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# THE NEOGENE FORAMINIFERAL BIOSTRATIGRAPHY OF EAST PAKISTAN

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The stratigraphy of East Pakistan with reference to its foraminiferal fauna is described. The exposed rocks of East Pakistan are post-Oligocene in age, although the oldest formations are encountered in subsurface drilling. Most of these formations are barren of foraminifera, except the Surma series which is characterized by nondiagnostic species of benthonic foraminifera referable to *Rotalia beccarii* group and few Miliolids. These species are characteristic of brackish water environments, thus it is inferred that the Surma series was deposited in a shallow brackish water environment.

The area of East Pakistan is mostly covered by Recent alluvium, with the exception of the short belt in the eastern region which is covered by older geological formations. These latter formations are Oligocene to Pleistocence in age, and are exposed in a continuation of the Arakan mountains of Burma.

The East Pakistan formations which are exposed are of younger geological ages ranging from Oligocene to Pleistocene in age. Although the older formations are encountered in subsurface drilling, and are exposed in the western part of East Pakistan and in the Assam area of India. These formations are a monotonous sequence of sandstone and shale. The foraminiferal assemblages of these formations are meagre, except from the Surma series where some nondiagnostic benthonic forms were recorded. Several hundred samples of different formations were examined, but none of these formations has yielded any diagnostic foraminifera species.

## Stratigraphy

The stratigraphy of East Pakistan is simple which is mainly confined to the Neogene in age. These younger formations are severely effected by the Himalayan orogeny, which is evident in the form of folding and faulting. The north–south trending anticlines to the east and southeast of the alluvial area are tightly folded and characterized by widespread faulting and thrusting.

The generalized stratigraphic succession of East Pakistan is as follows:

| Series | Stage | Geological age |
|---|---|---|
| Dihing | | Pleistocene to Pliocene |
| Tipam | Tipam sandstone<br>Girujan clay<br>Dupi Tila beds | Pliocene to Upper Miocene |
| Surma | Bhuban<br>Boka Bil | Lower Miocene to Upper Oligocene |

*Sumra Series (Upper Oligocene to Lower Miocene)*

These are the series of alternating shale, sandstone, mudstone and conglomerates, which are about 20,000 feet in thickness. These series are further divided into two stages i.e. Boka Bil and Bhuban stages.

*Bhuban Stage.*—This consists of an alternation of sandstone, shale and conglomerate. The Bhuban stage is further subdivided into three substages, which are as follows:

Upper Beds: It is composed of sandstone, sandy shale and conglomerate.

Middle Beds: It is mainly shale and sandy shale with minor amount of conglomerates.

Lower Beds: Lithologically it is composed of sandstone, shale, sandy shale and conglomerates.

The division of Bhuban stage is based on the lithological differences, as these beds are almost devoid of any diagnostic species, except for a few species of benthonic foraminifera which were recorded from these beds. A good collection of molluscan fossils were reported which are believed to be of Aquitanian age.

*Boka Bil Stage.*—Lithologically these beds are composed of sandy shale and ferrogenous sandstone forming the upper division of Surma series. It forms a sort of passage from the Bhuban stage into the Tipam sandstone stage of succeeding Tipam series. Few benthonic foraminifera species were recorded from this stage. On the basis of the mega fossils, Pinfold[6] assigned this stage to Burdigalian age.

*Tipam Series (Upper Miocene to Pliocene).*

This series is composed of ferrogenous sandstone, shale, sandy shale, mottled clay, coal and conglomerate. Fossil wood and lignite are common and well preserved. The fauna of this series is of little value in age determination, but suggests the Upper Miocene to Pliocene age for the Tipam series. The Tipam series is divided into three divisions or stages, i.e. Dupi Tila beds, Girujan clay and Tipam sandstone.

*Tipam Sandstone.*—It is composed of coarse, greenish ferrogenous sandstone with some conglomerate, shale and occasional fossil wood and lignite.

*Girujan Clays.*—It is composed of mottled clay with subordinate sandstone containing fossil wood and lignite.

*Dupi Tila Beds.*—It is composed of sandstone, grits and conglomerate, with many lignite intercalation.

*Dihing Series (Pliocene–Pleistocene)*

This series is mainly composed of conglomerate with subordinate sandstone and clay, overlying the Tipam series. The Dihing series marked the last phase of sedimentation in East Pakistan. This series has been subjected to intense folding and faulting.

