

### CHAPTER 3

#### REGIONAL GEOLOGICAL SETTING

The State of Gujarat is divisible into three physiographic divisions e.g. the Mainland, the Saurashtra peninsula and the Kutch peninsula. Geologically these areas comprise rocks ranging from Precambrian to Tertiary. The eastern and the northern parts of the Mainland form a part of cratonic Indian shield made up of Precambrian rocks. The Precambrians include the Aravalli System, the Champaner System, the Delhi System, and the Erinpura and the Malani suite of igneous rocks. A few isolated Mesozoic deposits are seen to occur along the western fringe, of the Precambrian mass. These outcrops include

those around Himmatnagar, Pavagadh, Nasawadi and Rajpipla. The southern and the south western parts of the Gujarat are occupied by Deccan Trap basaltic flows.

The western coastal parts of the Mainland Gujarat and the area in between the Saurashtra peninsula and the Precambrian outcrops of the Mainland form the Cambay basin which was the site of thick sedimentation during the Tertiary period.

The Saurashtra peninsula mainly exposes the Deccan Traps with a patch of Mesozoic sediments around Dhangadhra and Wadhwan and a narrow fringe of Tertiary deposits along its southern and western coast.

### GEOLOGY OF KUTCH

Since Wagad hills forms a major geological province within the entire Kutch basin, it is pertinent to have a general idea of geology of Kutch basin. Figure 3.1 displays the geology of the entire Kutch (After Biswas and Deshpande, 1970).

#### Stratigraphy

A complete sedimentary sequence from Bathonian to Pliocene is exposed in Kutch. However, the

**Fig. 3.1 Geological map of Kutch (After Biswas  
and Deshpande, 1970).**

majority of the area is occupied by the Mesozoic sediments. The main outcropping regions of Kutch form three important provinces namely the Mainland, the Island belt, and the Wagad hills.

Mainly the older rocks from Bathonian to Callovian are exposed along the Island belt in the N while the Mainland of Kutch exposes sediments from Callovian to Pli/estocene together with the Deccan Trap basaltic flows. Mesozoic sediments ranging from Callovian to Neocomian are exposed within the Wagad area.

Mesozoic rocks show E-W regional strike and often occur as high hills in contrast to low lying plains of Tertiary deposits.

Uptil now Waagen's (1873) four fold classification of Kutch Mesozoics i.e. the Pachham, Chari, Katrol and Umia Series has been widely followed in the texts. However, since detailed regional biostratigraphic work is still lacking, Biswas and Deshpande (1970) have suggested a practical mappable rock stratigraphic classification of the Mesozoic sediments. They have suggested three major stratigraphic provinces namely the Mainland, the Pachham Island, and the Eastern Kutch. The stratigraphic classification is shown in Table 3.1.

The oldest rocks Bathonian in age are exposed in the Pachham Island and have been termed as Kaladongar Formation. The rocks of this formation mainly include brown to reddish brown sandstones, siltstones, conglomerates and olive green shales. The lower part of Khadir Formation of eastern Kutch and the lower Jhurio Formation of the Mainland are stratigraphically equivalent to this formation. The Kaladongar Formation is overlain conformably by rocks of Goradongar Formation, consisting of limestones, sandstones and shales. The lower part of Jumara Formation of the Mainland, the upper Khadir Formation of the Khadir and the Bela Islands and lower part of the Washtawa formation of central Wagad are correlatable with the Goradongar Formation of the Pachham Island. The Jumara Formation of the Mainland consists mainly of shales with highly fossiliferous marl bands and sandstone alternations. This formation, because of its high faunal content has attracted many paleontologists.

The Jhuran Formation of the Mainland is divisible into three members, containing sandstone, siltstone and shale alternations.

The Bhuj Formation overlies the Jhuran Formation with a minor disconformity. Bhuj Formation consists of

alternations of hard, ferruginous and white friable sandstones. The friable sandstones are good reservoir of groundwater and occupy considerable areas of Kutch Mainland./ The Wagad Sandstone Formation roughly corresponds with lower Bhuj Formation and Jhuran Formation of the Mainland.

The Deccan Trap lava flows ranging from upper Cretaceous to Paleocene occur only within the Mainland, and show a roughly E-W outcrop pattern. No trap flows occur in the Island belt or the Wagad hills.

A complete Tertiary sequence of rocks from Paleocene to Pliocene is exposed along the western and southern coastal plains of Kutch. These Tertiary sediments are deposited as peripheral transgressions as narrow embayments within the already existing highs of the Mesozoic rocks. The Island belt and the Wagad hills, however, show only a thin peripheral Miocene and Pliocene deposits encircling the Mesozoic hills.

#### Tectonics

The entire Kutch basin is marked by six major uplifts namely the Mainland, the Pachham, the Khadir, the Bela, the Chorar and the Wagad.

The Wagad uplift is bounded by a high angled normal fault to its S while all the other uplifts are bounded by either high angled faults or flexure zones to their N.

The Mainland is marked by one more major fault - the Katrol fault having an E-W strike and occurs in the central part. Along with these master faults, 'bruch-faulten' type structures are developed towards their upthrow side. These structures have been termed as flexure zones and include Northern Range and Katrol Range flexure zones of the Mainland, the Kaladongar and Goradongar flexure zones of the Pachham Island, and the Bela, the Desalpur and the South Wagad flexure zones of the eastern Kutch. These flexure zones are usually marked by asymmetrical anticlines and domes.

