and Shingoda river valleys, the following stratigraphic reconstruction is possible:

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Average thickness (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Modern black-brown pedocal soil</td>
<td>1.0</td>
</tr>
<tr>
<td>grades into</td>
<td></td>
</tr>
<tr>
<td>2. Brownish, less calcareous sandy silt</td>
<td>4.5</td>
</tr>
<tr>
<td>sharp contact to</td>
<td></td>
</tr>
<tr>
<td>3. Miliolite - II, shelly conglomerate and oyster beds</td>
<td>1.5</td>
</tr>
<tr>
<td>sharp contact to</td>
<td></td>
</tr>
<tr>
<td>4. Brownish calcareous sandy silt with intercalated lenticular patches of</td>
<td>3.0</td>
</tr>
<tr>
<td>fluvial gravels</td>
<td></td>
</tr>
<tr>
<td>sharp contact to</td>
<td></td>
</tr>
<tr>
<td>5. Reddish brown calcareous sandy silt and associated fluvial gravels</td>
<td>4.0</td>
</tr>
<tr>
<td>sharp contact to</td>
<td></td>
</tr>
<tr>
<td>6. Miliolite - I</td>
<td>5.0</td>
</tr>
<tr>
<td>grades into</td>
<td></td>
</tr>
<tr>
<td>7. Fluvial gravels which rest unconformably on the pre-Quaternary</td>
<td>1.0</td>
</tr>
<tr>
<td>formations</td>
<td></td>
</tr>
<tr>
<td>( e.g. Deccan Trap )</td>
<td></td>
</tr>
</tbody>
</table>

The maximum thickness of the above mentioned Quaternary deposits in this area is about 40 m. The stratigraphic column shows that there are two major rock units, each characterised by fluvial sediments grading into...
the miliolite. This might suggest that the Hiran valley passed through two major marine transgressive phases during the Quaternary.

The Problem of the age of the miliolite - I could not be solved on a definitive basis as no absolute dates either for the miliolite or for the associated fluvial and littoral sediments are available. Similarly micropalaeontology did not help in dating as there is absolutely no difference in the palaeontological content of miliolite - I and miliolite-II. On geomorphological grounds, miliolite - I is separated from miliolite - II by fluvial deposits which can be subdivided into two major sub-facies, the earlier facies being characterised by a higher degree of calcification and oxidation than the later facies (Table - 16). As the sedimentological, chemical and clay mineralogical studies (Marathe et al., 1977) of pre- and post-miliolite-II sediments from the Hiran valley do not indicate any drastic changes in the climate and geomorphic processes, it is reasonable to assume a time lapse of several thousand years for the diagenetic changes that have taken place in the earlier sediments and therefore a considerable antiquity can be assigned to miliolite-I. The transgressive phase, co-incidental with the formation of miliolite-I could, then, be equated with Gupta's (1974) transgressive phase of 1,20,000 years or with the last interglacial high strandline.
This is the minimum age of the miliolite - I from the Hiran valley.

As stated earlier the basalmost fluvial gravel which has yielded Palaeolithic tools at Umrethi belongs to a period when the sea level was lower by at least 15 m. Allowing for a time lapse between the transgressive and regressive phase during which the geomorphic changes could have taken place, it is reasonable to assign a high antiquity to the tools found at Umrethi. They are certainly older than 1,20,000 years or early late - Pleistocene, and are most probably of mid - Pleistocene age. For the first time in India Palaeolithic cultures have been dated in the context of littoral stratigraphy. The tentative chronostratigraphical scale for the Palaeolithic industries found in the Hiran valley is given in Table 21.

