CHAPTER X

T E C T O N I C F R A M E W O R K

X.1 STRUCTURAL FRAMEWORK

Recently, a considerable rethinking has taken place in respect of the tectonic framework of the Saurashtra, and the available data from various sources, point to the fact that this peninsula may not be as stable as visualised earlier by many workers. As such, it has now been established beyond doubt, that the Saurashtra peninsula is bounded by

a number of faults on its all sides. The shape of the Saurashtra peninsula, typically reflects its limits being marked by four regional dislocations (Fig. X.1) as under :

1) Gulf of Cambay Fault (N-S)
2) Narmada Fault (ENE-WSW)
3) Gulf of Kutch Fault (E-W)
4) West Coast Fault (NW-SE)

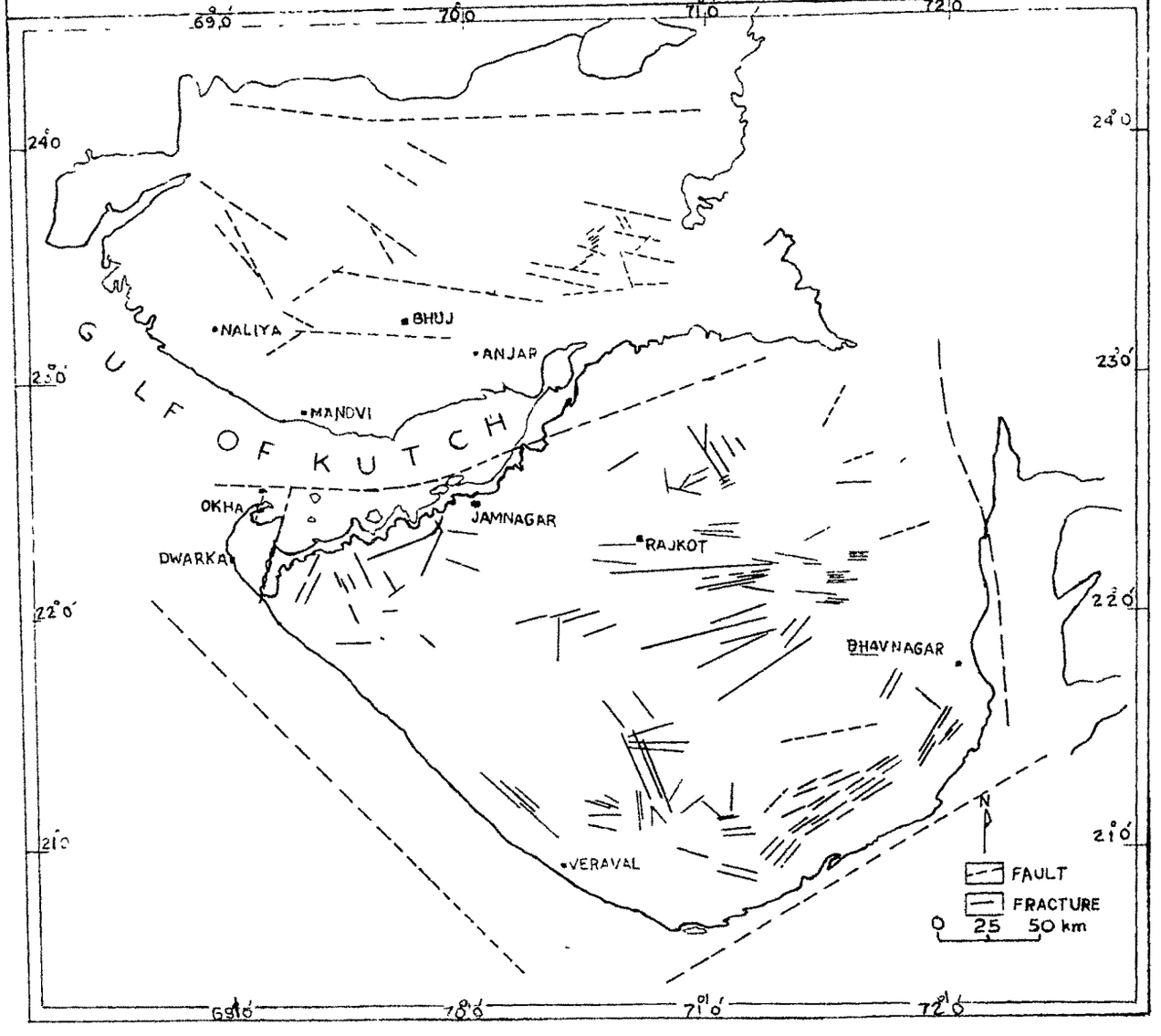
The airphoto and satellite imageries reveal a fracture pattern, criss-crossing the peninsula, the individual fractures being broadly related to one or other major dislocations mentioned above. At many places, trap dykes occupy these fractures. Obviously, the dyke system of Saurashtra reflects the fracturing pattern.

