

# Micropalaeontology and Depositional Environment of the Early Eocene Margala Hill Limestone and Chor Gali Formation of the Khairi Murat Range, Potwar Basin, Pakistan

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## ABSTRACT

The Early Eocene Margala Hill Limestone, Chor Gali Formation and the Middle Eocene Kuldana Formation are exposed along the Khairi Murat Fault in the Khairi Murat Range, Potwar basin. The carbonate rock units of the Khairi Murat Range contain a variety of benthonic foraminiferal genera such as *Assilina*, *Nummulites* and *Alveolina*. The presence of Early Eocene benthonic foraminiferal assemblages and dolomitization in the carbonate sequence of the Margala Hill Limestone and the Chor Gali Formation indicates a shallow marine, shelf and intertidal to supratidal environment of deposition.

## INTRODUCTION

The Khairi Murat Range is located in the northern part of the Potwar Basin on Survey of Pakistan Topographic Sheet 43 C/11. The Khairi Murat Range is formed by uplift along the Khairi Murat Fault. The eastern part of the Khairi Murat Range of the North Potwar Deformed Zone (NPDZ) of the Potwar Basin has been selected for a detailed micropaleontological study and environment of deposition (Figure 1). The area lies between longitude 72°, 40' E to 72°, 45' E and latitude 33°, 25' N to 33°, 30' N.

The Eocene to Miocene sequence is exposed in the Khairi Murat Range. This sequence includes the Margala Hill Limestone, Chor Gali Formation, Kuldana Formation and the Murree Formation (Table 1; Figure 2). The Murree Formation is exposed on the southern and northern parts of the Khairi Murat Range. The Chor Gali Formation is exposed in the core of the Khairi Murat overturned anticline. The Khairi Murat Fault has thrust the Early Eocene Margala Hill Limestone over the Middle Eocene Kuldana Formation.

Jurgen and Abbas (1991) carried out detailed work on Chor Gali Formation at the type locality. Mujtaba et al., (1989) and Mujtaba (1999) have extensively studied the depositional and diagenetic environment of the Chor Gali Formation.

In this study, an attempt has been made to interpret the micropaleontology and depositional environment of the Early Eocene carbonate sequence of the Khairi Murat Range of the Potwar basin.

## METHOD OF STUDY

Various carbonate beds of the Margala Hill Limestone and the Chor Gali Formation were selected for micropaleontological and petrographical study, including thin section analysis. Collection of rock samples was undertaken along the Chor Gali Pass in the Khairi Murat Range. Thirty

rock samples were collected from the Chor Gali Pass section at an interval of four meters. Among these, twenty thin sections were prepared for the micropaleontological studies. Fourteen species of smaller and larger benthic foraminifers were identified from the Margala Hill Limestone and the Chor Gali Formation.

## LITHOSTRATIGRAPHY

The Early Eocene carbonates of the Margala Hill Limestone and Chor Gali Formation are well exposed in the Khairi Murat Range (Figure 2). The lithological make-up of these formations in this region is described below.

## MARGALA HILL LIMESTONE

The Margala Hill Limestone of Latif 1976 (Shadara Village near Islamabad), has been formally accepted by the Stratigraphic Committee of Pakistan (Shah, 1977) for the Nummulitic Formation of Waagen and Wynne (1872). Middlemiss (1896) regarded this formation as a part of "Nummulitic series". The name is derived from Margala Hills in Hazara, District Abbottabad. The Margala Hill Limestone is grey to dark grey, massive, fine to medium grained and hard with diffuse nodularity. The limestone is dolomitic, fossiliferous and fractured. Calcite veins are abundant and irregularly placed throughout the unit. The unit is 10 meters thick in the Chor Gali Pass (Table 2). Its lower contact with the Kuldana Formation is faulted in the area and the upper contact with the Chor Gali Formation is conformable.

