CHAPTER - 2

PREVIOUS WORK

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GENERAL

The earliest reference to the geology of the West Coast was made by Oldham (1893) who envisaged a major fault running parallel to the coastline. In fact, the NNW-SSE trending almost straight coast has been attributed to this Fault, subsequently referred to as West Coast Fault by all the workers. According to Oldham (1893) this faulting took place in Miocene or slightly earlier.

According to Pascoe (1959), the vast alluvial plains flanking the west coast of Gujarat were of recent origin. He (1959) observed that southward near Bombay, the alluvium was much reduced and was more or less salty and 'Kankarous'. At Bombay, Pascoe (1959) noted indications of subsidence where a large number of tree trunks were found in the blue clay in upright position. He further observed that the littoral concrete of Bombay was an agglutinated shelly grit composed of shells,

corals, pebbles and sands cemented by calcium carbonate. He alsc noted evidences of upheaval along the western side of Bombay and of subsidence along its eastern margin and a tilt along the N-S axis uplifted the area now occupied by Bombay Island and submerged that covered by Bombay harbour.

Krishnan (1963) pointed out that along the west coast, the margin of the continental shelf is remarkedly straight from Cape Comorin to West of Kathiawar and he concluded that the faulting of the West Coast was comparatively of recent times. He remarked that the Deccan Trap near the Bombay coast was over 6000 ft. and became gradually thinner eastward, showing a slight dip towards the sea near Bombay, and this was due to a flexure (Panvel flexure) trending roughly parallel to the coast. The series of hot springs between Ratnagiri and north of Bombay which are oriented in a straight line parallel to the coast indicate a faulted coast. Subsequently, Krishnan (1965) concluded that the final faulting of the whole West Coast took place in late Pliocene, concurrently with the Makran Fault which ran from Iraq through the Arabian Gulf and Makran coast to the Rann of Kutch. According to him, the Cambay trough that ran N-S was bounded by faults on its eastern side. He suggested them to be step faults as there was no break in the strata and the structure was more like a syncline than a steepsided trough. Mehdiratta (1962) supported the faulted nature of the West Coast with its downthrow side towards the Arabian sea. In contrast to the postulations of Oldham (1893) and Pascoe (1959) the O.N.G.C. officers, Mathur, Rao and Chaube (1968) thought that the volcanic activity of

western India, towards the end of Cretaceous period, was also connected with the Cambay graben formation and according to them the formation, of the Indian West Coast had already commenced during the Condwana period and the present coast was due to later faulting along the pre-existing earlier plane of weakness.

Pandian et al (1988) studied the coastal Quaternary sediments, exposed between Agashi creek in the north and Bassein creek in the south, District Thane, Maharashtra, for their shape aspects.

Sukhtankar et al (1988) have studied in detail the sedimentological aspects of the tidal clastics exposed along the coast in parts of Thane district, Maharashtra.

Ramanujam (1988) has given a hydrodynamic modelling of coastal sediments using principal components analysis.

Sychanthavong and Merh (1988) have studied surface textures of quartz grains of Gujarat.

WEST COAST DECCAN TRAPS

The West Coast has attracted attention of geologists, mostly on account of the vast stretch of its rocky nature comprising basalts of the Deccan Trap. Earlier workers studied the trappean rocks in and around Bombay. In the early parts of the nineteenth

century, Thompson (1836) made a preliminary study of the Deccan trap of Bombay. Clark (1847) established the different flows of the trap rocks. Carter (1852) gave the first account of the flora and fauna of the intertrappean beds. He also threw some light on the structure of the lavas of Bombay area and suggested that the eastern lava flows were a repetition of the western ridge flow due to some deep faulting, parallel to the ridge. Blanford (1856) has also described the Deccan Trap of Western India and he reported the occurrance of ash bed in the intertrappeans. Oldham (1893) studied the field relation of tuffs. Hallowes (1922) prepared the first geological map of the Salsete Island. Fox (1922) reported the occurrance of bitumen in the intertrappeans of Bombay. Fermor (1925) pointed out that the volcanic activity was mainly represented by fissure type of igneous activity. Fermor (1934) while examiing the cores of boring at Bhusawal, observed that olivine and to some extent labradorite had settled down to the bottom of the flows due to gravity settling. Mathur and Naidu (1932) have stated that the coastal trap rocks are different from the typical plateau basalts of the Deccan Trap. Bruce Foote (1938) pointed out that the vast piles of lava poured out subaerially over Western India during the Cretaceous period caused the crust to subside in this region such that the exposed rocks were invaded by the sea.