Considerable neotectonic activity has been found to be related to these dislocations, and the geological and geomorphological evolution of the Saurashtra coast-line during the Quaternary period provides ample evidences of tectonic instability.

FIG X I

TECTONIC MAP OF KUTCH AND SAURASHTRA

AFTER SHRIVASTAVA (1968) AND BISWAS (1970)



One of the most important neotectonic phenomena which has considerable relevance to the geomorphic evolution of the study area, is the conspicuous submergence of the northern Saurashtra coastline. Numerous evidences point to the sinking of this coastal area during Quaternary times. Obviously, the various faults and flexures observed in the study area, are the manifestations of this Quaternary tectonism.

X.2 FAULTS AND FOLDS

The most important fault that has direct bearing on the coastal evolution is the Gulf of Kutch Fault, which has been recognised on the basis of bathymetric data and airphoto studies. This fault, in all probability joins up eastward with the Dhrangadhra Fault, postulated by O.N.G.C. In the study area, it extends in the offshore region in an E-W direction, and shows a progressively increasing downthrow from E to W. It is this fault that is reflected in the submarine cliffs of the northern Saurashtra coast. The author has prepared bathymetric profiles across the Gulf of Kutch (Fix. X.2). It is found that the westernmost profile joining Okha and Bhada (Kutch) shows a sharp down fall of 60 m in

