

# Stratigraphy of Sir Edmund Lake and Godpar area, Southwest of Bhuj, Kachchh, Gujarat, Western India

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**Abstract**— Detailed study of the stratigraphy of Sir Edmund Lake and Godpar area was carried out. Study area falls in Kachchh Mainland and lies in southwest of Bhuj on Mandvi road. The study area comprises of rocks of Bhuj Formation, which is divided into two members that are Lower Member and Upper Member. Stratigraphically, the lower boundary of the Bhuj Formation with Jhuran Formation is sharp and distinct. The relation is parallel unconformable junction to overlapping sequence. The boundary between the Lower and Upper Members of Bhuj Formation can be fixed by cross-bedded sandstones, which are overlain by highly bioturbated ferruginous sandstones of the Upper Member of Bhuj Formation. The uppermost boundary of the formation is unconformable. It is also the topmost part of Mesozoic sedimentary sequence. The age of the Bhuj Formation can be given from Neocomian to at least Santonian i.e. Lower Cretaceous.

**Key words:** Stratigraphy, Sir Edmund Lake, Godpar, Bhuj, Kachchh

## I. INTRODUCTION

Kachchh has crescent shaped outline and topographically resembling tortoise in shape and hence named accordingly. The Kachchh region forms an important site of Mesozoic and Cenozoic sedimentation. The Kachchh sedimentary basin, extending from the Great Rann of Kachchh in the north to the Kathiawar (Saurashtra) peninsula in the south, is typically a peri-continental embayed basin occupying a rifted graben [6]. The Mesozoic rocks exposed in the region range in age from Callovian to Albian i.e. Upper Jurassic to Lower Cretaceous and are overlain by the Deccan Traps. Milliolitic sandstones of Quaternary age are exposed along valleys and on gentle hill slopes. As per the lithostratigraphic classification of [5] the Mesozoic sediments are classified in to four units – Jhurio Formation, Jumara Formation, Jhuran Formation and Bhuj Formation. Kachchh Mainland lies to the south of Banni and extends up to the Gulf of Kachchh. The study area falls in the Kachchh Mainland and is approximately 20 km away from the Bhuj city on Mandvi road.

## II. STRATIGRAPHY

Stratigraphy of the study area comprises of rocks of Bhuj Formation (Figure 1).

### A. Bhuj Formation

The name of the formation has been given from its type locality around the city of Bhuj, where these rocks are very well exposed. It is the youngest Mesozoic Formation of the Mainland Kachchh, represented by marginal marine rocks. This formation is defined by the marine beds of the Jhuran Formation below and the Deccan Trap lava flows above. Rocks of Bhuj Formation are exposed extensively in the Mainland Kachchh and almost occupying about 3/4<sup>th</sup> of total

area of the Mesozoic outcrop. Being composed chiefly of soft friable sandstones, the formation is easily weathered out forming the low lying sandy plains. These are good aquifers, so the low lying plains are highly cultivated. In fact, it is one of the key features of the formation that after barren hard exposures of sandstones of Jhuran Formation, the highly cultivated plains indicates the starting of Bhuj Formation. The lower boundary of Bhuj Formation with Jhuran Formation is unconformable to overlapping. This unconformity exists between sandstones of Jhuran Formation and rhythmic alternation of ferruginous bands and shales of Bhuj Formation. The upper boundary is very sharply defined below the Deccan Trap lava flows. These lava flows rests on the eroded undulating surface of Bhuj Formation, which is indicating long exposure to erosion for the formation.

The rocks of the formation are exposed in form of east-west trending plains bordered in south by Deccan Trap range, which is lying south of Charwar range. Bhuj Formation informally divided into two members that are Lower Member and Upper Member (Figure 1) and are described as follows.

### 1) Lower Member

The typical section is exposed just north of Godpar village. The coordinates of the section are 23° 07' 21.76" N latitude and 69° 32' 48.24" E longitude. It is 690 m due NNE of Godpar village. Another beautiful section exposed just south of Sir Edmund Lake which is nearer to the previous section. The member is characterized by cyclic repetition of ferruginous or lateritic bands, shales and sandstones. The thickness of the sandstone increases, while thickness of the shales, siltstones and ferruginous bands decreases and completely vanish in the upper part of the sequence.

