CHAPTER III

GEOLOGICAL SETTING

C H A P T E R III

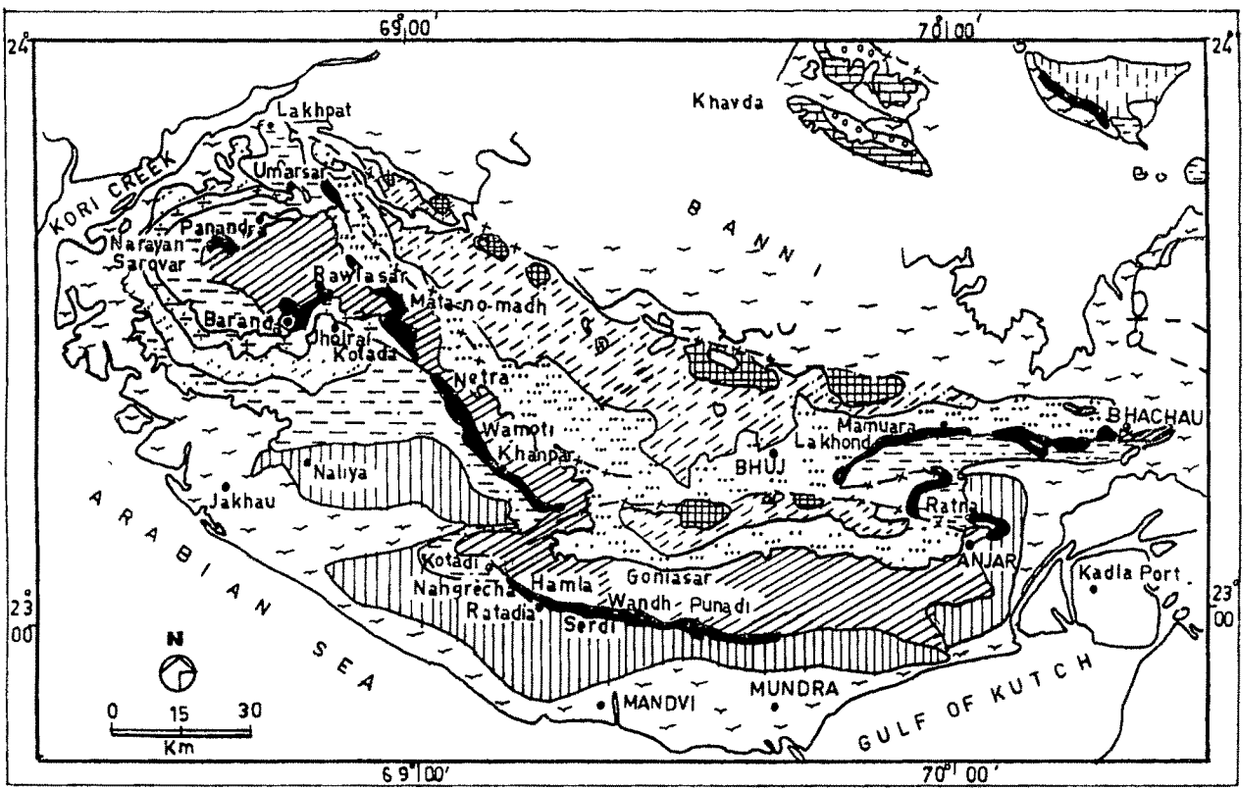
G E O L O G I C A L S E T T I N G

According to the present author, the generalised stratigraphy of the laterite areas of Kutch is as follows: (Fig 6. After Biswas and Deshpande, 1970).

Table 2

	Alluvium, blown sand, etc.	.....Recent
Porbander Series	Arenaceous limestone	.....Pleistocene
Kankawati series	Gritty sandstone, clays	.....Pliocene
----------UNCONFORMITY----------		
Khari series	Shales with intercalations of fossiliferous limestone	.....Miocene
----------UNCONFORMITY----------		
Bermoti Series	Dirty white and yellow banded marl and impure limestone	.....Oligocene
----------PARACONFORMITY----------		