## CHOR GALI FORMATION

The name Chor Gali beds of Pascoe (1920) has been formalized as the Chor Gali Formation by the Stratigraphic Committee of Pakistan (Shah, 1977) after the Chor Gali Pass in the Khairi Murat Range. The Chor Gali Formation is the last marine facies and is dominantly composed of limestone and shale (Mujtaba, 1999). The lower part of the formation is mainly limestone with minor shales. The limestone is creamy, dolomitic, cherty and mediumly bedded. Algal mats are also present in the lower part. The upper part of the Chor Gali Formation consists of khaki, greenish, blackish and brownish colour shales. Shale is splintery and calcareous in nature. The thickness of the formation at the type locality (Chor Gali Pass) is 91 meters (Table 2). The lower and upper contacts with Margala Hill Limestone and Kuldana Formation are conformable.

## BIOSTRATIGRAPHY

The Margala Hill Limestone and the Chor Gali Formation are fossiliferous and contains a wide variety of larger benthic

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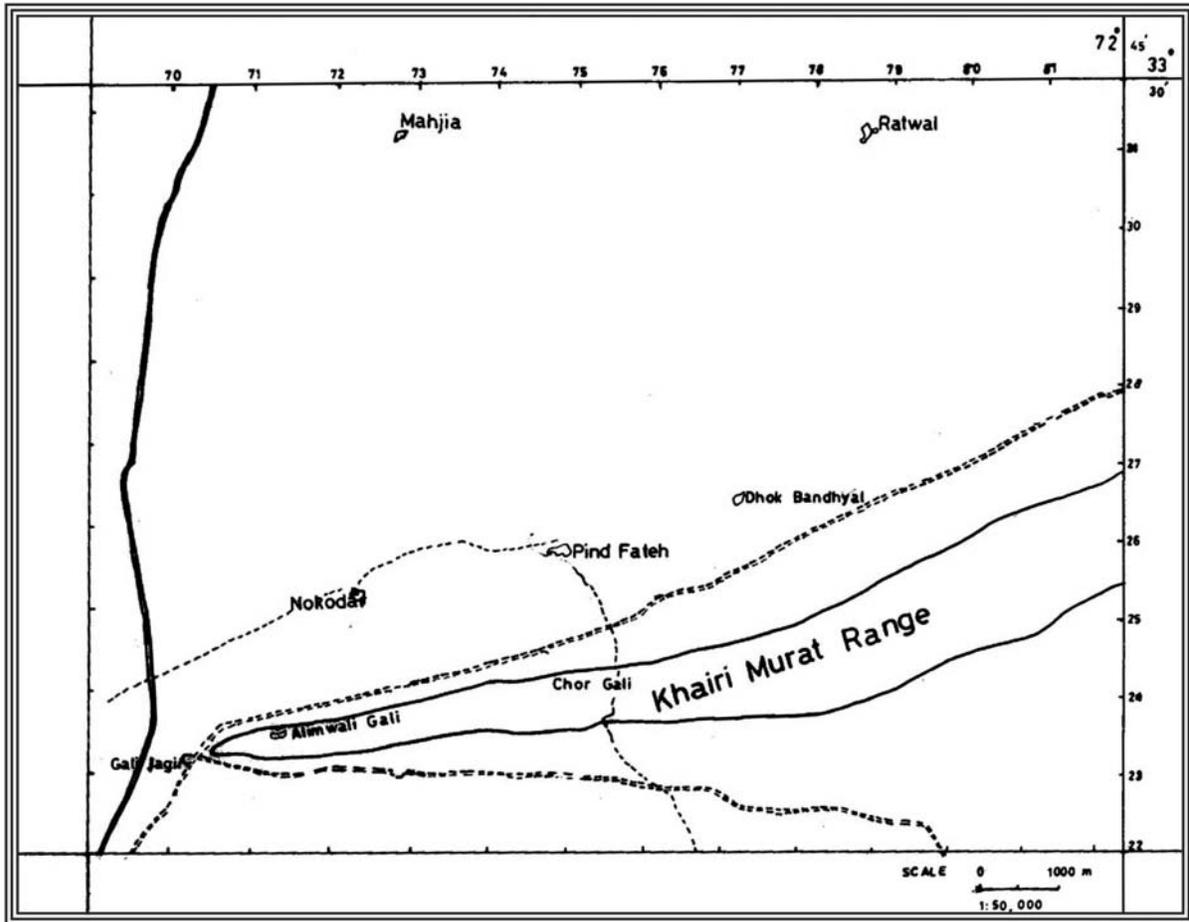


Figure 1- Location map of the study area.