The sandstones exposed in different parts of the study area are yellowish, reddish-ferruginous, fine to coarse grained, soft, friable, well sorted and intercalated with shale and siltstone in lower part, while towards top it is thick, coarse grained to gritty and cross-stratified. In the lower part along the partings of shale-siltstone, bioturbation is abundant which is found at Sir Edmund Lake (Plate 1a and 1b) as well as near Godpar stream. Shales are yellowish, pinkish and black-carbonaceous intercalated with ferruginous bands. Ferruginous bands are characterized by hematitic or lateritic nature with spongy or nodular weathering. At places glauconitic bands are also encountered along these partings. Siltstones are gray to white and calcareous in nature containing minute mica flakes.

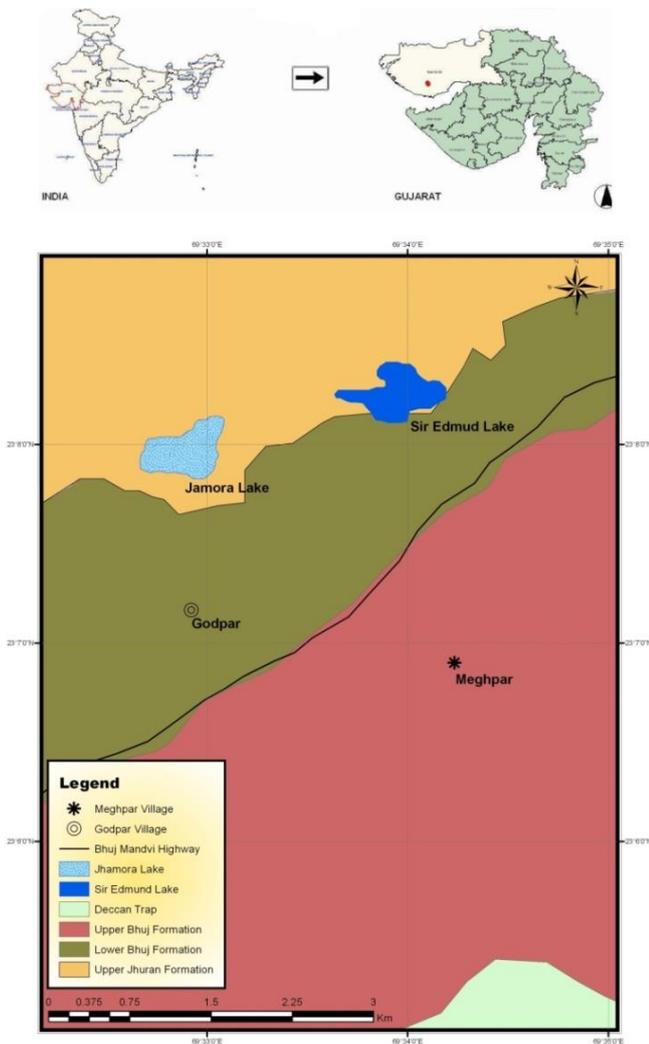


Fig. 1: Geological Map of the Study Area.

Stratigraphically, the lower boundary of the member with Jhuran Formation is sharp and distinct. Lithologically the lowermost beds of the member are rhythmic alternation of ferruginous bands and shales, which are lying above the sandstones of Jhuran Formation. The relation is parallel disconformable junction to overlapping sequence. The upper boundary can be fixed by cross-bedded sandstones, which are overlain by highly bioturbated ferruginous sandstones of the Upper Member of Bhuj Formation.

Among the sedimentary structures trough cross-stratification, hummocky cross-stratification, ripple marks, interference ripple marks with development of hummock structure, load cast, inverse grading, air trap structure and box work on the surface of fine grained ferruginous band are found in the study area. Low and high-angle planar cross-stratification and the overall paucity of bioturbation suggest middle to upper shoreface setting [3]. Minor faults are also common which displaces the strata vertically 5-7 inches as found on Bhuj-Mandvi road.

