CHAPTER II

PREVIOUS WORK

QUATERNARY OF SAURASHTRA IN GENERAL

Although Carter (1849) was the first worker to describe the composition and the fossils of the problematic Quaternary carbonate rocks - the miliolite, the first detailed account of the distribution, mode of occurrence, origin etc. of the same was given by Fedden (1884) in his monograph on the geology of Saurashtra. Chapman (1900) and Evans (1900), not only described the Quaternary limestone deposits of Saurashtra with special reference to their mode of origin, but also compared
them with identical rocks of tropical and sub-tropical regions like Kutch, Arabian coasts, islands of Persian Gulf, Bermuda, Bahama, Canary Island and with that of colder region like Dog's Bay (Galway). After a gap of about seven decades there appeared papers by Shrivastava (1968a, b) and by Hardas & Merh (1968) which were followed by a steady stream of contributions to our knowledge of Quaternary carbonate deposits of Saurashtra. Some of notable works have been put forth by Biswas (1971), Gupta (1972, 1977), Verma & Mathur (1973, 1976, 1977a, b, 1978), Verma, Mathur & Misra (1973, 1975, 1976), Lele (1973, 1975), Goudie et al. (1973), Goudie & Sperling (1977), Govindan et al. (1975), Sperling & Goudie (1975), Mathur (1977), Mathur & Mehra (1975), Mathur & Verma (1976), Mathur et al. (1975, 1976), Rajaguru & Marathe (1977), Marathe, Rajaguru & Lele (1977), Agrawal & Roy (1977), and Bhatt & Patel (1977). Many excellent contributions on Quaternary presented at the National Seminar on Quaternary environments with special reference to western India, organised by M.S. University of Baroda are in press.
EARLY STUDIES

Carter (1849) proposed the name 'miliolite' for a group of granular calcareous deposits composed of oolitic particles of calcareous sand and united together into a firm compact rock on the Arabian Sea coast having predominance of the form belonging to the genus *Miliolina*.

In his memoir on Saurashtra, Fedden (1884) described the miliolite limestone and four other biogenically rich Quaternary rocks. He defined miliolite as a finely oolitic freestone, almost free from sand and other particles, the nuclei of the oolitic grains being mostly organic. The field characters of Porbandar, Veraval, Jafarabad, and Gopnath-Point deposits of coastal Saurashtra were discussed. Amongst the miliolite deposits of interior Saurashtra he made a special mention of Chotila hill near Rajkot where according to him, miliolite formed "a fringe around the truncated top, at a height of 1173 ft above sea level". He further suggested that this limestone is the product of littoral marine accumulation. In his geological map of Saurashtra the miliolite limestones were shown to overlap the older volcanics and sedimentaries. Stratigraphically younger rocks were designated by him as
'Littoral concrete', 'Dead coral reefs' and 'Oyster beds'.
Littoral concrete was described as an earthy calcareous
grit containing marine shells and corals that rest upon
the denuded surface of the miliolite. The dead coral
reefs and oyster beds are the accumulation of coral masses
and oysters respectively, which have the same stratigraphical
position as Littoral concrete in relation to miliolite.

Foote (1898) reported the rocks from Kodinar area
as 'Miliolite' - a fine oolitic freestone composed of
greater part of foraminifera whose tests form the nuclei
of the oolitic grains of which the limestone is composed.

Evans (1900) gave detailed account of the thick
deposit of Quaternary limestone of Junagarh (his "Junagarh
limestone") which were identical with the miliolite lime-
stone of Fedden (1884). He gave an account of its
structure, faunal and mineralogical contents and discussed
its mode of origin. He opined that although "there seems
be to every reason to believe that Junagarh Limestone was
formed by aeolian action'.......'but it is impossible
to believe that this calcareous material could have been
blown 30 miles over barren plains.......'. '.......we
must assume that city of Junagarh was close to the margin
of the Sea". Evans also compared Junagarh Limestone with similar rocks found at other localities in Saurashtra, Kutch, south-eastern coast of Arabia, the islands of Persian Gulf and other tropical and sub-tropical coasts of the world.

