

Chapter 3

PREVIOUS WORK

3. PREVIOUS WORK

Before embarking on sedimentological studies on the Quaternary calcrete-bearing sediments of Mainland Gujarat an effort was made to evaluate the nature and extent of research carried out by scientists (both archaeologists as well as geologists) in the past. The available literature is synthesised in this chapter.

The first documentation's on the geology of any area usually achieve considerable importance. This applies equally well to the work of Robert Bruce Foote (1898) who provided initial inputs on an area that had remained uninvestigated. He worked on areas along the banks of the river Sabarmati. The ubiquity of various stratal horizons did not escape his attention. He also recorded the first prehistoric-finds at Sadolia and Pedhmali (for locations of sites mentioned in this chapter and subsequent ones please refer figures 2.1, 2.2, and 2.3). The tools were usually found in basal gravels.

Considering the Madhaoghat section, Foote (1898) constructed his first order of superposition of the various lithofacies. He made a broad reference to the depositional processes responsible for the formation of the sediments:

'As will be seen in the section the bedding on these several formations is very irregular and shows that they were deposited by a river with a strong and variable current.'

Moreover one of the most surprising observations was the recognition of rhizoliths and nodular calcrete from the capping 'loessic' deposits. He noted the distribution of loessic deposits in clusters located around Sidhpur, south-west of Mehsana, Kadi, Vijapur, east of the river Watrak, between rivers Meswa and Khari, along the Orsang river near Bodeli station and finally near the bridge on the Mahi river. It is obvious that this facies is truly ubiquitous. Foote (1898) also pointed out the

disappointingly unfossiliferous nature of these sediments. Neolithic remains found by him, associated with such loessic deposits were always on the surface.

Almost half a century later Sankalia (1946) initiated an archaeological survey of the Sabarmati river valley. Through this work Sankalia practically left 'no stone unturned,' a fact that strikes one while reading descriptions on the meticulously catalogued prehistoric discoveries. At Sadolia he documented a different stratigraphic succession that began with a bluish clay missed by Foote (1898). The most interesting part of the memoir, are the elaborate sections drawn at Sadolia-Kot, Hirpura and Pedhmali that bring out the spatial extent of certain horizons viz. the red soil and the loessic strata.

Within basal lateritic conglomerates Sankalia (1946) recorded flakes and a 'Madras type' axe (cleaver). At the same stratigraphic level more elements were retrieved at Hirpura. The richest archaeological site for Sankalia is the Pedhmali section from where Foote (1898), had already found an oval hand axe.

Sankalia divided the tools from a laterite-overlying conglomerate into three classes:

CLASS 1	finds from the conglomerate
CLASS 2	finds at the junction of the conglomerate and overlying alluvium (reddish silt)
CLASS 3	finds collected from alluvium (reddish silt)

Class 1 included oval hand axes, cleavers, choppers, flakes and scrapers. In spite of the known stratigraphic occurrence of each tool he reported no apparent typological evolution. Class 2 differed from the previous class in the absence of oval hand axes. Class 3 implements from the red soil horizon comprised hand axes (ovate), cleavers, scrapers, pebble tools and flakes. Again an analysis on evolutionary trends in the Pedhmali Palaeolithic Industry by him yielded negative results. Sankalia (1946), commented that

the only change observed was a slight improvisation in the flaking technique as seen in the almond and pear shaped hand axes from the topmost stratum. He opined that the tools contained features of the European Acheulian Industry. The inferior variety represented typologically, the lower Acheulian while the superior one was similar to the Middle and the Upper Acheulian, dating to the Middle Pleistocene.

With regard to the Microlithic Industry, archaeologists were faced with several fundamental questions. Of principal concern was deciding the affinity of the Microlithic Industry either to a Mesolithic Industry or a Neolithic culture. Sankalia (1946) refrained from calling it a Mesolithic culture owing to an absence on any connection with the underlying (older) Palaeolithic Industry. An important archaeological lacuna, he pointed out was the absent (or undiscovered) Upper Palaeolithic culture. Similar arguments were furnished for not referring it to a Neolithic culture.