### Foraminiferal Fauna

The sporadic occurrence of a few benthonic species of foraminifera was recorded from the Surma series, which were localized to a few samples of Upper Bhuban beds and Boka Bil stages. The faunal association of the various formations are as follows:

*Bhuban Stages.*—The lower and middle beds of the Bhuban stage have not yielded any foraminifera, only the Upper Bhuban beds are characterized by the presence of *Rotalia beccarii* (Linne), and in some of the samples these species have been recorded in fair abundance. A few species of *Quinqueloculina* and Ostracods are recorded but these were nondiagnostic in character.

*Boka Bil Stage.*—Except for the *Rotalia beccarii* (Linne) and *Cibicides* sp. no foraminifera have been recorded from the samples of these beds.

*Tipam and Dihing Series.*—Neither of these series has yielded any foraminifera.

### Age Determination

There is a complete absence of any diagnostic forms, which could be helpful in the age determination of these deposits. The sporadic occurrence of the benthonic foraminifera species is the only evidence which is available from the Upper Bhuban beds and Boka Bil stages.

*Rotalia beccarii* (Linne), *Cibicides* sp. and *Quinqueloculina* sp. are the foraminifera which have been recorded from the Surma series. *Rotalia beccarii* (Linne) is the species which has been dated from Miocene to Recent in occurrence from various formations and localities of the world. Thus on the evidence of *Rotalia beccarii* (Linne) the Upper Bhuban and Boka Bil stages may be assigned to Lower Miocene age but no concrete evidence is available on the basis of the foraminifera. On the evidence of Molluscan fauna these deposits were assigned to Upper Oligocene to Lower Miocene by Pinfold.[6]

The Tipam and Dihing series are proved to be barren and none of the foraminifera is recorded from these samples. The megafossils of these series are of little value in age determination. As these deposits are rich in fossil wood and lignite thus more precise age determination of these fors mations are required from the other microfossils such as spores.

STRATIGRAPHIC CHART OF FAST PAKISTAN

| Geological Age | | Series | Stages | | Lithology | Fauna |
|---|---|---|---|---|---|---|
| Pleistocene | | Dihing | | | Cg with SS + clay | Barren |
| Pliocene | | Tipam | Dupi Tila bed | | SS + Cg with lignite | Barren |
| Miocene | Upper | Tipam | Girujan clay | | Clay + SS with lignite | Barren |
| | | Tipam | Tipam | | SS with Cg + Sh with lignite | Barren |
| | Lower | Surma | Boka Bil | | Sandy Sh + ferrogenous | *Rotalia beccarii* *Cibicides* sp. + *Quinqueloculina* sp. |
| | | Surma | Bhuban | Upper beds | SS Sh + Chg | *Rotalia beccarii* *Cibicides* sp. + *Quinqueloculina* sp. |
| Oligocene | | Surma | Bhuban | Middle beds | Sh + Cg | Barren |
| | | Surma | Bhuban | Lower beds | SS Sh + Cg | Barren |

## Paleoecology

The paleoecological environment at the time of deposition of these sediments is difficult to infer, because most of these formations are devoid of characteristic benthonic foraminifera. However, *Rotalia baccarii* which is found in the Upper Bhuban and Boka Bil stages is a good index fossil for paleoecological interpretation. The present occurrence and the past geological record of this species indicates that *R. beccarii* assemblages flourished in a brackish water environment or in stagnant water with low oxygen content and high organic content. *R. beccarii* assemblages is also associated with the species of *Quinqueloculina* and *Cibicides*, and to few Ostracods. The association of *Quinqueloculina* and *Cibicides* are indicative of shallow brackish water environment rather than to the stagnant water environment.

Thus on the evidence of these benthonic foraminifera the Upper Bhuban beds and Boka Bil deposits are considered to be laid down in a brackish water environment. The Tipam and Dihing series are completely barren of foraminifera, and it is believed that they were deposited in continental or nonmarine environments. This view is also supported by the presence of lignite and fossil wood in the Tipam series.

## Summary

East Pakistan is mostly covered by the Recent alluvium, with the exception of the eastern region where the older geological deposits are exposed, which are mostly post-Oligocene in age. The Surma, Tipam, and Dihing series are the monotonous sequence of sandstone, shale, clay and conglomerate. The foraminifera assemblages is only confined to Surma series, which are sporadic in occurrence.

The Surma series is characterized by few benthonic foraminifera belonging to the genera *Rotalia beccari*, *Quinqueloculina*, and *Cibicides*, which are indicative of brackish water assemblages of the present environment. Although these benthonic species are nondiagnostic for age determination, but on the meagre evidence of these species the deposits are considered to be of Upper Oligocene to Lower Miocene age.

The Tipam and Dihing series are completely barren from the foraminifera, and believed to be nonmarine in origin, as they are characterized by the plant fossils and lignite deposits.

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