Chapman (1900) examined various specimens of foraminifera from miliolite rocks of Junagarh and Porbandar areas. He found that the worn and polished nature of the foraminifera (which originally inhabited moderately shallow to littoral marine seas) contained in the miliolite limestone was suggestive of their rolling by the transporting action of wind. The miliolite rocks, therefore, represented an accumulation of material derived by wind transportation from littoral calcareous mud. He, however, suggested that it was quite likely that some of Saurashtra calcareous rocks were deposited in the shallow marine waters.

RECENT STUDIES
Sastri & Pant (1959) studied raised beaches, miliolite limestones and other calcareous Quaternary deposits giving special emphasis on their bearing on
the eustatic changes in the sea levels during Quaternary period. They mapped Quaternary carbonates of Mangrol-Sil area and arrived at an important conclusion that the presence of raised beaches on Saurashtra coast at heights upto 4.5 m above mean sea level indicated an eustatic rise of the sea level during Sub-Recent times.

Shrivastava (1968a, b) made a detailed petrographic study of miliolite rocks of Porbandar-Veraval area and suggested that these rocks were deposited in shallow, warm, agitated waters of the tropical sea. Discussing the Quaternary tectonics of Saurashtra he suggested that the entire Saurashtra was down-faulted in Pleistocene causing widespread marine transgression during which the formation of miliolite rocks took place. Following this, the process of uplifting commenced during Sub-Recent, which is still continuing.

Hardas & Merh (1968) studied "miliolite - like arenaceous limestone" of Kutch. This paper forms the first contribution to Quaternary carbonates of Kutch. They concluded that Kutch "sandy fossiliferous comicrites" were the product of shallow marine conditions of deposition resulting from encroachment of the sea. According to them this transgression was either "due to rise in sea-level
during the post-glacial period or due to subsidence of the Kutch region. Both these possibilities are very much likely in an area like Kutch).

Glennie (1970) believed that miliolite limestone is aeolian in origin. He visualised that due to slight lowering of the sea-level during Quaternary polar glaciation, broad areas of present continental shelf of Saurashtra were exposed, resulting in the wind transportation of calcareous material to the interior parts.

Biswas (1971) discussed the mode of occurrence and origin of miliolite rocks of Kutch and Saurashtra. He concurred with Glennie and suggested that miliolite rocks were first deposited under marine conditions in the coastal areas of Saurashtra and later on transported by the action of wind and redeposited in the interior parts of Saurashtra and Kutch. He assigned Pliocene-Pleistocene age to the coastal Saurashtra rocks and late Pleistocene age to the inland miliolites.

Gupta (1972 1977), and Gupta & Amin (1974) dated corals from Dead coral reefs and shells from raised
beaches and suggested that their measured radiometric dates fall in three well defined groups: (i) between 4,500 yrs B.P. to 35,000 yrs B.P., (ii) between 23,000 yrs B.P. to 35,000 yrs B.P., (iii) between 105,000 yrs B.P. to 125,000 yrs B.P. They postulated that the sea level during 6,000, 30,000 and 120,000 years B.P. was 2 to 6 metres higher than the present sea level.

Lele (1973, 1975) strongly advocated a marine origin theory of miliolite limestone on the basis of the field studies and sedimentological data.

A systematic and comprehensive investigation of the carbonate rocks of Saurashtra has been taken up by the present author in collaboration with Verma and a number of papers have been contributed by them (Mathur, 1977; Mathur & Mehra, 1975; Mathur & Verma, 1976; Mathur, Verma & Mehra, 1975, 1976; Verma & Mathur, 1973, 1976, 1977a,b, 1978; Verma, Mathur & Misra, 1973, 1975; Verma, Mathur & Barman, 1978), their work comprising the first substantial contribution to the studies of these Quaternary sediments. Some of the notable conclusions include (i) a revised classification of Quaternary carbonates of Saurashtra, (ii) establishments of field criteria for
distinguishing the marine and aeolian deposits of miliolite rocks, (iii) evidences in favour of stability of Saurashtra during Quaternary, (iv) establishment of sea-levels comparable with the positions of higher sea-levels during Quaternary in other stable coasts of the world, (v) studies on the cross bedding in miliolite rocks for establishing the palaeowind direction, (vi) studies on the textural characteristics of the carbonate beach and dune sands to establish the criteria for separating the above two environments etc.