Table 1- Stratigraphic sequence of the Khairi Murat Range area.

AGE	FORMATION	DESCRIPTION
Miocene	Murree Formation	Cyclic beds of sandstone and shales. Sandstone is Purple, grey, dark grey and greenish grey and thickly to massively bedded. Shales are of purple and reddish brown color. Intraformational conglomerates are also present.
Middle Eocene	Kuldana Formation	Greenish grey, yellow, brown, silty shale with subordinate thin beds of sandstone.
Early Eocene	Chor Gali Formation	Dolomitic, grey to dark grey, creamy, medium -bedded, cherty, calcareous, fossiliferous and fractured limestone with algal mats. The shales are greenish grey, maroonish blackish and calcareous.
Early Eocene	Margala Hill Limestone	The limestone is light grey to dark grey, fine to medium grained, massive with diffuse nodularity. The limestone is dolomitic and fossiliferous.

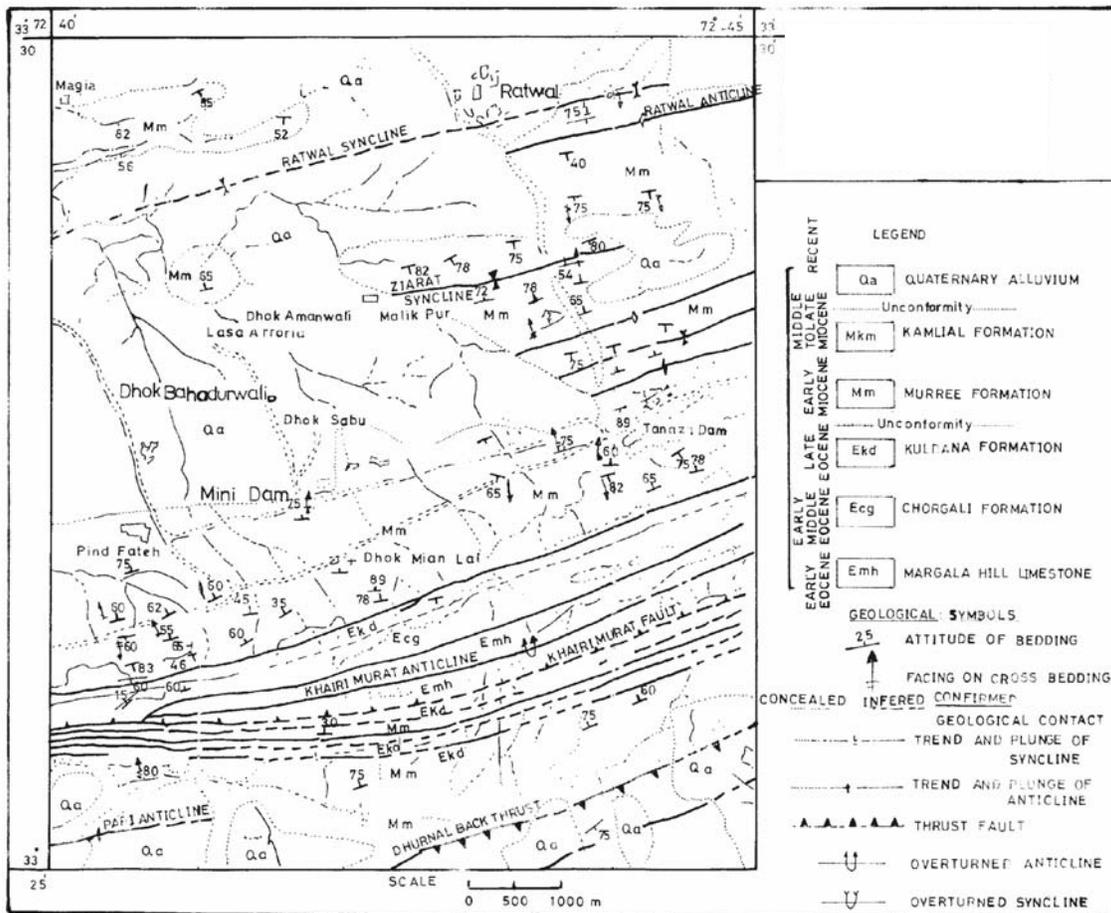


Figure 2- Geological map of the Khairi Murat Range, Potwar Basin, Pakistan.

foraminiferal genera such as *Assilina*, *Nummulites* and *Alveolina*. Fossil samples from limestone beds were collected from bottom to top of the formation. The larger benthic foraminifer species are good index fossils for age determination of the rocks as they have restricted stratigraphic ranges.

**FORAMINIFERS FROM THE MARGALA HILL LIMESTONE**

The Margala Hill Limestone has yielded seven species of foraminifers which includes *Nummulites mamillatus* (Fichtel and Moll), *Nummulites atacicus* Leymerie, *Assilina subspinosa* Davies and Pinfold, *Assilina laminosa* Gill, *Assilina dandotica* Davies and Pinfold and *Textularia* sp. (Plate 1; Photos 1-6).

The above mentioned fossil assemblages indicate an Early age Eocene for the Margala Hill Limestone.

**FORAMINIFERS FROM THE CHOR GALI FORMATION**

The Chor Gali Formation has yielded eight species of foraminifers. These species are *Nummulites mamillatus* (Fichtel and Moll), *Nummulites atacicus* Leymerie, *Alveolina* sp., *Assilina spinosa* Davies and Pinfold and *Dasycladacean*

*algae* (Plate 2; Photos 1-8).