**TABLE : 21.**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Geomorphic events.</th>
<th>Geomorphic Cultural finds.</th>
<th>Approximate age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soils, alluvia, beaches and dunes</td>
<td>Fluctuating sea level</td>
<td>Mesolithic and Chalcolithic</td>
<td>Holocene</td>
</tr>
<tr>
<td>sharp contact to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil soils, yellowish</td>
<td>low sea level</td>
<td></td>
<td>Late Pleistocene to Early Holocene.</td>
</tr>
<tr>
<td>brown alluvial silts,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gravels and aeolianites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithology</td>
<td>Geomorphic events</td>
<td>Cultural finds</td>
<td>Approximate age</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>sharp contact to Miliolite-II, oyster beds, tidal clays and beach rocks</td>
<td>High sea level</td>
<td><em>Late Pleistocene (about 30,000 yrs. B.P.)</em></td>
<td></td>
</tr>
<tr>
<td>grades to Fluvial gravels and brownish moderately oxidised silts and clays</td>
<td>Major valley filling Palaeolithic strong rejuvenation</td>
<td>Early Late Pleistocene (?)</td>
<td>40,000 yrs. B.P.</td>
</tr>
<tr>
<td>sharp contact to Miliolite-I with intercalated tidal clay, aeolianites and terrigenous sediments</td>
<td>High sea level</td>
<td><em>Terminal mid or Early late Pleistocene (?)</em> about 1,20,000 yrs. B.P. (?)</td>
<td></td>
</tr>
<tr>
<td>grades to Fluvial, gravels silts</td>
<td>Low sea level Palaeolithic</td>
<td><em>Mid Pleistocene (?)</em></td>
<td></td>
</tr>
<tr>
<td>unconformity beach rocks, limestones (Flanka beds)</td>
<td>High sea level</td>
<td>Miocene</td>
<td></td>
</tr>
<tr>
<td>unconformity Deccan Traps</td>
<td></td>
<td><em>Eocene-Cretaceous.</em></td>
<td></td>
</tr>
</tbody>
</table>

*Terms Early and Late are purely arbitrary. They only point out the imprecise nature of the Quaternary time scale.*
4) PALAEOCLIMATE

"Palaeoclimatology includes data gathering and analysis as well as synthesis and interpretation. It is a cross-disciplinary endeavour that draws data from a wide array of specialized subdisciplines, whose roots rest in a number of physical and biological sciences" (Butzer, 1976: 27). In Western India, late Pleistocene climatic inferences are mainly based on aggradational and erosional phases of rivers, changes in land-and-sea relationships and related sedimentary deposits.

Perhaps the first systematic attempt to establish a correlation between artifacts and palaeoenvironment was made by Zeuner during his visit to India in 1949. His work (Zeuner, 1950, 1963) in the Sabarmati, Mahi and Narmada river valleys (Gujarat) was concentrated mainly on the study of alluvial sediments, buried soils and sand dunes. He put forward the hypothesis of increased aridity in this region during the Upper Pleistocene. Later on, attempts were also made to understand the palaeoclimate prevailing at the Mesolithic sites in Gujarat (Sankalia, 1964) and Rajasthan (Misra, 1973). On the basis of the occurrence of microliths even within the sand dunes and associated fauna they suggested that the climate was essentially dry during the mid-Holocene. Further, Sankalia (1974) equated the erosional and aggradational phases of the various plateau streams of the Deccan.
peninsula with wet and dry climatic phases during the late Pleistocene.

In recent years, the study of alluvial deposits in western Maharashtra (Rajaguru, 1970), the Upper Krishna valley (Pappu, 1974), coastal Maharashtra (Guzder, 1975) and Saurashtra (Lole et al., 1974) suggests that climatic inferences based merely on fluvial morphology are likely to be far from perfect. They further postulated that climatic changes in the present semi-arid parts of the Deccan and Saurashtra were of a degree only and not of a kind.

Recently Allchin and Goudie (1971) and Hegde (1976) have brought to light interesting geomorphological evidence in parts of Gujarat and Rajasthan. On the basis of the study of deeply weathered fossil dunes and related artifacts around Baroda in Gujarat and Jaipur in Rajasthan they inferred that during the closing phase of the Pleistocene the rainfall in parts of western India was less than about 33% of the present normals. Palynological studies (Singh, 1971) of lake sediments from Sambhar Didwana and Lunkaransar (Rajasthan) suggest that this area was affected by severe aridity prior to the beginning of the Holocene and by increasing wetter conditions from 10,250 to 3,750 years B.P.