Zeuner (1950) following up on the foundation stone laid by Foote (1898) and Sankalia (1946) provided more details on the palaeoclimatic successions in the Sabarmati, Mahi and Narmada river areas. Here, work pertaining to Mahi and Sabarmati is reviewed.

Discussing the excavations on Langhnaj, he made an interesting observation on the youngest dunal aggradation event. Based on the presence of an aeolian horizon sandwiched between a buried and the modern soil he commented:

“From this it must be inferred that the sand between the buried soil and the modern soil indicates merely a revival of wind activity in Neolithic to Iron Age times...”

“Since we know from archaeological evidence that at that time an agricultural population was present in that area, it is conceivable that the increase of wind activity was due to their appearance on the spot.”

At the Hirpura section he noted that the red soil which underlay aeolian deposits contained non-corroded feldspar grains which he interpreted as evidence for the recycling of red soil matter. The red soil according to him formed in a rainfall regime of 20-40 inches in a climate with a prolonged dry season under the influence of a wooded vegetation cover. This red soil developed on fluvial sands and silts.

Zeuner (1950) interpreted coarser deposits as indicative of seasonally dry climates with occasional heavy floods, whereas fluvial silts represented a drying up phase succeeded by damper conditions manifested as the red soil.

The reduction in the amount of cleaver noted by Sankalia (1946) was interpreted by Zeuner (1950) rather ingeniously. Cleavers are functionally speaking wood choppers. He opined that their scarcity may probably be a response to the reducing wood cover synchronous with increasing aridity. The mottled clay facies in his opinion formed through intense weathering in a warm humid climate.

Subbarao (1952) investigated Palaeolithic and Microlithic tools in the Mahi region between Vasad and Sevalia. The Palaeolithic artifacts included hand axes and choppers. Similarities between the Palaeolithic Industry and Microlithic culture in the Mahi valley and the Sabarmati valley were also noted.

Allchin & Goudie (1971) studied the topmost aeolian deposits in Gujarat and the associated Mesolithic culture. Their results suggested that before the advent of Microlithic man in Gujarat rainfalls were less than 250 mm. Subsequently large magnitude climate changes effected human occupation in the area. They also pointed out that since most sites were found on the top of dunes, the Mesolithic industry in Gujarat fell within the time bracket of 9 ka BP to 3 ka BP. Their study of the Visadi dune east of Baroda revealed the presence of an Upper Palaeolithic Industry implying that dune building spanned a period between 40 ka BP and 12 ka BP.

Allchin et al., (1978) summarised their results spanning six field seasons between 1969 and 1976. Although the book deals with Gujarat and Rajasthan in entirety portions specifically dealing with the Gujarat Alluvial Plains are reviewed here.

Phase	Date	Evidence
Moister phase	10,000-9500 BP	Pollen rich lake sediments without aeolian component overlying dunes. Freshwater gastropods around lake basins. Extensive microlithic settlement.
Major dry phase	pre 10,000 BP, Later Upper Palaeolithic	Dunes extend over lake basins (like Sambhar) and Middle Stone Age soils. Miliolite deposited in Kutch and Kathiawar. Aggradation of rivers of the plain of Gujarat with some interruptions for fossil soil development. Little substantial evidence of human activity over wide areas.
Major wet phase	Middle Stone Age (? Younger than 40,000 BP)	Major sheets of aeolian sand with some slope-wash material containing kankar and rolled Lower-Palaeolithic artifacts.

Table 3.1: Climatic phases and their chronology through the Late Quaternary in Gujarat and Rajasthan, (Allchin et al., 1978)

Northeast of Baroda, a massive windward obstacle dune at Pavagarh was scrutinised wherein they reported the presence of a red sand inferred to be a buried soil. Their studies in the Mahi and Sabarmati valley regions largely corroborated the earlier work by Sankalia (1946), Zeuner, (1950) and Subbarao (1952) in the geomorphological and sedimentological context, whereas a plethora of archaeological data added upon the earlier works. Based on their combined archaeological and geomorphological approach they constructed four climatic phases in western India (Table 3.1), from the Lower Palaeolithic to the present.