Auden (1949) made a significant contribution to the problem of the Deccan Trap emplacement by studying the dyke rocks of Narmada Valley. He further studied the Panvel Flexure, and concluded that the minor and subsidiary lineaments oriented in

the same direction were connected with the major lines of weakness in the trap area and he suggested that two lines or zones of weakness existed in the western India, one being the Narmada valley going straight but into the Kathiawar region and the other trending from Puna river valley into Gujarat and thence into Western Rajasthan. He contradicted the generally accepted view that the dykes cutting the Deccan basalts functioned as feeders of the lava. According to him they might have belonged to post lava hypabyssal phase. The concentration of dykes in certain regions, according to him, were either due to plutonic centre in Saurashtra or folded zones of Gujarat and Konkan. These plutonic intrusions and tilting of flows must have been later in age than the flows. Subsequently, Auden (1975) found that majority of these faults were not accompanied by vertical or horizontal displacement. Another significant contribution to the coastal trappan rocks came from West (1958) who studied the petrography and petrogenesis of 48 flows of Deccan Traps. He concluded that lavas were erupted from the fissures now seen as dykes and major focii were off the West Coast in Saurashtra and Tapti and Narmada valleys. Sukeshwala and Poldervaart (1958) gave a detailed patrographic study of rocks of Bombay and Salsette and suggested that the rocks were formed due to fissure eruption accompanied by central type of eruption. Krishnan (1965) who investigated th Deccan Trap near Bombay coast, explained that the slight dip of trap towards the coast was due to the Panvel Flexure. Sukeshwala and Avasia (1972) reported the occurrence of nephline syenites in Thana district and discussed their origin.

Agashe and Gupte (1991) discussed the various civil engineering aspects of the volcanics and associated rocks of Bombay. According to Ray (1967) whenever deep fissures reached the depth of mantle, ultramafic lavas were erupted while the vast expanse of normal basalts arose through the subsidiary fissures. Deshpande and jagtap (1968) recorded 8 prominent lava flows in Koyna.

Sethna et al (1977) gave chemical classification of the intermediate and acid rocks (Deccan trap) of Salsette Island, Bombay.

SEISMIC STUDIES

Glennis (1951) explained the gravity anomaly of the Deccan Trap as due to local upwards or downwards of the subcrustal heavy layers. Sengupta (1967) provided supporting evidence of the faulted West Coast margin of Bombay by furnishing seismic data. He found that quite a few fractures deepseated probably reaching the mantle. According to him (1967) these fractures, gravity high and high thermal gredients, all indicate that the oil bearing Cambay basin was formed by deep seated fractures extending into the mentle, Rao (1968) thought that the gravity anomalies in the central part of Cambay basin were due mainly to the variation in thickness of high density trap lying between the Tertiary asdiments and the crystallines, gravity survey revealed a belt of positive anomaly of high amplitude and large areal extent in the central part of the basin. Negi (1952) was of the