Evidence obtained from the excavation at the Late Harappan site of Prabhas Patan throws some light on the
changing relationship between land and sea during mid-Holocene times. There is, however, no positive evidence to suggest that the climate during the mid-Holocene was drastically different from today (Dhavalikar, M.K. - p.c.).

In Saurashtra there is an excellent example which throws light on climatic conditions during early historic times. In the year 310 B.C. Chandra Gupta constructed an earthen dam in the valley of Girnar by damming the tributaries of the two rivers Palashani and Suvarna Sikta (Sonarkhi) which had their source in the mountains of Revyataka (Barda) and Urjayat (Girnar). The dam was breached for the first time on November 16th, 150 A.D. and for the second time during the regime of Skanda Gupta, in August - September 456 - 457 A.D. due to heavy rainfall. The breached portion of the dam was 45.75 m long, 31.01 m wide and 11.30 m high indicating that the intensity of the rainfall was very high. Therefore, the evidence of heavy rainfall in August, September and November indicates the unchanged monsoon pattern since about 2,200 years ago.

The reconstruction of late-Pleistocene and early-Holocene climatic conditions is possible by the study of various fluvial, coastal and aeolian formations which are fairly well preserved in the region. These formations are limited in aerial extent and are devoid of pollen and animal fossils.
Mid-Pleistocene fluvial gravel occurring at the base of Girnar hills were formed when the gradient of streams were steeper than today due to the lowering of sea level. Hence, their significance in palaeoclimatic studies have not been discussed. The late Quaternary sedimentary deposits discussed are as follows:

a) Gravels.
   b) Silts and associated calcareous nodules.
   c) Palaeosol.
   d) Sand dunes.

a) Gravels

Bouldery pebbly gravel, sandy pebbly gravel and sandy gravel have been studied at different sites (as mentioned in Chapter III and compared with modern gravels at the same sites.

It has been observed that the degree of rounding and sliding index of pebbles from the late Pleistocene gravels varies from 18.10 to 45.60 and from 41.12 to 61.20, while those from the modern gravels varies from 12.30 to 43.20 and from 34.20 to 61.20 respectively.

The morphometric analysis of Pleistocene as well as modern gravels shows that these gravels are predominantly subrounded, heterogeneous and have been transported by rolling motion. The parameters such as sliding index and
flattening index was not found useful in this particular case as the pebbles studied are either of compact basalt or dolerite which have intrinsic blocky character in the Hiran valley.

The heterogeneous texture and dominance of rolling motion during bed load movement show that the Pleistocene gravels have been moved by turbulent high intensity floods of short duration. The gravels have been laid down as braid bar or point bar deposits. As there is considerable similarity between Pleistocene and modern gravels it appears that the climate during the late Pleistocene was also essentially semi-arid monsoonic. Palaeohydrological studies based on similar parameters have been carried out in the Kom Ombo river (Egypt: Butzer, 1966).

The study of the bedding features, such as horizontal lamination and cross-bedding, assists in estimating a quasi-quantitative index of current velocity (Jopling, 1966). The most common type of sedimentary structure observed in the old sandy gravels is cross-bedding mostly of planar type; a trough type of cross-bedding is rarely seen. The dip of foresets of planar beds is generally less than 30°. The individual lamina of the cross-bedding deposits is usually more than 5 cm in thickness and often quite long (10 to 15 m). These bedding features suggest
that the stream flow must have been strong and at times torrential, as the thickness of the bed is more than 5 cm (Butzer, 1964). The cut and fill phenomenon observed in the cross-bedded sandy gravels at some places (as at Ghusia village) also indicates high velocities.