Faunal content is very less in this member. Only bivalve casts are found from Sir Edmund Lake. Fossil wood encountered from north of Godpar. It is rich in fossil flora, which containing several plant species allied to Upper Gondwana flora, found from carbonaceous shale beds exposed in the north of Godpar. Common forms reported earlier are species of *Ptylophyllum*, *Williamsonia*,

*Brachyphyllum*, *Pecopteris*, *Aurocarites*, *Taeneopteris*, *Cladophlebis*, *Equisatum*, *Elatocladus* etc [5]. Bioturbation – trace fossils abundantly preserved in the lower part of the member, while in the upper part sandstones having very less and indistinct bioturbation. It includes *Didymaulichnus*, *Gyrochorte*, *Monocraterion*, *Oldhamia*, *Ophiomorpha*, *Palaeophycus*, *Skolithos* and *Trichichnus*.

The micro / macro-spores from the Ghuneri and Trumbow coal beds [4] indicate that the Ghuneri and lower member of Bhuj Formation are equivalent and correlatable with Wealden Formation of England. Reference [7] from leaf impressions of the Lower Member came to similar conclusion. This indicates a Neocomian age, i.e. Berriasian-Hauterivian for the lower member of Bhuj Formation [5].

## 2) Upper Member

Upper Member of Bhuj Formation is beautifully exposed just south of Godpar village along a stream as well as south of Sir Edmund Lake on Bhuj–Mandvi road. Here, it is characterised by cyclic repetition of ferruginous sandstones and variegated shales. It is represented by buff and pink coloured medium to coarse grained, poorly sorted, friable, massive, current bedded, felspathic sandstones. At places, it is gritty and micaceous. Near Dahisara it is quarried also as a building stone. In the lower part intercalations of shale-siltstone beds are common along with ferruginous bands at regular intervals. Shales are yellowish brown, grayish, red-ferruginous and black-carbonaceous having plant fossils in it. Yellowish to red, micaceous siltstones are also alternating these beds. Like the Lower Member, in Upper Member also there occurs a rhythm in the sedimentation.

Stratigraphically, the lower boundary of the Upper Member with underlying Lower Member is distinct. It can be defined by the lowermost beds, which are rhythmic sequences of highly bioturbated ferruginous sandstones. These sandstones are having abundant bioturbation and ferruginous in nature (Plate 1c and 1d), which might be developed during the sub-aerial exposure of the area. The upper boundary of the member is unconformable. It is also the topmost part of Mesozoic sedimentary sequence. A zone of weathered sandstone lying beneath the Deccan Trap lava flows indicate long exposure to erosion before it being covered up by lava flows.

Rocks of the member are horizontal to sub-horizontal with comparatively less sedimentary structures because of intense bioturbation, which obliterate the sedimentary structures. Ripple marks and structures produced due to differential erosion of wind action are also observed in the stream of Godpar area (Plate 1e and 1f). Plant rootlets in the rocks support terrestrial conditions in the uppermost part of the sequence.



Fig. 2: (a) and (b) Section of Lower Member of Bhuj Formation exposed at Sir Edmund Lake, (c) and (d) Highly ferruginous and bioturbated sandstone of Upper Member of Bhuj Formation, (e) and (f) Structures produced due to differential erosion of wind action.

The member is devoid of any fossil fauna, but it is rich in fossil flora containing several plant beds in the carbonaceous shales and sandstones. Fossil wood and plant debris are beautifully preserved in highly ferruginous gritty sandstones of the study area. Trace fossils are abundant in the lowermost bed of the member, while towards upper part bioturbation is scarce and indistinct. It comprises *Diplocraterion*, *Monocraterion*, *Pholeus* and *Skolithos*. Higher bioturbation intensities reflect longer hiatuses between depositional events [1].

The plant beds are considered to be younger than the Jabalpur series and basal Cretaceous in age [2]. Reference [8] on palynological evidences fixed the upper limit as Santonian.

### III. CONCLUSIONS

Rocks exposed around Sir Edmund Lake and Godpar area belongs to Bhuj Formation, which marks the topmost part of Mesozoic sedimentary sequence. Informally they are divided in to two members Lower and Upper. Boundary characteristics are distinct. The boundary between the Lower Member with the underlying Jhuran Formation is disconformable and overlapping. Both the members of the Bhuj Formation can be separated by first band of highly ferruginous and bioturbated sandstone of the Upper Member. The age of the Bhuj Formation can be given from Neocomian to at least Santonian i.e. Lower Cretaceous.

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