GEOLOGICAL MAP OF KUTCH
(AFTER, BISWAS AND DESPANDE, 1970)
SHOWING LATERITE OCCURRENCES



	RECENT PLEISTOCENE DEPOSITS		QUATERNARY SYSTEM
	KANKAWATI	SERIES PLIOCENE	TERTIARY SYSTEM
VINJHAN STAGE BURDIGALIAN AIDA STAGE AQUITANIAN	KHARI	SERIES MIOCENE	
	BERMOTI	SERIES OLIGOCENE	
	BERWALI	SERIES EOCENE	
	MADH	SERIES PALAEOCENE ⊛	
	DECCAN TRAP FORMATION		
INTRUSIVE BODIES			
	BHUJ FORMATION		(BATHONIAN TO ALBIAN)
	JHURAN FORMATION		
	JUMARA FORMATION		
	JHURIO FORMATION		
FAULT			

⊛ LATERITE OCCURRENCE

FIG. 6

Berwali Series	Babia- Fragmental fossiliferous Stage (nummulitic) limestone	..... Upper Eocene
	Kakdi- Buff coloured clays,marls) Stage sandstones and shales) with flakes of gypsum and) intercalated laterite/bauxite)	.....Middle .....Eocene to .....Lower Eocene
	----------DISCONFORMITY----------	
Madh rocks	Laterite/bauxite) Ferruginous and lithomarge) clays, bentonitic clays)	.....Lower Eocene
	----------UNCONFORMITY----------	
	Deccan Trap lava flows)	.....Lower Eocene to Upper Cretaceous
	----------UNCONFORMITY----------	
Upper Bhuj Series	Felspathic sandstone	.....Upper Cretaceous
Lower Bhuj Series	Shale, ferruginous sandstone	.....Lower Cretaceous

Bhuj Series

The oldest rocks exposed in this area belong to the Bhuj series and are very well developed in parts of Anjar, Bhachau and Rapar talukas. They mostly comprise of medium to coarse grained, current bedded sandstones. The lower Bhuj rocks consist of alternations of soft shale and hard, ferruginous sandstones that occassionally contain scattered remains of fossil-wood. The upper Bhuj sediments are composed of soft, current-bedded,coarse to gritty and felspathic sandstones with intercalations of clays at the top. The absence of marine fossils, current bedding and ripple marks in upper Bhuj sandstone are suggestive of shallow water estuarine and fluviatile conditons. In Bhuj taluka, laterite rests directly on the upper Bhuj sandstones. The topmost Bhuj rocks, sometimes referred to as infra-trappean beds,

consisting of quartzo-felspathic sediments of Bhuj series indicate tropical palaeoenvironmental conditions during their deposition (Desikan et al. 1976)

Deccan Trap Lava Flows

Deccan Trap lava flows resting unconformably on Bhuj rocks, outcrop in a long strip bordering the Mesozoic formation. They extend from Panandhro in the west to Anjar in the east, covering a distnace of 160km. The width of outcrops varies from 1 to 20 km and attains a maximum thickness of 460 m in the south, while in the east and northwest, it tapers to 150 m. The long ridges of Deccan Trap have broad, flat peaks. Basaltic hills along the coastal plain in Kutch are locally known as Garda hills in the west, and Dhola hills in the south and southeast extending upto Anjar. Some isolated and conical hills are also common in this area. Generally, the basaltic flows are horizontal to sub-horizontal with gentle dips varying from 3^{o} - 5^{o}, with a maximum of 10.

The dip directions are southerly near Wamotj and Naredi, westerly near Panandhro and easterly near Anjar. These Traps are medium to fine-grained, often glassy and at times porphyritic and generally dark-greyish or greenish-grey. The basalt flows show alternations of columnar and amygdaloidal basalts and are occassionally separated by thin laterites, red bole and/or intertrappean beds. The columnar type flows form prominent ridges and hills while amygdaloidal ones are softer and are eroded to plains. Alternating valleys and ridges are common topographic features of the Trap country. The non-vesicular type are hard, tough compact,

fine to medium grained and break with a conchoidal fracture. The dykes are coarse to medium grained greenish and doleritic. In Indian stratigraphy, the age of Deccan Trap lava flows is placed between upper Cretaceous to lower Eocene.

Biswas and Deshpande (1970), suggested that the central mainland including Charwar and northern hill ranges were elevated when the Traps were erupted in Kutch from the evidence that the Trap thins out towards the central highland from the west, south and southeast. They also suggested that the distribution of Trap flows was controlled by pre-Trappean topography. They further suggested that Trap flows were Hawaiian type eruptions, erupted from "shield volcanoes".