At Sangodra and near Ghusia some of the foreset cross strata show grading along the inclined laminae with the poorly sorted sediments in the lower portion of the bed. These characters possibly indicate deposition by a braided stream (Fairbridge, 1968). The structural features of modern and ancient channel bars and point bars are similar in the Hiran valley. It, therefore, appears that floods in the Hiran valley during the late Pleistocene were torrential.

b) Silt and associated calcareous nodules

The mechanical analysis of the silt samples from the Hiran valley indicate that they are mostly flood loams. These silts are in general devoid of distinct lamination. The absence of lamination is more likely to be due to the absence of changes in sediment characteristics (such as, alternations between sand and clay or silt) and also due to post-depositional diagenetic changes.

Size distribution characteristics of sediments are given in Table 11. From the coefficient of sorting it
can be inferred that the silts are moderately well sorted and the same is the case with the modern silts deposited by floods. The associated sandy and gravelly lenses throughout the depth of the silty deposits, indicate changes of channel position. The coefficient of Geometrical Quartile Skewness is not of much help from the point of view of finding out the depositional environment of sediments.

It is observed from the results of chemical analysis (Table: 16) that the silica content in these deposits varies from 37.82 to 49.30 percent and most of the silica is in combined form mainly with alumina. The content of aluminium oxide is significantly higher than the oxide of iron and varies from 8.50 to 20.15 percent. All the samples are relatively low in iron oxides. Calcium is present as oxide and carbonate and occurs in a fairly high proportion. The presence of calcium oxide is indicated by a high ignition loss. The magnesium oxide content is comparatively high and may either be in the form of silicate (biotite) or chloride. The alkali contents are low for all the samples. The molecular ratio of SiO₂/Al₂O₃ for all the deposits is very high. These characteristics indicate that the samples are mainly composed of montmorillonitic minerals. Further, it is observed that the deposits have not been subjected to intense leaching action probably on account of moderate rainfall and hot climatic conditions prevailing over the area of these deposits.
As explained earlier in chapter III, the mineralogical characteristics of these deposits have been confirmed by DTA (Fig. 42, 43). It is observed from these figures that all the samples showed a dominant peak at about 160° - 170° C, on account of the loss of absorbed water which is relatively high in montmorillonitic minerals. The silts from the river Hiran shows a small endothermic peak at about 265° C which indicates the presence of a small quantity of lepidocrocite (Kulp, 1951 and Takeuchi, 1955) a mineral of the iron oxide group. All the samples showed a predominant endothermic reaction with a peak ranging between 565° - 590° C indicating the dominance of montmorillonite minerals (Grim, 1955). The endothermic reaction with a peak at about 880° - 950° C is due to the presence of a large percentage of calcium carbonate (Gruver, 1950, Rowland, 1951 and Kerr, 1948). The variations in the temperature of the peak may be attributed to variations in the composition, quantities and crystallinity of the minerals (Spell, 1945 and Bayliss, 1964). The DTA curve of the silt + clay fraction obtained after the removal of calcium carbonate by acid treatment and washing with water, indicate a small endothermic peak at about 820° C. This may be due to the presence of a small quantity of pyrophyllite mineral, while the exothermic peak at about 870° C in the case of the sample from Sasan is due to illite (Grim, 1940). All these curves indicate that the deposits studied are dominantly montmorillonitic in their mineralogical composition.
The chemical and mineralogical composition of silts also throws light on the depositional environment and indirectly on the climate of the past. The dominance of montmorillonite in most of the samples analysed clearly indicates less intense leaching conditions. According to Sherman (1952), montmorillonite develops at its best in basaltic terrain e.g. tropical Hawaii, in the rainfall range of 0 to 1650 mm per annum, the most favourable range being 0 to 760 mm per annum. The Late Quaternary silts and soils from the Hiran Valley are also rich in montmorillonite. The present annual average rainfall in the Hiran Valley is about 850 mm. This suggests that during the late Quaternary the rainfall in the Hiran Valley was not significantly different from the present.