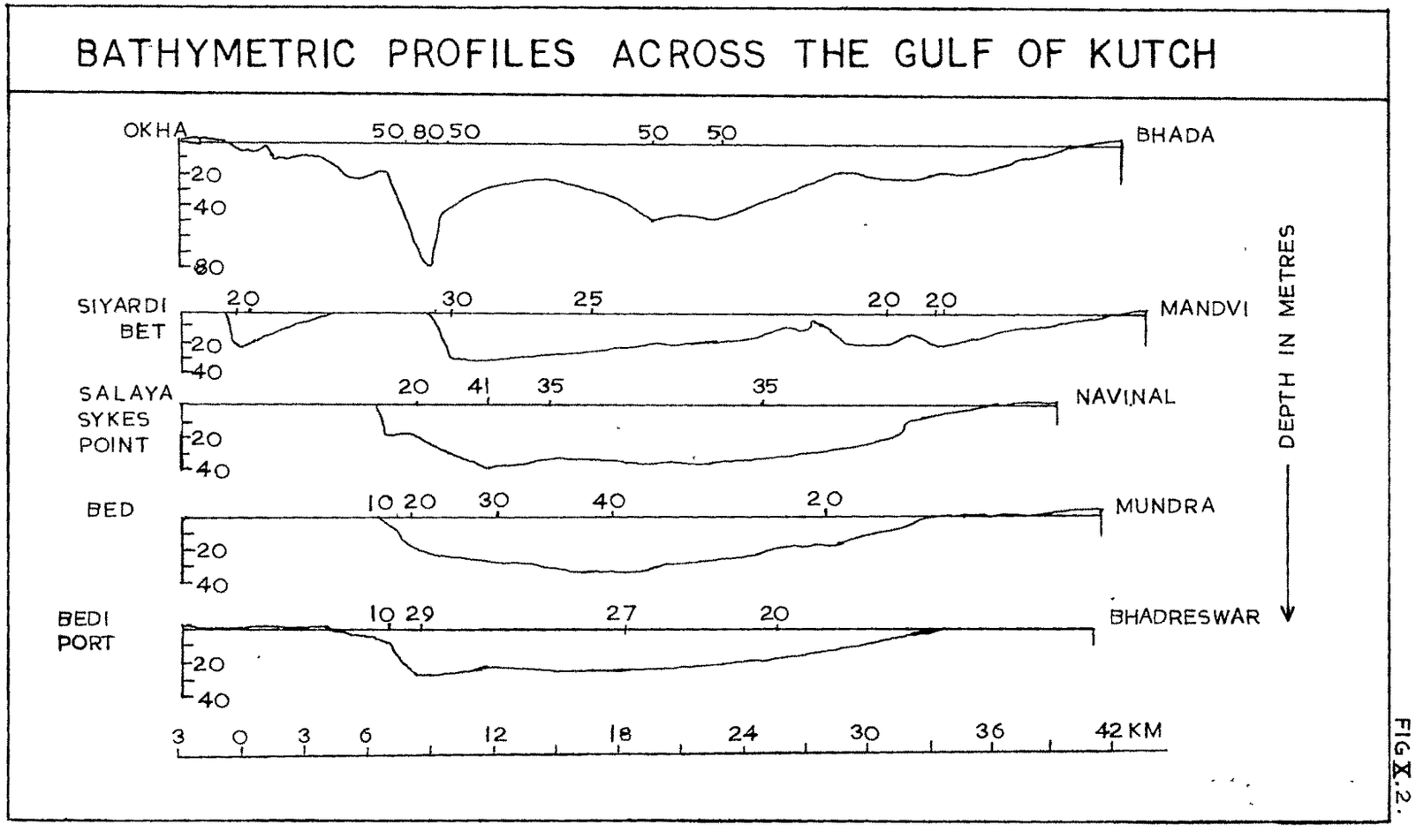

BATHYMETRIC PROFILES ACROSS THE GULF OF KUTCH
OKHA
50 80 50
50 50
BHADA
20
40
80
SIYARDI BET
20
30
25
20 20
MANDVI
20
40
SALAYA
SYKES POINT
20 41 35
35
NAVINAL
20
40
BED
10 20
30
40
20
MUNDRA
20
40
BEDI PORT
10 29
27
20
BHADRESWAR
20
40
3 0 3 6 12 18 24 30 36 42 KM
DEPTH IN METRES

FIG X.2.

which northern side has gone down. The successive values of downthrow decrease as 30 m, 23 m, 20 m and 18m in the east across Bedi Port (Jamnagar) - Bhadreswar (Kutch). The development of this fault and the drowning of the high-order segments of the various north-flowing rivers of the study area and offshore bars are related neotectonic events. Considering the gradual submergence of the coastal tract and the sudden cliff like drop in the shelf, it has been visualised by the author that during the process of tilting, both sides of the fault have gone down, the northern side having been downfaulted and sunk to a larger extent as compared to the subsidence of the southern part.

The Okha-Rann Fault is another conspicuous dislocation, forming the eastern limit of the uplifted Okha-Mandal Block. Topographic profiles (Fig. X.3) across the Okha Rann, clearly show that this NNE-SSW fault has a progressively increasing downthrow of 7 m (in south) to 40 m (in north). Because of this fault, the Okha Rann has come into existence and the Tertiaries are repeated on its two sides. This