The "shield volcanoes" of Holmes (1975) are "high fluid basaltic lavas from which gases escape so easily that explosive activity becomes sub-ordinate, and they spread out as thin sheets for great distances. By the accumulations of successive flows in various directions, a wide spreading dome with gentle slopes, rarely exceeding $6^{o} - 8^{o}$ is constructed ". He also stated that tephra deposits were scarce.

Red Bole

Red bole is a brick red, porous decomposed product of basaltic rock and forms a persistent marker horizon between the flows. It varies in thickness from a few cm to 50 cm and invariably shows a development of curvi-columnar joints on a miniature scale. Thin films of dirty-white to grey zeolites are noticed around each of the columns. Auden (1949a), regarded these beds to be "ash beds" erupted during the explosive phase between periods of more quies-

cent lava emission. Sahasrabudhe (1966), suggested that they were the upper limits of flows, which had been completely altered to clayey ferruginous matter. Agashe and Gupta (1966),considered red bole as products of atmospheric weathering and not, as generally considered, by the baking of soil by the heat of upper flows. Raja Rao (1976), opined that they were derived by the alteration of a glassy crust.

Tertiary Rocks

The advent of the Tertiary depositonal sequence represents a major event in the geological history of kutch. According to Biswas (1965,71), these rocks were deposited under stable shelf conditons in a slowly transgressing sea since early Eocene times, except for a short transgressive phase during the Oligocene. Their environment of deposition never exceeded the limits of the neritic zone. The Tertiary rocks form two broad structural noses, Narayan Sarovar nose and Vinjhan nose-around the noses of Mesozoic anticlines. The exposed thickness of stratigraphic units thicken towards the deeper parts of the basin e.g the off-shore region and graben basins of Banni and Rann of Kutch.

Madh Rocks

Biswas (1965), named these rocks as Madh series after the well known village of Mata-no Madh in northwestern Kutch. The outcrop pattern of these rocks is very irregular as it follows the post-Trappean topography. According to Biswas (1965), this series of colourful outcrops and characteristic lithology consist of tuffs, volcanic ash tuffaceous shales, sandstone and bentomtic clays. These rocks have yielded well preserved dicot leaf

impressions and spores, pollens which are common in Lower Eocene. The Madh series overlies the Deccan Trap (Cretaceous to Lower Eocene), but underlies Kakdi rocks which correlates well with the Lower Eocene Laki rocks. Thus considering the order of superposition, these rocks were assigned Palaeocene age by Biswas(1965). This series is correlated with the Lower Ranikot series (Palaeocene) consisting of sandstones, shales and veriegated clays with leaf impressions and fossil wood and underlying bituminous and pyritous shales of Laki age (Sahasrabudhe,1966).

Biswas (1971), has grouped the bentonites and associated formations viz. the laterites and bauxites together and designated them as Madh series. According to him, trap-wash and volcanoclastic sediments were deposited in a continental to supra-littoral environment, which gave rise to Madh series during the Palaeocene period. But Samanta (1974), stated that the occurrence of marine fossils in the Madh series had been mentioned by Krishnan(1958). However, Biswas and Raju(1971), and Biswas (1971),have considered this unit to be devoid of marine fossils. Mathur et al. (1970), reported planktonic foraminifera of Lower to Middle Palaeocene in the Jura and Jumara domes. But this observation was not supported by suitable details and illustrationas of fauna. Tandon (1971), reported the presence of lamellibranch Venericardia beaumonti , and solely on this evidence he dated these beds as Palaeocene. But there is considerable difference of opinion regarding the age of the series. Mathur(1972), published figures of a few nanno-fossils and assigned a Palaeocene-Eocene age to the beds containing them. However, from the reported range of the forms identified, it follows that the nanno-fossil assemblage indicates an Eocene age. Thus, the Palaeocene age which has been

assigned to the Madh series is highly suspect and the present author believes that these rocks should not be designated as Madh series and they should be treated only as a small unit in the stratigraphy of Kutch. From the west to east, these rocks are unconformably overlain by the following facies of Tertiary sediments:

1) Babia stage rocks of Berwali series (Kirthar) between Panandhro and Baranda.
2) Vinjhan stage rocks of Khari series (lower Gaj) between Jhulrai and Sherdi.
3) Kankawati series rocks (Manchhars) between Wandh and Adesar.