After almost a decade of quiescence, Pant & Chamyal (1990) investigated the Quaternary sediments in the Mahi region. They identified three depositional environments including marine, fluvial and aeolian with associated intercalated soils of

various types. Based on the typological similarity of Lower Palaeolithic tools found by Subbarao (1952) to those in the Hiran valley in Saurashtra they surmised that the basal sediments dated back to Middle Pleistocene (~350 ka BP).

Subsequently Chamyal & Merh (1992), Merh & Chamyal (1993), Sridhar et al., (1994) contributed towards providing a regional stratigraphic and sedimentological framework of the region. Chamyal & Merh (1992) proposed a trinomial stratigraphic classification (Table 2.2).

MAHI RIVER BASIN		SABARMATI RIVER BASIN	
Formation	Lithology	Formation	Lithology
Timba	Dunal sands, aridisol, aeolian silt, brown soil, coarse sand and gravel-III.	Valasna	Aridisol, dunal sands, aeolian silt, yellowish sand.
Shihora	Aeolian silt, red (rubified) soil, highly fractured and pedogenic mud, finely laminated mud with marly bands.	Vijapur	Pedogenised laminated mud, thick red (rubified) soil developed over silty sands.
Raika	Cross bedded gravel-II, carbonate rich and pedogenically altered fractured mud gravel-I, clay laminations alternating with marly bands, mottled at places.	Hirpura	Cross-stratified gravel-II, pedogenised fractured mud, consolidated gravel-I, greyish, bluish, greenish basal clay, mottled at places.

Table 3.2: Lithostratigraphic classification of the Mahi and Sabarmati river valley successions, after (Chamyal & Merh, 1992).

The criteria chosen for defining the boundaries of the basal formation (Raika Formation and Hirpura Formation) was the top of the conglomerate bed number 2. This may not be altogether valid considering the discontinuous nature of such coarse-grained units and lateral facies variations so common in river deposits. The overlying Shihora Formation (Mahi valley) and equivalent Vijapur Formation (Sabarmati valley) was

defined using the upper surface of the buried red-soil and the remaining overlying deposits categorised as the Timba Formation (Mahi valley) and equivalent Valasna Formation (Sabarmati valley).

Sridhar et al., (1994) stated that presently the rivers of north Gujarat were degradational or erosional. The stratigraphic successions seen along the reaches of Sabarmati were deposited by an earlier more powerful 'super-fluvial' system. This river system, they speculate could have been disrupted on account of a combination of neotectonism and climate change. The older rivers according to them drained westward into the Little Rann of Kachchh. Rachna & Chamyal (1997) supported the initial contention of Merh (1992) that the basal clays seen at most localities were marine/fluvio-marine using microfossil evidence. Based on the presence of foraminifera genera *Pararotalia*, *Brizalina*, *Nonion*, *Turborotalia*, *Florilus*, *Globogerina* and *Globogerinoides* they concluded a low-salinity estuarine environment of deposition. A recent compilation of existing data by Merh & Chamyal (1997) on the Gujarat Alluvial Plains provides a bird's eye view of the nature of the stratigraphic record

Contemporaneous work by Sareen et al., (1993), Sareen & Tandon (1995) and Tandon et al., (1997) highlighted certain significant points regarding the nature of the present day Sabarmati river and the ancient record. They suggested that the Sabarmati succession represented deposits of a semi-arid alluvial fan/fluvial depositional system (Tandon et al., 1997, Sareen & Tandon, 1995). They highlighted the incompleteness of the stratigraphic record using luminescence based chronological techniques and identified three aggradational phases, the final one being a combination of both aeolian as well as alluvial agencies. Using lineament and slope analysis Sareen et al., (1993) demonstrated that the river Sabarmati follows a 'slope-deviatory' trend implying a structural role in controlling the path of the Sabarmati river.