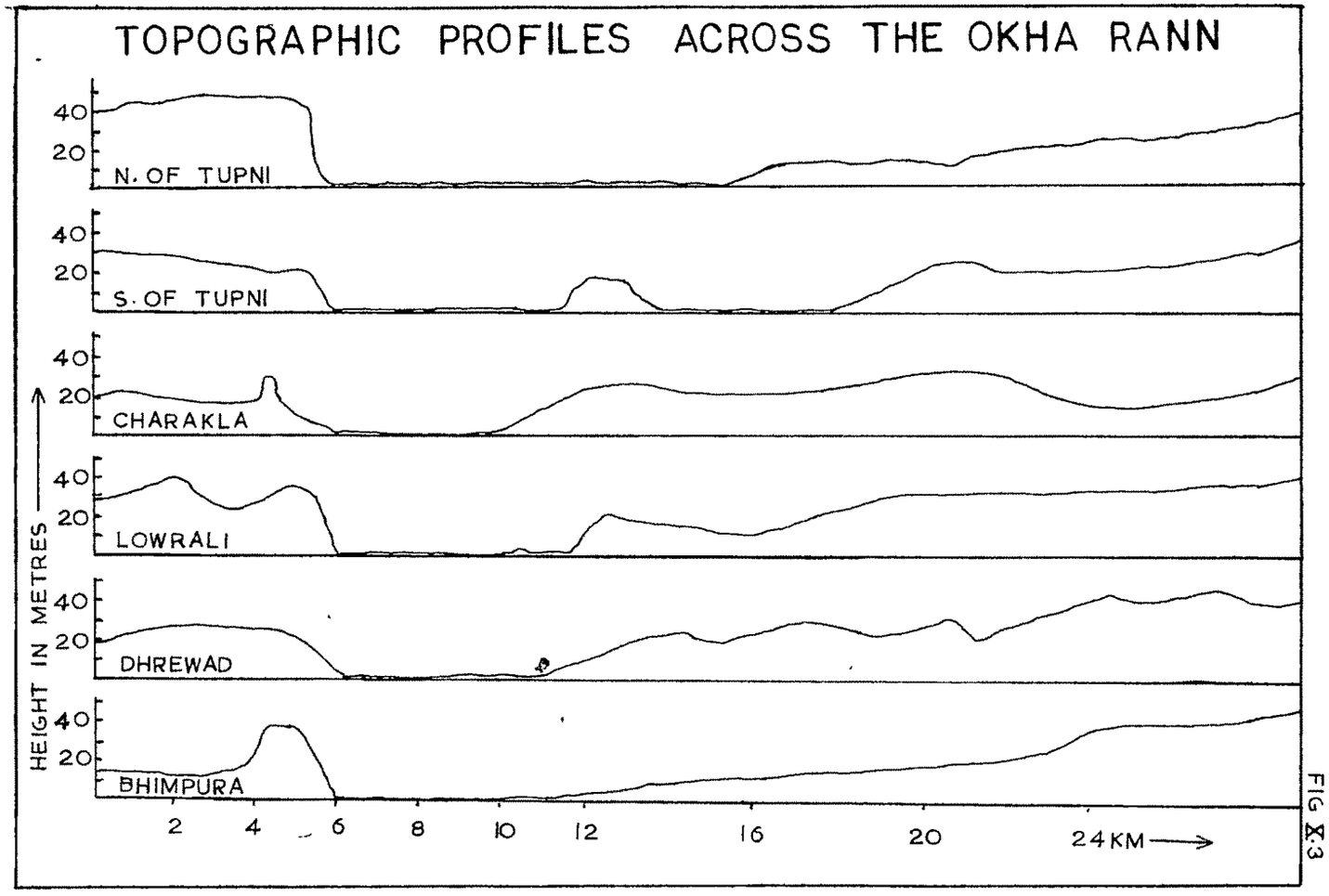

TOPOGRAPHIC PROFILES ACROSS THE OKHA RANN
N. OF TUPNI
S. OF TUPNI
CHARAKLA
LOWRALI
DHREWAD
BHIMPURA
40
20
HEIGHT IN METRES
2
4
6
8
10
12
16
20
24 KM

FIG 3.3

dislocation is definitely younger than the Dwarka rocks, as it is seen affecting these Pliocene rocks. As it gets truncated by the Gulf Fault in the north, it is presumed to be older to the latter.

In addition to the above two major dislocations, the author has recognised a number of N-S faults, extending for 10 to 15 km at the maximum, and restricted to trap areas. Most of them are strike slip faults with slip movement of 50 to 70 m. Such faults are more easily distinguished when they are seen cutting and displacing basic dykes. In all, the author has recorded 5 faults of this nature from the Lalpur Taluka of Jamnagar district.