Calcereous concretions are commonly found in older silts. They have been attributed to continued lowering of the water table with a balance between precipitation and evaporation and evaporation tending to reduce downward percolation of dissolved salts. The presence of calcareous concretions (kankar) is usually a sign of age and an indication that the silt in which they occur, belongs to the older alluvium rather than the younger (Pascoe, 1963). Flint (1963) considered these secondary carbonates indicative of a relatively dry climate and they seem to form best under rainfall conditions of about
460 mm per annum. Manson and others (1959) have, however, questioned such conclusions drawn from calcretes (kankar). Possible variations in a number of factors do limit the usefulness of calcareous bands as indicative of palaeoenvironment. Calcareous nodules are relatively abundant in the present day semi-arid tract of the Hiran valley. These formations have been found to be negligible in the heavy rainfall zone and are common in the rainfall zone of 635 mm to 1525 mm per annum in Western India. Calcretes occur in the older silts, almost throughout the Hiran valley; it can be suggested that rainfall there never exceeded the limit of 1525 mm per annum during the Late Quaternary. Kankar formations, therefore, indicate that during the Late Quaternary period the climate was typically monsoonic (i.e. an annual wet spell of short duration followed by a long dry season).

c) Palaeosol

The black buried soil, 1.5 m thick, showing typical crumb structures, observed on the left bank of the river Shingoda about 0.5 km downstream of Kodinar, 8 m AMSL and 1.5 km in lateral extent. The buried soil rests on the yellowish brown (10 YR 5/3), laminated sandy silt, overlain by reddish brown (5 YR 5/4) less kankary silty sand, which is capped by the surface soil. There is a slight development of nodular carbonate at the base of the profile.
The yellowish brown sandy silt is of post-Middle Palaeolithic age and the reddish brown silty sand was formed before the subrecent alluvium. Therefore, the palaeosol could be of Early Holocene age.

Montmorillonite is the most dominant clay mineral present. The high silica sesquioxide ratio indicates a minimum leaching soil environment. Pedologically this soil can be classed as "vertisol" and indicates a semi-arid environment characterised by short wet and long dry periods.

The detailed study of the black soil from Maharashtra (Nujumdar, 1968 and Kajale et al., 1976) the Pre-Chalcolithic and Neolithic periods in has shown that the rainfall was slightly higher (by 20 - 25%) during the early Holocene. The present day exposed black soil is degraded and is in the process of adjusting itself to the changed conditions. It is quite possible that more or less similar climatic conditions might have existed in Saurashtra during the early Holocene.

d) Sand dunes

The aeolianites of the area near Somnath, Veraval, Una and Kodinar have been distinguished on the basis of their occurrence as obstruction dunes, coastal dune ridges etc. The geomorphological and archaeological studies of the dunes showed that they can be placed in the
late Pleistocene period. Mathus and Verma (1976) have also placed these in the late Pleistocene to Early Holocene period.

Cross-bedding, characteristic, the intense tendenancy of preferred orientation of the long inclined laminae, the small scatter of dips and wedge-planar cross stratification of the dunes have been taken to be suggestive of their aeolian origin. The textural parameters (moment statistics) of the carbonate beach and dune sands have also been carried out to compare the carbonate sands and the quartzose sands from beach to dune environments. It was found that the mineralogy of the sand has not affected the tendency of the dune sand to be positively skewed or the beach sand to be negatively skewed.

The mean vector of the palaeowind, around Porbandar, based on the cross-stratification azimuthal data was determined (Mathur and Verma, 1976) which showed that the wind regime had changed from a predominantly northwesterly to southwesterly direction, since the mid-Pleistocene.