Recently Agrawal et al., (1996) interpreted the existence of huge palaeo-deltas using remotely sensed data. However the absence of ground truth checks sheds some doubt on such interpretations.

Thus it is apparent that a great deal of work has been carried out already in this area. Though at first initiated by archaeologists, the area has been found to be a vast repository of sedimentological and palaeoclimatic information. The thesis addresses the nature of these characters in further detail.

References

- Agrawal, R.P., Dotiwala, S., Mitra, D.S. & Bhoj, R. (1996). The palaeodelta of the "Proto" Vatrak and "Proto" Mahi rivers of northeastern Gujarat, India: A remote sensing interpretation. *Geomorphology*, 15, 67-78.
- Allchin, B. & Goudie, A. (1971). Dunes, aridity and early man in Gujarat, western India. *Man*, 6, 248-265.
- Allchin, B., Goudie, A. and Hegde, K.T.M. (1978). The Prehistory and Palaeogeography of the Great Indian Desert. *Academic Press, London*, 370 p.
- Chamyal, L.S. and Merh, S.S. (1992). Sequence stratigraphy of the surface Quaternary deposits in the semi-arid basins of Gujarat. *Man and Environment*, 17, 33-40.
- Foote, B.R. (1898). Geology of Baroda state. *Government Press, Baroda State*, 194 p.
- Merh, S.S. (1992). Quaternary sea level changes along Indian coast. *Proceedings of the Indian National Science Academy*, 58A, 461-472.
- Merh, S.S. & Chamyal, L.S. (1993). The Quaternary sediments in Gujarat. *Current Science*, 64, 823-827.
- Merh, S.S. & Chamyal, L.S. (1997). The Quaternary geology of the Gujarat alluvial plains. *Proceedings of the Indian National Science Academy*, 63A, 1-98.

- Pant, R.K. & Chamyal, L.S. (1990). Quaternary sedimentation pattern and terrain evolution in the Mahi river basin, Gujarat, India. *Proceedings of the Indian National Science Academy*, 56A, 501-511.
- Rachna, R. & Chamyal, L.S. (1997). A note on foraminiferids from a new Mahi Formation, Rayka, mainland Gujarat. *Geoscience Journal*, 18, 123-129.
- Sankalia, H.D. (1946). Investigations into the prehistoric Archaeology of Baroda, Gujarat. *Baroda State Press*.
- Sareen, B.K. & Tandon, S.K. (1995). Petrology, micromorphology and granulometry of mid to late Quaternary continental deposits of the semi-arid Sabarmati Basin, Western India. In Quaternary Environments and Geoarchaeology of India (Eds., S. Wadia, R. Korisettar & V.S. Kale). *Memoir, Geological Society of India*, 32, 258-276.
- Sareen, B.K., Tandon, S.K. and Bhola, A.M. (1993). Slope deviatoric alignment, stream network and lineament orientation of the Sabarmati river system-neotectonic activity in the mid to late Quaternary. *Current Science*, 64, 827-836.
- Sridhar, V., Chamyal, L.S. and Merh, S.S. (1994). North Gujarat rivers: Remnants of a super fluvial system. *Journal of the Geological Society of India*, 44, 427-434.
- Subbarao, B. (1952). Archaeological explorations in the Mahi valley. *Journal of the M S University of Baroda*, 1, 33-72.
- Tandon, S.K., Sareen, B.K., Someshwar Rao, M. & Singhvi, A.K. (1997). Aggradation history and luminescence chronology of Late Quaternary semi-arid sequences of the Sabarmati basin, Gujarat, Western India. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 128, 339-357.
- Zeuner, F.E. (1950). Stone age and Pleistocene chronology in Gujarat. *Deccan College, Poona*, 46 p.