opinion that these fractures were due to sial-sima upwarping Kailasam and Murthi (1969a, 1969b) who made gravity cum magnetic investigations of the Deccan Trap, interpreted the prominent features in gravity anomalies as being due to subtrappear topography because of the thinning and thickening of the trap formation. Tandon and Chaudhury (1968) obtained two layered crustal model on the basis of studies on the main Koyna earthquake and the following after shocks. Leo and Rayleigh (1969), Sykes (1970), Gobunova et al (1970) and Toai and Aki (1970) also studied the crustal structure of Koyna and suggested that the Koyna earthqake might be due to a fault running in a NNE-SSW direction. However, Gupta et al (1969) and Khatri (1975) indicated strike direction as 328 degree and 359 degree respectively. Das and Ray (1973) thought that the zone of structural weakness marked by panvel flexure along with awarms of dykes, alignment of hot springs, shear and tensional fractures including the Koyna river valley were due to reactivation of tensional fractures within the basement during post-Deccan-Trap thus giving rise to a monoclinal flexure with accompanying tension and shear fractures in the covering strata of Deccan basalt.

WEST COAST BEACH ROCKS

Occurrence of beach rocks is known since last Century through the works of Theobald (1872), Blanford (1884), Foote (1890) and others, and were broadly termed as the "Litteral Concrete" Sudharma et al (1979) have recorded beach rocks in the

coastal segment between Vaitarna and Alibaug in Maharashtra Further South along the Konkan coast it has been reported b Rajaguru's students (Ghate, 1986).

Badve, et al (1984) have observed that beach rocks of th West Coast exhibit a consistent lithological succession in tim and space, therby necessiating to assign a definite straighraphi status. These rocks have been grouped here as the Raigad Grou comprising the Nagaon Formation, mainly mudstone and the Div Agar Formation, predominently shell limestones with occasional gritty and conglomeratic bands, in ascending order.

Kale and Rajaguru (1984) have reconstructed the late Quaternary transgressional and regressional history of the West Coast. By plotting radiometric dates of beach rock and beach dune complex formation from Konkan, other shore zone dates from Goa, Karwar and Kerala and offshore dates from Bombay to Karwar, these authors have obtained a curve showing the trend of sea level changes from the closing phase of pleistocene to late Holocene period. On this curve, the estimation of the sea level about 12,000 yrs. B.P. comes to 138 m., a figure which compares well with global findings and conforms with the offshore datas from the depth. These workers have also postulated a rise from 12,000 yrs. B.P., the rate being very rapid during the early Holocene, the rate of rise computed being about 1.8m/century (18mm/year). This rapid rise was interrupted with phases of still stands. According to these workers, inspite of still stands, the early and middle Holocene were marked by a large rise in sea level, and

at about 5,000 to 6,000 Yrs B.P. the sea level along the West Coast reached very close to the current level, since then it seems to have oscillated to positions both above and below the present level and in the course of last 5 to 6 millenia, it has been above the current level twice with intermittent regressional phases. An interesting observation made by Kale and Rajaguru (1984) pertains to the late Pleistocene (last interglacial stage) about 1,20,000 yrs. B.P. They have invoked a sea level almost same as the present, clearly stating that the intertidal beach rock which has given a C-14 date of 30 to 36 kilo years could in fact be much older. They have also stated that in the absence of undesputed wave-cut platforms, abandoned sea caves and other littoral features outside the present shore zone (both altitudinally and spatially) it is difficult to perceive high sea levels during late Pleistocene or even earlier times, and according to them the sea has been lower for a large part of the late Pleistocene period.

It has been observed that along the coast south of Gujarat, from Dahanu onwards the last high sea level is very well represented by a littoral concrete (shelly beach rock) rising upto 6m above the sea level and located fairly away from the shoreline (upto 400 - 500 m inland). The beach rock shows intermittent development from Dahanu to Bombay (Hussain-personal communication.)

Sukhtankar (1986) reported raised beaches of Quaternary sediments separated from the present intertidal zone along the coast of Vengurla, Sindhudurg district, Maharashtra.