The aeolianites seem to have developed at a time when the sea level was low and a large part of the continental shelf was exposed to strong wind action. It is difficult to assess the role of climate in the formation of aeolianites have observed upto 100 km inland from the
coast in the parts of southern and southeast Australia, the areas which are not tectonically disturbed and much further in areas which are (Twidale, 1976). Therefore, the origin of aeolianites in the Hiran valley has been ascribed to the period of low sea level during the last glacial phase and no inferences regarding the palaeoclimate have been drawn. The late Pleistocene formations and their probable climatic inferences are given in the following table : 22.

TABLE : 22

<table>
<thead>
<tr>
<th>Formation</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aeolianite.</td>
<td>lowering of sea level strong wind activity.</td>
</tr>
<tr>
<td>2. Palaeosol.</td>
<td>climate more or less like that of today.</td>
</tr>
<tr>
<td>3. Kankar and montmorillonite rich brownish silts.</td>
<td>semiarid, monsoonic, more or less similar to that of today.</td>
</tr>
<tr>
<td>4. Rolled, coarser gravels.</td>
<td>climate slightly wetter (?) than today.</td>
</tr>
</tbody>
</table>

Thus, these studies show that the climate was probably slightly wetter during the early part of the late Pleistocene when Middle Palaeolithic man lived in the
area. It became drier during the closing phase of the Pleistocene. On the whole the climate was semi-arid monsoonic throughout the late Quaternary and was not very different from the modern climate. The sedimentary characters of various formations certainly set limits on palaeoclimatic inferences since similar features are likely to have formed in different conditions. The palaeoclimatic model suggested here, is therefore, highly subjective and requires to be tested. However, it is certain that Early Man continued to occupy the Hiran valley from the mid-Pleistocene inspite of moderate changes in climate and sea level.
5) MAN-LAND RELATIONSHIP

The study of geomorphology and eustasy in the context of archaeology is a relatively recent development in India. Although, the data are meagre, it was felt that correlation of geographically contiguous area studied thus far (Saurashtra, Maharashtra, Karnataka and Kerala) would enhance the value of present study. The central theme of this investigation is Early Man and his ecology. Therefore, an attempt has been made to investigate the archaeological, geological and geomorphological findings in the Hiran valley and project them against the recent observations made in coastal parts of Western India.

Hiran valley

The mid-Pleistocene Palaeolithic habitations are observed to have been confined to the foothills of the Girnar. Availability of raw material (compact basalt, acidic Deccan Trap), assured rainfall even in the lean years, dense forest cover and abundant game were the main environmental factors responsible for habitation in and around the Girnar area.

The late Pleistocene Middle Palaeolithic sites are not only confined to the foothill regions but also found on the gently sloping valley pediments and stream channels. Availability of silicious rocks for making tools
and congenial semi-arid climate might have supported human occupation during the late Pleistocene.

Though the transgressive phases of the Pleistocene have been established, in the Hiran valley, their effect on human settlements are not yet well understood. But it is clear that the Palaeolithic habitations were restricted to the inland areas (at least 25 km from the coast) while the Mesolithic and Chalcolithic habitations are found almost on the coast, probably because the weaker transgressive phases of the sea during the Holocene were less inhospitable.

Saurashtra

A more or less similar pattern of man-land relationships is observed in other parts of Saurashtra. Most of the Palaeolithic sites have been located on the inland plateaus and near the source of raw material like dolerite, acid Trap, chalcedony and chert. A middle Palaeolithic site at Dhrangadhra has been found near an outcrop of Wadhvan sandstone which is about 13 m AMSL and 9 km south of little Rann. As in the Hiran valley, Holocene cultural sites are found quite close to the coast.
South Gujarat

Lower and Middle Palaeolithic sites have been discovered in the piedmont zone of the Western ghats and on the banks of the Ambika and Surya rivers, in the Dangs district (I.A.R. 1965-66). In this area there is a dry deciduous forest cover, fairly high rain fall (more than 1000 mm) and availability of raw material such as acid Trap, dolerite, basalt, chert and chalcedony. Interesting work-shop sites of the Middle Palaeolithic period occur near Waghai and Ahwa. These sites are near a source of chert and well away from the major streams.