This fossil assemblage is also indicative of shallow shelf marine environments.

**DEPOSITIONAL ENVIRONMENT**

**Margala Hill Limestone**

The petrographical study of the Margala Hill Limestone identifies two units, a dolomitic limestone unit and a biomicrite unit. The dolomitic limestone unit is composed of anhedral and rhomb-shaped crystals with a micrite core. The biomicrite unit is predominantly composed of micrite with benthonic foraminifers. These two units correspond to different environments of deposition. Overall the Margala Hill Limestone is interpreted as being deposited in a shallow shelf setting with water depths up to 40-70 meters, shown by the dominance of *Assilina* and *Nummulitids*. The shift of environment of deposition may be attributed to uplift of the area due to tectonic events.

**Chor Gali Formation**

The Chor Gali Formation mainly consists of dolomitic limestone and biomicrite microfacies.

Table 2- Litholog of the Chor Gali pass section, Khairi Murat Range, Potwar Basin, Pakistan.

AGE	FORMATION	LITHOLOGY	SAMPLE NO	THICKNESS Meter	DESCRIPTION		
MIDDLE EOCENE	KULDANA FORMATION			NOT MEASURED	Greenish grey to yellow, brown, silty shale with subordinate sandstone.		
EARLY EOCENE	CHOR GALI FORMATION			0.6m	Buff sedimentary breccia bed containing clasts (from sand to pebble size) of intraformational.		
			CG CG4	3m	Creamish to light grey, fine-grained limestone with filled fractures and stylolites.		
			C12	2m	Khaki/blackish shale interbedded with creamish thinly bedded limestone		
			CG3	28m	Grey to greenish grey maroonish, brownish shale at northern limb of Khairi Mural anticline.		
			C14	0.9m	Light grey to black cherty thinly bedded limestone.		
			CG9	4m	Greenish grey, calcareous shale.		
			CG18 C15	23m	Dark grey, finely crystalline dolomitic limestone with cherty bands and algal mats.		
			C16 CG11	30m	Dolomitic grey to black, fractured limestone with chap board weathering, exposed in the core of Khairi mural anticline.		
		EARLY EOCENE	MARGALA HILL LIMESTONE		C17	10m	Light grey to dark grey massive, dolomitic fossiliferous, limestone fine grained with diffused nodularity.