Fakhri and Vashi (1988) worked out the details of beach rocks in Umargaon-Dahanu area and proved them to be related to an ancient high stradline (Flandrian transgression)

GEOMORPHOLOGY AND ALLIED ASPECTS

Although till recently no systematic geomorphic studies were conducted on the West Coast, from time to time, sporadic mentions have been made about one or the other aspects of the geomorphology and Quaternary deposits of areas along the coastline. Medlicott (1879) gave a brief account of the alluvial deposits of the central portion of Narmada Valley. Blanford (1856) in his unpoblished report considered this alluvial deposit to be either marine or estuarine since it contained variable amount of cognats salt derived from the precipitation of brackish water. Later on Bruce Foote (1938) described the alluvial plains between the the rivers Kim and Tapti and opined that the black cotton soil was the disintegration product of the Trappean rocks. Pascoe (1949) who investigated the alluvial plains of the West coast recorded more than 300 ft. thick alluvium at Sanand railway station. West (1947) found 20 ft. of superficial alluvial deposit on the bank of Kalai river, near Daman. Deshpande (1954) during his investigation of groundwater of Gujarat proposed marine and estuarine origin for the alluvium, its salt content

originating from the precipitation of brackish water and also from the onshore prevailing wind carrying fine salt particles from the Arabian sea. Sudhakar et al, (1970) studied the deformation of the Tertiary and Quaternary sediments of Cambay basin, south of Mahi river and found that the Quaternary deformation produced asymmetrical well defined folds with sharp axes trending ENE-WSW or E-W. Dikshit (1970) studied the polycyclic landscape and surface erosion in Deccan Trap country rock. Gupta and Rajaguru (1972) worked on the late Pleistocene geomorphological history of the rivers of western Maharashtra. The National Institute of Oceanography (N.I.O. 1972) reported submerged beaches on the western continental shelf. Ahmed (1972) has described the coastal geomorphology of India. He has stated that the Gulf of Cambay has a slope of 1-2 m from the shore to 100 fathoms submarine contours, and here the continental shelf is widest (over 400 km). North of Bombay, the low gradient of the shelf near the slope continues to occur but near Daman the shelf steepens so that the 5 fathom contour intersects the shore near two points, one about 13 km, south of Daman and the other at Navsari, but the 10 fathom contour is about 35 km away, giving a very gentle gradient of about 1 minute. He has described the littoral concrete which is in the process of formation, more or less stratified and dips at a low angle towards the sea and is underlain unconformably by alluvium. Cliffy coast is prominent near Daman but beyond which northwards cliffs are not seen upto Cambay. Setty and Wagle (1972) studied the raised beach rock of Goa coast and found that the process of formation are chiefly controlled by groundwater evaporation, inorganic

precipitation and optious temperature under the beach and inland. They found that the thickness of concrete depends upon variabilities of precipitation, hinterland, water table fluctuation, temperature changes, composition and changes in sea level. The occurrence of beach rock according to them indicated eustatic movement, since they originally formed in the tidal or spray zone.

Allchin and Joshi (1972), on the basis of archaeological evidence have reported estuarine culture of Harappan civilisation near Malvan village. Hegde (1979) estimated the age to be 3500 B.P. Hegde and Switsur (1973) worked on the Older Alluvium of Gujarat and gave an age 24,000 B.P., though the buried soil might have begun forming several thousand years before the above age. Samanta (1977) investigated the marine Palaocene outcrop in Surat and Broach area. Varma and Mathur (1978) have identified five strandlines during the Quatarnary on the Saurashtra coastline. Powar et al (1978) studied the geomorphology and tectonics of the West Coast, between Rewas and Srivardhan. Shrivastava (1976) studied the geomorphology around Coondapur, of west coast of India and found them to be in equilibrium since 1912. Babu (1977) carried out the geomorphological analysis of a sedimentary basin around Ratnagiri. Desai and Peshwa (1978) studied the drainage anomolies on the West Coast with the help of landsat imagery and aerial photos. Sriram and Prasad (1979) concluded from their geomorphological investigation that the present West Coast re-emerged during the late Neogene and presumably before the onset