In the Okha Mandal Block, there are clear evidences of ENE-WSW folding. The flat elevated terrain to the South-East of Dwarka, is dotted with sporadic low anticlinal ridges extending ENE-WSW. These ridges 5 to 6 m high, comprising anticlinally folded limestones of Dwarka, invariably show their northern flanks faulted. It is also observed that intensity and amplitude of the flexures progressively decrease southwards. This folding and faulting phenomenon is a clear case of Post-Dwarka neotectonism.

Also near the village Okha-Madhi at the southern extremity of the Okha Rann, a ENE-WSW fault is suspected. Here, the Dwarka beds show a tectonic contact with the Gaj formation.

X.3 NEOTECTONIC IMPLICATIONS

The Saurashtra peninsula as a whole might not be showing spectacular uplifts and subsidences as a single block, but there are numerous indications to suggest that its various parts did undergo differential movements during the Pleistocene and Recent times.

It is most significant to observe that the Saurashtra peninsula as a whole exhibits a distinct northward tilting on an E-W axis, as a result of which while the northern coast of Saurashtra has been gradually submerging, the southern counterpart points to an emergence. This tilting process has been going on throughout the Quaternary period. The Gulf of Kutch Fault, the Okha Rann Fault and the various smaller N-S and ENE-WSW faults on the trappean mainland and the Okha Mandal Block respectively, would be manifestations of this tilting process, the exact mechanism of which however is not yet fully understood.

The Miliolite Formation of the south-west and south coast, provides evidences of uplift and emergence, and related to this, several tectonic features are observed. Neotectonic movements are also reported from southern Saurashtra, along the valleys of SSW flowing rivers like Hiran, Shingavada and Machhundri. These rivers perhaps follow fault lines. The southern Saurashtra rivers cutting across miliolites, show variable thickness of these rocks within a short east west distance. This aspect has been explained by Dr. B. Roy (Personal communication). He has worked on the southern Saurashtra coast and has reported that the miliolite rocks of same stratigraphic age occupy different topographic levels, and that some of the striking evidences of tectonism are observed in the river valleys in the form of differential river gradients, variation in thickness of miliolites, convergence of terraces and antecedence of streams. Rivers Hiran and Sonarki offer good evidence of differential uplifts. Dr. B. Roy (Personal Communication), has envisaged certain 'down-faulted' pre-miliolite river valleys along which sea 'ingressed' during transgressions. These linear

weak zones, depressed to different depths, thus gave rise to variable thicknesses of miliolites, and these were subsequently uplifted along some prominent basement faults in varying amounts. These differential movements along faulted blocks, probably correlatable with the major offshore lineaments, have given rise to the confusing miliolite topography. He has further suggested that this phenomenon of differential movement could be attributed to the "continental flexures" which are the zones of spasmodic movements along the length of the continental borders. These flexures could give rise to epeirogenic movements of varying amplitudes at different points along the axes of the flexures, and that such epeirogenic movements would not affect all parts of continent equally. Presuming that the Saurashtra landmass comprises a mosaic of numerous block, the uplift due to the flexuring might vary in its different parts. Coasts of such a region would be thus unequally submerged.

Dr. S.P. Synchanthavong, another research worker of my department has attempted (Personal Communication) to explain the tectonic lineaments of Saurashtra and differential movements along the

Saurashtra coast by invoking the concept of plate tectonics. He has divided the Saurashtra coastal areas into following four main tectonic zones of instability with varying intensities of movements either vertical or lateral :

1) Western Cambay Basin Border Fault,
2) Narmada Fault,
3) Gulf of Kutch Fault,
4) West-coast Off-shore Fault.

These tectonic zones and the related fracturing, according to Dr. Sychanthavong, are the manifestations of the stress distribution derived from the main stress field related to the north-eastward movement of the Indian Plate. This north-east direction represents the movement of the stress field which generates and distributes various kinds of forces into the above four tectonic zones.