#### Intrusives

Kutch is marked by several mafic intrusive bodies, prominent among them are the gabbroic intrusive of Nir Wandh of the Pachham Island, and the doleritic masses of the Varar, Dhinodhar, Nana, Dhrubiya, and Dhardongar etc. of the Mainland.

## GEOLOGY OF WAGAD

The salient points of the geology of the Wagad area as worked out by the author are briefly given here to provide a suitable background to the reader. Detailed descriptions - formationwise and memberwise, have been presented in the subsequent chapters.

The Wagad hills comprise an isolated outcropping region occupying the easternmost part of the Kutch basin and form an important entity of the geology of Kutch. In fact, the outcrops of Wagad divide the Great Rann to the N and the little Rann to the S.

The rocks of the area constitute a Mesozoic sequence with a narrow fringe of Tertiary sediments encircling them. The author has classified the Wagad rocks from base to the top into three formations viz., the Washtawa Formation, the Kanthkot Formation, and the Gandau Formation.

The Washtawa Formation occurs mainly in (1) the central part of the area from Kanthkot in the W to Dabunda in the E, (2) south central parts N of village Washtawa and S of village Chitrod and (3) south eastern parts around Dedarwa-Mewasa (Fig. 1.4). The base of this formation is nowhere exposed. In the

western parts, the basal portion of this formation is made up of shale-sandstone alternations while the upper part is shaly. In the eastern parts the basal shale-sandstone alternations grade upwards into a sandstone sequence. The top of the Washtawa Formation is characterised by a marker conglomeratic mudstone horizon, which is richly fossiliferous, in the western half, while it contains no fossils in the eastern half. This band could be continuously traced all over the area.

The Washtawa Formation is overlain by the rocks of the Kanthkot Formation with a minor disconformity. The Kanthkot rocks occupy far extensive areas of the Wagad as compared to those above and below them. Except for the central and south central areas which are occupied by the Washtawa outcrops, the Kanthkot Formation is exposed from Mae-Manfara-Bharodia area in the W to Hamirpur-Bhimasar-Sae areas in the E (Fig. 1.4). The Kanthkot Formation consists shales and sandstones. Its basal portion is shaly while the upper is dominantly sandy. This formation has been divided into upper and lower on the basis of a marker horizon of conglomeratic sandstone, which is highly fossiliferous (Lower Astarte band). A similar fossiliferous band also occurs on the top of

the Kanthkot Formation (Upper Astarte band) marking a disconformity between the Kanthkot and the overlying Gamdau Formation.

The Gamdau Formation occurs only in the south western part of the area along the Gamdau syncline and as a narrow fringe from Manfara to Kankoi and Bharodia (Fig. 1.4). The Gamdau rocks are mainly thin shale-sandstone alternations and massive sandstones. The top of this formation is nowhere exposed as these rocks gently dip towards W and SW and go beneath the Rann and alluvial cover.

The total exposed thickness of the entire stratigraphic column of Wagad is of the order of 2,000'. Generally, all the formations show a gradual increase in their thicknesses towards W and SW. Regionally, it is seen that, as one traverses from W to E progressively older stratigraphic units are encountered.

As is the case of Kutch Mainland and other areas of Kutch basin, the Wagad also shows a very good conformity of structures with topography. Domes and anticlines usually stand out as hills while synclines form valleys.

The Wagad sediments show a regional E-W structural strike. This E-W trend, as discussed in a later chapter, probably reflects the Precambrian basement trend of the area. The southern limit of the Mesozoic outcrops is bounded by an E-W fault (South Wagad fault). It is a high angled normal fault having the downthrow side towards S, and as such only younger Tertiaries are exposed to its S. In the south western part of the area, another fault having WNW-ESE strike (Kanthkot fault) extends from Manfara in the W to Washtawa in the south central part. It appears to almost merge with the South Wagad fault, S of Washtawa.

An interesting and striking structural feature of the Wagad area is the existence of a number of anticlines and domes with intervening synclines. It is obvious that folding and faulting are interrelated, and the two faults referred to above are flanked by chains of domes to their N. Most these structures show E-W to WNW-ESE axes.

The structures occurring in the northern half of the area including the Chobari nose, the Ramwao syncline, the Wagad anticline, the Tramau nose, the Narada dome, the Dabunda dome, the Sonalwa dome, the Hamirpur dome and the Bhimasar anticline are more gentle and of symmetrical

type. The structures occurring to the N of the Kanthkot fault which includes the Manfara dome, the Kakarwa anticline, the Kanthkot domes, the Nara dome, and those occurring to the N of the South Wagad Fault i.e. the Mae dome, the Wamka dome, the Halrae dome, the Adhoi anticline, the Washtawa dome, the Chitrod dome, the Dedarwa dome and the Mewasa dome exhibit asymmetric pattern with very steep southerly limbs (Fig. 1.4).

The southern chain of domes and anticlines show much complexity and the Washtawa dome, appears to have experienced highest degree of uplift and hence correspondingly exposes the oldest rocks of the area.

The area is intruded by several dolerite dykes, the prominent amongst them being the Badargadh dyke, the Tramau-Lilpur dyke and the Khirai dyke (Fig. 1.4).

**PART II : STRATIGRAPHY, DISPERSAL AND CURRENT  
SYSTEM**