There is as yet no correlation between the cut-and-fill fluvial terraces in the Dangs and the coastal littoral deposits further west. Therefore, dating of the Palaeolithic industry in this region is not possible.

Maharashtra

Bombay: There is no indisputable evidence of Lower Palaeolithic sites, although Palaeolithic artifacts have been found at Kandivli, Borivli and Dahisar. These sites are confined to the alluvial fans, developed at the foot of the Padan hills, 3.5 km inland from the coast. No correlation is possible between the late Plaistocene alluvial terraces and the mid-Holocene cemented littoral formations around Bombay. The Mesolithic sites are situated
on the coastal promontories. Interestingly, the raw material used for making tools was chalcedony which is apparently not found in the vicinity.

Further south between Bombay and Malvan a few Palaeolithic sites have been discovered as surface finds. A few Lower Palaeolithic sites have been discovered near the source of quartzite at Malvan. These sites are located on the early Pleistocene lateritic plateau (50 - 259 m AMSL) and 15 km away from the coast. An interesting Lower Palaeolithic site is located at the mouth of the Haddi creek near Malvan. On the basis of the available archaeological evidence, the Konkan does appear to be an "area of relative isolation" (Guzder, 1975).

Inspite of the presence of lateritic plateaus, fluvial terraces of Quaternary age and beach rock of mid-Holocene age, the Palaeolithic industry could not be dated due to the lack of proper geomorphic and statigraphic data.

Primary Mesolithic sites in the rockshelters at Hathkamba and Pachad are found not to be important from the point of dating the industry.

Kerala

The discoveries made in north Kerala (Rajendran, 1977) have established the presence of Palaeolithic sites
in this region. Typologically early cultures belong to the late Acheulian and early Middle Palaeolithic industry. They are yet to be established stratigraphically as the tools have only been generally found on the surfaces. These artifacts occur about 80 km inland plateaus at altitudes more than 33 m AMSL. In Kerala, Mesolithic sites occur on the lateritic surfaces, higher than 65 m AMSL. Typologically the Mesolithic industries of Kerala are comparable to the Teri industry of the Tinnevalley district of Tamilnadu (Zeuner and Allchin, 1956). The stratified microliths discovered in the Teri dunes were dated to c. 4000 B.C. by the excavators and assigned to the late Atlantic phase of the post glacial transgression which lent support to the theory of slight transgression, during the mid Holocene.

During early prehistoric times habitations were concentrated along streams. The sea transgression only caused an upstream shift. Economically this geomorphic phase could have been useful as the source of food came more closer to the settlements. During the Mesolithic times the spread of these sites close to the coast perhaps indicates far larger dependence on the fish and molluscan food as is commonly noticed in the Mesolithic sites in Europe. During the later periods, particularly with the spread of Harappan culture, the importance of the sea
enhanced it provided easy transport facilities connecting the inland areas to the coastal ones through the navigable rivers. Thus, we get the sites of these cultures both along the coast as well as in inland areas.

A brief mention may be made of protohistoric and historic sites which are related to the sea level changes. The decline of the Harappan culture continues to be a vexed problem. A number of Harappan sites in Saurashtra are located in the coastal region. The early historic sites affected by sea level changes have been studied, on the coast of Saurashtra and Maharashtra. Changes in the sea level affected the fortunes of once flourishing ports, lothal (Rao, 1973), Dwarka (Ansari and Mate, 1966), Nala Sopara and Chaul (Gusder, 1975) are among the better known sites.

It is apparent from the above discussion that the Palaeolithic man preferred the semi-arid, sparsely forested plateaus of Saurashtra to the humid, hilly, dissected and densely forested parts of Western India. On the contrary Mesolithic man during the Holocene occupied the coastal region of Western India inspite of environmental adversity.

Thus, the stratified Palaeolithic sites discovered in the context of littoral formations are extremely
important in deducing the chronology of Early man, related sea level changes and environmental changes in Saurashtra in particular and Western India in general.