Chapter - 1

GENERAL INTRODUCTION

I. 1. STUDY AREA, LOCATION AND EXTENT:

The area investigated by the author comprise part of Bhuj taluka in the district of Kutch, Gujarat state. It occupies approximately 400 square km of land towards South and Southeast of Bhuj, the district headquarter of Kutch. It further constitute the North, the Central, the Northeast and the Eastern part of the Survey of India Toposheet no. 41E/12, and the Northwest and the Northern part of Toposheet no. 41E/16, between latitudes 23°04'N to 23°15'N and longitudes 69°35'E to 69°47'E (Fig. 1).

Towns and villages where important stratigraphic sections are studied include Bhuj, Madhapar, Kukma, Ler, Hajapur, Reha, Kotada, Jambudi, Chakar, Kera, Baladia, Bharapar and Jadura, with Bhuj on the North, Kukma at the Northeast, Kotada and Chakar on the Southeast and Kera on the Southwest.

Almost all the above places are well connected by fair weather roads or by asphalted roads. State highways connecting Bhuj-Mandvi and Bhuj-Mundra are passing through the area. Bhuj, the district headquarter, is also an important station of Western Railway on Nalia-Ahmedabad and Palanpur metergauge railway section, and is connected with Ahmedabad by national highway no. 8A. State transport buses are plying regularly on all roads. Bhuj is connected with Ahmedabad and Bombay by daily air service.

I. 2. SCOPE OF WORK:

The Mesozoic rock sequence is well exposed and widely distributed, in the area of study. Deposition of these rocks, is almost continuous since Middle Jurassic to Lower Cretaceous without major break.