of Pleistocene deglaciation. They (1979) found that the last Paleocene planar surface was marked by benches and terraces that were probably the result of oscillation of the sea laval during pleistocene. Sharma and Vashi (1979) studied the South Gujarat coastline and concluded that there is a progradation of the shoreline. Hardas et al (1979) analysed the geomorphological and sedimentological characters of the sand bodies along Dahej coast on the Mainland Gujarat and concluded that fluvial processes have been marked by marine processes. Patel and Desai (1979) have examined gravels and cobbles near Udvada beach and concluded that the Oyster shells clustered on these rocks indicated a slight uplift of the coast. Vashi and Roy (1979) have investigated the South Gujarat coastline and have described geomorphic expressions of Flandrian tranagrassion. Sudhama et al (1979) have surveyed the coastline between Vaitarna and Alibag and have reported littoral concrete of 6 metre height above M.S.L. along the coast.

Subramanyam and Rao (1979) have observed 2-3 metres high raised beaches at Varsova. Merh (1980) invoked eustatism and tectonism to explain various strand lines of Saurashtra, but on Mainland Gujarat coast, he observed only one higher strandline of 5-B metres above M.S.L.

Rajguru and Murthy (1984) reported the neotectonic activity around Ratnagiri on the basis of three prominent surfaces of littoral deposits at 150-90, 60-48 and 21-15 meters level. Occurrence of multiple laterite profiles and of relict, channel

gravels at + 30 to -20m from the mean sea level strongly suggests neotectonic activity in the coastal parts of Maharashtra particularly around Ratnagiri.

Mukherjee (1984) worked out the morphology of the south Gujarat coast and worked out itis neotectonic significance.

Patel et al (1984) worked out the geomorphic evidences of Quaternary sea level changes in the Mahim, Tapi coastal segment of Gujarat and reported three eustatic sea levels, Wurm (- 20m), Flandrian (+ 8 m) and present day level. Using landsat imagery Nayak and Sahai (1984) gave a detailed account of the coastal geomorphology of the Gulf of Khambhat. According to Ganapathy et al. (1984) Narmada geofracture divides the Gujarat Mainland Cenozoic sequence (Cambay Basin) into Narmada Block and Jambusar-Broach block. According to them, the post-Miocene reactivation of this fault uplifted the former or down faulted the latter, and this led to the deposition of Broach and Jambusar formations (Pliocene - Pleistocene) in Jambusar - Broach block only.

Islam and Merh (1988) have made a detailed studies of the tidal currents and sediments in the Gulf of Khambhat.

Patil et al (1988) reported geomorphic evolution of the Konkan coastal belt between Palghar and Vijaydurg Maharashtra.

The genesis of tidal mud of Gujarat and their environmental significance is worked out by Patel et al. (1988)

Sukhtankar et al (1988) studied geomorphic evolution of the coastal tract of Maharashtra between Tarapur and Jaigarh and identified various geomorphic features in the area of fluvial and marine origin.

PALAEONTOLOGICAL STUDIES

Rather limited palaeontological studies have been carried out on the Gujarat and Maharashtra coastline area. Sastri and Mathur (1968) have recorded the occurrence of nautiloid genus Ataria from the Eocene rock exposed at Broach. Singh (1972) has discovered a new species of Anomelirella from the upper Eocene of Ghalha clay member of Bodhan formation exposed in Ghalha nalla section in Surat district. Earmes (1952) classified the upper Eocene rocks of Surat as part of Tapti series and recorded the occurrence of Discocyclimajavaria, D.dispansa, Pallalispira indica etc, from it. Eocene succession of Cambay area has been worked out by O.N.G.C. From the lower Eocene sediments the species neccypridesis, leptocythers, paracypris, schizocythere, globigerina and few rotalids and miliolids have been encountered. On the basis of microfossil contents, Mohan and Chatterjee (1956); Bhatia and Mohan (1959) divided the Miocene of Surat and Broach into there distinct horizone :

Pandya (1984) elaborated upon the ecological controls of the microfaufnal diversity of Saurashtra and Gujarat coast.

Ghare and Vartak (1984) gave an account of Serpulid fauna from Dive Agar formation of Raigad district west coast of Maharashtra.