The observations by Sperling & Goudie (1975) are on the origin and age of miliolite rocks. They strongly believed in an aeolian origin of miliolite limestone for which a number of arguments were put forward. They have criticized the evidences of marine origin of miliolite put forward by Lele (1973). Earlier, Goudie et al. (1973) had described an interesting fossil dune morphology of miliolite deposits in Una-Veraval area.

Rajaguru and his co-workers (Rajaguru & Marathe, 1977; Marathe, Rajaguru & Lele, 1977) carried out their studies in Hiran Valley of southern Saurashtra. Their field and laboratory (geomorphological, petrological and archaeological)
evidences are in favour of fluvio-marine origin of miliolite deposits occurring upto 20 km inland from the coast and upto 75 m above mean sea level. While those occurring above 75 m are aeolian and fluvio-marine in origin. They have also tried to establish that there exist two miliolite formations which belong to two transgressive phases of the sea during the Quaternary. On the basis of the discovery of Lower Palaeolithic tools (Middle Pleistocene) in rocks below miliolite limestone they have suggested that miliolite limestone of higher reaches were of Middle Pleistocene age, while late Pleistocene age was given to coastal miliolite rocks. They have also come to the conclusion that early man saw the relationship between land and sea changing at least twice in the coastal parts of southern Saurashtra.

Agrawal & Roy (1977) studied the grain surface morphology of quartz in the miliolite rocks of Junagarh and Chotila areas and concluded that miliolite of the interior highlands were of aeolian origin.

Bhatt & Patel (1977) measured the geometrical characters of pseudo-oolites and commented on the depositional environments of the miliolite rocks.
Amongst other important contributions on Quaternary, is an attempt made by Patel & Hardas (1977) wherein the tectonics of three distinct physiographic units, viz. Kutch, Saurashtra and Gujarat mainland, have been treated separately. This is significant in view of the fact that most of the research workers on Quaternary sedimentation have treated Saurashtra and Kutch as a single tectonic unit having the identical Quaternary tectonic history and depositional environments.

**QUATERNARY OF STUDY AREA**

The detailed account of the geology and geomorphology of Una–Jafarabad area of southern Saurashtra was not available in any of the published work till the author took up the study. Fedden (1884) had however, made a passing reference of Jafarabad area mentioning that the coastal cliffs here were not made up entirely of miliolite rocks. He had noted that there were "light-grey calcareous sandstones, indifferently cemented, associated with miliolite".

More recently, Sperling & Goudie (1974) have made mention of cemented parabolic dunes composed of miliolite in Una–Veraval area which represented a typical dune morphology and were oriented transverse to southwesterly winds.
The present author has given a preliminary account of the geology and geomorphology of the study area in a paper presented at a Seminar at Hyderabad (Mathur & Verma, 1976). The textural characteristics of the Recent sediments form the part of author's research paper on the Holocene carbonate sediments of studied area (Mathur, 1976).

The Diu Island is separated from the study area by a narrow creek of 250 m width. Its geology, microfauna and petrography is known by the contributions of Portuguese workers. Ubaldo (1961) has given an account of the petrography of the calcarenites of Diu island. According to her, all the Diu rocks were of uniform composition—being slightly clayey detrital limestones. They were composed of oolites, organic remains and cement. The presence of aragonite as the dominant constituent of oolites made her conclude Recent age for Diu calcarenites. Rocha & Ubaldo (1964) have contributed towards the foraminiferal fauna of the recent sediments of Diu Island and neighbouring Mainland coast near Simar and Goghala. Fedden (1884) had mentioned that the miliolite rock is nowhere encountered in the deep quarries and cliffs of Diu Island.