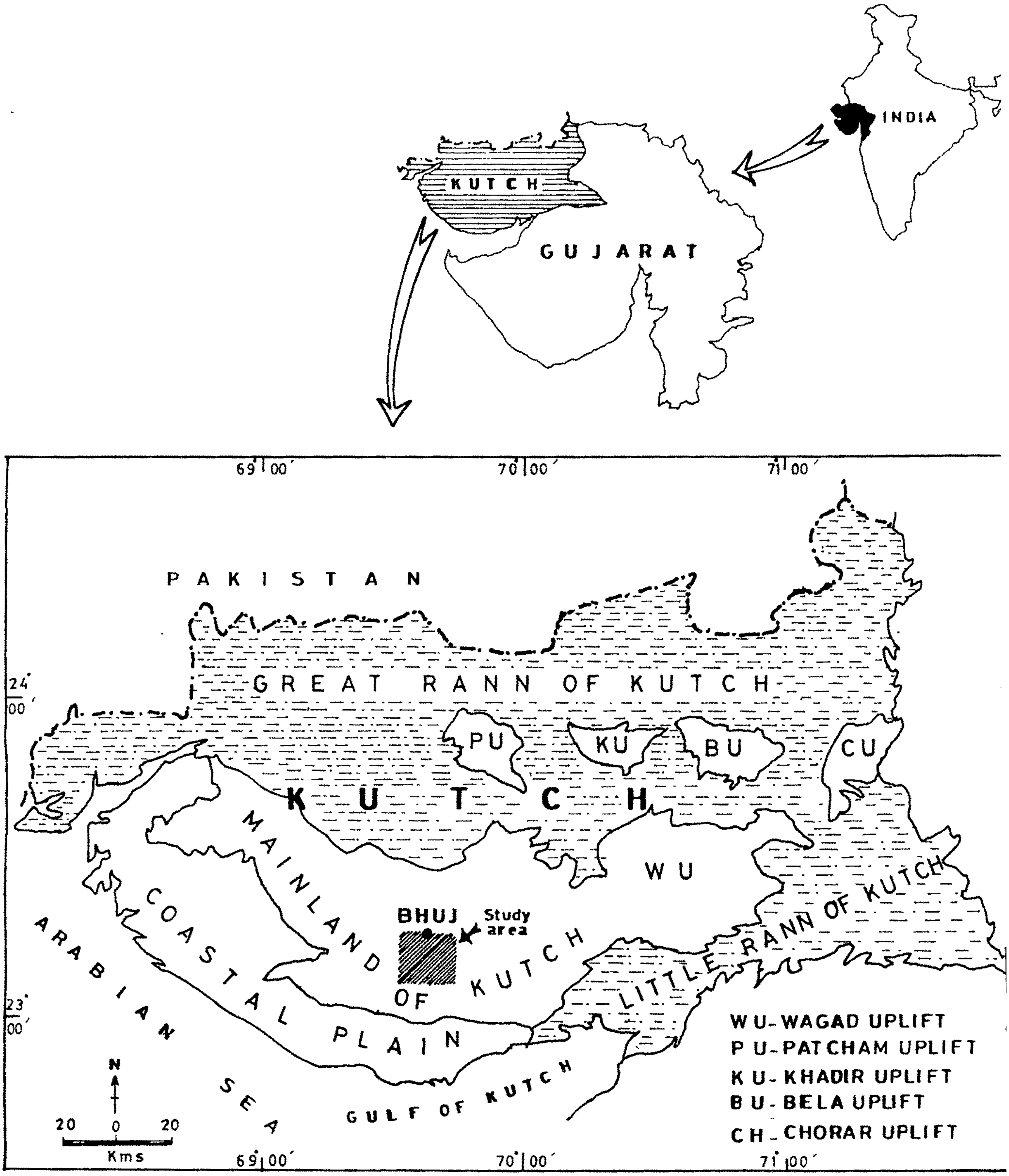

FIG. 1. LOCATION MAP OF THE STUDY AREA

The rocks are further well known for their wealth of mega and microfossil and floral contents. The great potentials of trace fossil assemblages within these rocks, which the author intends to investigate, however, have not been explored as yet and wide scope is available for their study. In fact, the whole area, as such, constitutes an ideal site for study of the clastics and their contained trace fossils along with varieties of primary sedimentary structures, depicting major and minor geological events that took place during the Mesozoic time when these rocks were being deposited.

I. 3. AIMS AND OBJECTIVES:

The author proposes a range of studies to meet the following objectives:

1. Acquisition of new data, based on ichnologic and stratigraphic events.

2. Integrated sedimentologic, stratigraphic and palaeoecologic interpretations.

3. Demarcation of major and minor episodes that took place during various stratigraphic time intervals.

4. Interpretation of the sedimentological and ichnological information in context with the depositional and palaeoenvironmental understandings.

5. The investigation is further aimed at studying in detail different trace fossils in relation to their stratigraphical, sedimentological, ethological, palaeoecological and environmental backgrounds and interpret the geological history from such traces and trace fossil associations and their distribution in time and space.

6. Whenever possible, it is also intended to workout details of the individual traces in relation to their possible originators and environmental implications under which they lived.

7. The other major objective of the author will be to trace the vertical and lateral facies changes in the sedimentary sequence in space & time, and further view these changes in light of the global events.

8. Finally based on the information thus obtained the author intends to present a sedimentological model.

I. 4. METHODOLOGY AND APPROACH:

Geological fieldwork was carried out with the help of Survey of India toposheet no. 41E/12 & 41E/16.

During the course of preliminary reconnaissance, geological maps by Wynne (1872), and the geological and tectonic map by Biswas and Deshpande (1970) were used. The entire area has been remapped by the author on scale 1:50000. Use of aerial photographs was also made to check the ground details and the information so obtained was also incorporated in the geological map prepared by the author (fig. 6). Stratigraphic sections at 28 localities were examined in detail by measuring the exposed succession in stream beds, on ridge crests, on cliff faces and quarry walls, in the open fields and any other place where there was a reasonably continuous outcrop. At the same time occurrences of important physical and biogenic structures were carefully noted, and photographed.

Following information at the outcrop level was collected at the time of section measurement: (a) Thickness and geometry of the beds, (b) Relationship of the lower & upper contacts with the underlying and overlying beds, (c) Approximate grain size and gradation, (d) Rock type, (e) Colour, (f) sedimentary structures, (g) Palaeocurrent measurements, (h) Trace fossils, (i) Body fossils, (J) Miscellaneous features.

Stratigraphic samples were collected from different stratigraphic levels covering full sequences and were further subjected to the laboratory studies. Particular attention was given to the trends of the sedimentary and biogenic structures and these were further photographed. Wherever possible trace fossil samples were collected for finer laboratory studies.

A final detailed tracing of the exposure showing the various lithologic units, contacts, sedimentary and biogenic structures, was used to evaluate environmental analysis of the sequence.

As suggested by Miall (1985), the first step was the establishment of the framework of major sequences, through detailed lithostratigraphic correlation. The next step was to interpret each sequence in terms of its component depositional systems, using sedimentological data, the principles of facies analysis and basin mapping methods. Within each depositional system it was then possible to recognize units on the basis of genetic criteria. Wherever required these units were defined and named for the convenience of interpretation.

Based on the field and laboratory studies different illustrations and diagrams were prepared in order to show:

(i) The abundance and distribution of trace fossils in different stratigraphic units.

(ii) The ethological distribution of traces.

(iii) Distribution of ichnocoenoses (trace fossil assemblages).

(iv) Graphical sections to show the distribution of ichnological events.

The overall approach used by the author has been to describe what was actually seen in the sediments first, and then to discuss what kind of interpretations could be made from them.

All this information, thus, obtained has finally been utilized to postulate a sedimentation model of the clastic depositional event in the central part of Kutch.

I. 5. OBSERVATION AND RECORDING OF TRACE FOSSILS:

Although special techniques are required to study the trace fossils, the best approach is to study the variously oriented cross sections provided by bedding and joint surfaces. Experience, knowledge of the way that modern animals move through sediments and a vivid imagination are also helpful as suggested by Lindholm, 1987.