Berwali Series

The type section of Berwali series is exposed along the Berwali Nadi in southwestern Kutch between the villages of Baranda and Bernana. According to Biswas (1965,71), this series is divisible into two stages. 1) lower-gypseous and ochreous clays and marls, containing Assilina granulosa and varieties of molluscas, well exposed in Kakdi Nadi and 2) upper-well exposed on Babia hill in western Kutch, consisting of dense fossiliferous fragmental limestone with a basal calcareous clay bed and numerous distinctive fossil zones. The base of Kakdi stage is marked by an unconformity.

In parts of Lakhpat taluka (Samajirao, Rawreshwar, Saran, Jhulrai, etc.), the rocks corresponding to this stage are black shales with lignite seams, buff clays, sulphurous and pyritous shales with disseminated flakes of gypsum. The lithology suggests

development of euxinic facies in lagoonal environment. The coarse to fine-grained mottled sandstone along with flakes of gypsum is also noticed.

The bauxite is overlain and underlain by shales belonging to the Kakdi stage in a nala section near Ratadia Nana temple. Also the lignite horizon is older and exposed further below. This indicates the nature of reworked and transported bauxite with depositonal features.

Ferruginous layers in the form of conceretionary limonitic or hematitic nodules are observed at Ratadia Nana. Thick sand beds with ferruginous layers occurring at Gangapur and Bhadia are peculiar because they exhibit textures reminiscent of vegetable matter. Among shales also, concretionary bodies resembling twigs and branches of plants are frequently seen. These rocks seem to occupy small basins and depressions.

The Babia stage is correlated with Kirthars and ovelies the Kakdi stage with a disconformity. It depicts a epineritic to neritic environment of deposition (Biswas,1965,71) 1 km southeast of Wandh and south of Goniasar, nummulitic limestone with fossils of numulities,echinoids and lamellibranches are exposed. The second marine transgression after bauxitization is evidenced from the development of limestone (Kirthar age), within small depressions of bauxite material.

Bermoti Series

Bermoti series is well exposed in a continuous belt south of Lakhpat in northwestern Kutch and does not overlie any of the bauxite deposits.

Khari Series

Khari series is named after river Khari in SW Kutch where it is well exposed in the high cliffy banks of the river. Biswas (1965), has divided the series into two stages. The lowest stage consists of variegated siltstone, grey to khakhi coloured gypseous clays with hard marl bands packed with fossils. According to him, the Khari rocks were deposited in a transgressing sea under tranquil conditions. The fossil assemblage indicate that they are identical with the lower Miocene (Gaj series) of Sind.

In the south, in Abdasa and Nakhatrana talukas, yellowish-grey shales, fossiliferous and gypseous with thin, hard layers of yellowish limestone (Gaj rocks) often cover the laterite. Gaj rocks in Lakhpat taluka consist of grits and shales with intercalations of fossiliferous limestone. The grit consists of sub-rounded grains of bauxite and lithomarge. The shales are yellowish,grey and at times fossiliferous.

Kankawati Series

Kankawati series is well exposed around Kankawati river beteen Sandhan and Vinjhan. These beds represent typical beach and deltaic deposits in a shallow sea (Biswas,1965). They are probably correlatable with Manchhar beds of Sind-Baluchistan.

Grey sandstones and conglomerates cover the laterite and Trap in their eastern extremity near Ramania. Poddar (1955), considered them as equivalent to Siwaliks (?). The lowest part consists of grey and reddish, gritty sandstone with clays. The upper part is composed of reddish , kankary sandstone with occassional mottled

clays. There is a pebble bed between the two parts indicating an unconformity.

Porbander series

The youngest formation observed in the laterite areas, is an arenaceous limestone which overlies laterite and Trap. It has strong resemblance to the mililolite limestone occurring on the Saurashtra coast. It occurs at several places in Mandvi, Abdasa and Nakhatrana talukas on the Trap. It occurs on the top of laterite/bauxite, at Roha hill, around Kotada village and on the top of a long, broad, Trap ridge between Kotada and Nangrecha. It is porous, white, light and generally crossbedded.