In order to observe, measure and record the trace fossils effectively, the following set of information was gathered based on the following questionnaire (after Collinson and Thompson, 1982).

The first set (Q. 1) attempts description of the morphology of preserved structures; the second group (Q. 2 & Q. 3) discusses the mode of preservation; and the last group (Q. 4 to Q. 8) describes the position and process of preservation.

Q. 1 What is the morphology of the trace fossil? Are there identifiable shapes of organisms or parts of them? Can the trace be described as:

(a) a single shape (e.g. a print or track made by a foot);

(b) several similar shapes repeated to form a pattern (e.g. a track made during locomotion);

(c) a trail (i.e. a continuous groove made during locomotion);

(d) a radially symmetrical shape developed in a horizontal plane (e.g. by the resting of a star fish);

(e) a tunnel or shaft caused by a burrower seeking food and/or refuge;

(f) a series of spreiten, which are U-shaped, closely related, concentric laminae caused by an animal shifting the location of its burrow as it grows or moves upwards, downwards, forwards and backwards by excavating and backfilling;

(g) a pouch shape, for example caused by the resting of bivalves;

(h) a network pattern.

Q. 2 Is the trace fossil preserved as a cast or mould? Is there evidence that the fill was passive i.e. by normal sedimentation, or active, for example, the back-filling action of a burrower?

Q. 3 Is the trace fossil preserved as a diagenetic concretion? *Chondrites, Rhizocorallium, Thalassinoides*, and *Ophiomorpha* are often preserved as calcite and siderite nodules in shale or limonite nodules in sand. Small diameter burrows are often preserved in pyrite, which oxidizes to red-brown goethite, in flint or chert. These features are often distinguished by burrow margins with different chemical and physical compositions.

Q. 4 Is the trace fossil preserved in an inter-facial position on the top of the casting medium as an epichnial trace like a ridge (positive feature) or a groove (negative feature)? Are there any marks on the top or bottom of the ridges and grooves?

Q. 5 Is the trace fossil preserved in an inter-facial position on the bottom of the casting medium as a hypichnial trace, e.g. a ridge or groove? If so, is there any evidence that this was a sediment/water interface? Was the trace fossil preserved at a sediment/sediment interface, possibly between contrasting lithologies, possibly at a concealed junction? Are the underlying and overlying laminae deformed?

Q. 6 Is the trace fossil preserved with a bed but out side the main body of the casting medium as an exichnial trace? Here the traces of one lithology (e.g. sandstone) are isolated in a different lithology (e.g. shale).

Q. 7 Is the trace fossil preserved in an internal position within the main body of the casting medium as an endichinial trace? Are the burrows very densely distributed and interpenetrating? If so, the sediments should be referred to as having a bioturbate texture.

Are the burrows common but distinct? If so, the term burrow mottling may be more appropriate. Are the structures preserved in full relief? Is the wall of the cast of different composition from the body of the cast, as when a burrow in sand is lined by a layer or layers of mucus and/or faecal pellets made of mud. Does the trace contain internal structures, e.g. spreiten?

Q. 8 Is the trace preserved by burial following erosion, i.e. is it a derived trace fossil? This arises when, after burrowing, erosion takes place and currents winnow away a soft matrix leaving the mucus bound burrow linings as sediment filled gloves. These can be covered by later, possibly different, sediments. Alternatively currents may scour out burrows made in mud and afterwards fill them with sand.

I. 6. TECHNIQUES IN ICHNOLOGY:

The study of trace fossils requires one to try and relate fragmentary two dimensional patterns to complex three dimensional records and behavior left by a diverse range of organisms. A wide range of techniques have been developed. These include acid etching, base etching, sand blasting, staining, serial sectioning, x-ray radiography, infrared and ultraviolet photography, peeling by polyester resin, lacquer, epoxy resin, casting using plaster of Paris, silicon, rubber, polyester resin etc. The senckenberg box and the can cover are the most satisfactory devices for sampling both intertidal environments and in modified form - offshore regions. Relative merits of each of these techniques, however, depend on the likely problems one has to encounter.

In the present study the author has concentrated on the following cheaper and simple techniques for the trace fossil studies.

Most of the trace fossils were photographed in the field. Such samples that could be conveniently removed in the field were brought to the laboratory for their finer details. It should be noted that the photography of trace fossils requires a style slightly different from that adopted with body fossils. Burrows are generally accentuated by wetting the rock surface or by smearing ink over it and then washing it off. Ink smearing process is a stain controlled by differences in porosity. Alizarin red and methylene blue are preferentially absorbed by clay minerals and thus are useful in dealing with trace fossils in fine grained sediments.In instances traces having delicate claw scratches or other fine details, whitening by chalk dust and photography in strong side light advantageously produces good results. Many of the staining techniques normally performed indoor were also applied for the outdoor photography. Spraying carbonate cemented rocks with dilute HCl or siliceous rocks with KOH was advantageously used to increase relief on fresh faces or rock surfaces.