The Chor Gali Formation also contains a restricted diversity of fauna including foraminifers and ostracodes. The presence of species of *Assilina*, *Nummulites* and *Alveolinids* in the Chor Gali Formation reveals that deposition of this formation took place in a shallow marine setting in depths up to 30-60 meters. Algal mats and stromatolites are present in Chor Gali Formation at Chor Gali Pass which characterize the tidal flat deposition. Tidal flats areas are dominated by wave currents and wave action. These are developed extensively upon epeiric platforms and they occur along the shorelines of low-energy shelves and ramps, typically behind beach barriers and around lagoons (Jurgan and Abbas 1991).

The microfacies and the faunal assemblage suggest that the deposition of the Chor Gali Formation took place in a shallow, partially restricted, subtidal to supratidal, low energy ramp type of setting in a moderately arid climate

Received Nov. 1, 2006, revised Sep. 15, 2007, and accepted Sep. 25, 2007.

### CONCLUSIONS

The presence of Early Eocene benthonic foraminiferal assemblages and dolomitization in the carbonate sequence of the Margala Hill Limestone and the Chor Gali Formation shows a shallow marine, shelf and intertidal to supratidal environment of deposition.

The occurrence of abundant shallow marine, benthic foraminiferal fauna, rare green algae, echinoids and mollusks in the Lower Tertiary sequence of the Khairi Murat Range reveals that these carbonates were deposited in low energy warm water and shallow marine environmental conditions.

The microfacies of Margala Hill Limestone and Chor Gali Formation are indicative of a shallow shelf deposition.

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# PLATE 1



Photo 1- Equatorial section of *Nummulites mamillatus*



Photo 2- Vertical section of *Nummulites atacicus*



Photo 3- Vertical section of *Assilina subspinosa*



Photo 4- Vertical section of *Assilina subspinosa*



Photo 5- Vertical section of *Assilina laminosa*



Photo 6- Vertical section of *Assilina dandotica*

## PLATE 2

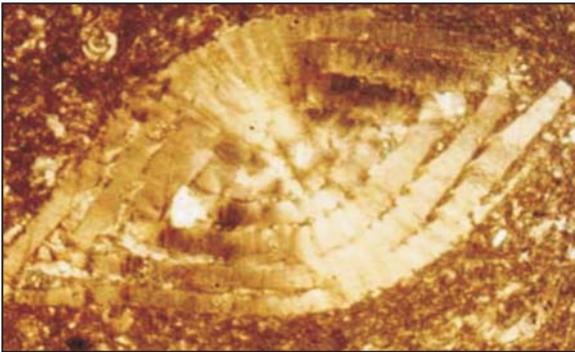


Photo 1- Vertical section of *Nummulites mamillatus*



Photo 2- Tangential section of *Nummulites atacicus*



Photo 3- Axial section of *Alveolina sp.*

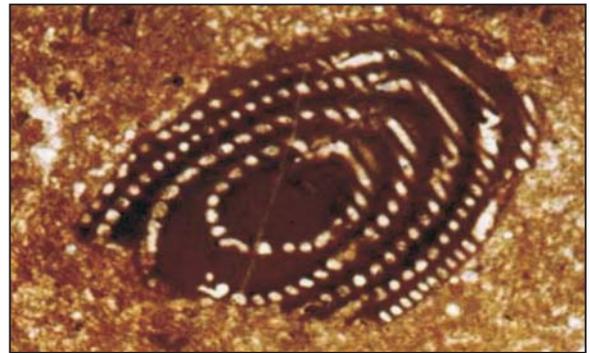


Photo 4- Axial section of *Alveolina sp.*



Photo 5- Vertical section of *Alveolina sp.*



Photo 6- a) Axial section of *Alveolina sp.*  
b) Vertical section of *Nummulites mamillatus*



Photo 7- Vertical section of *Assilina spinosa*

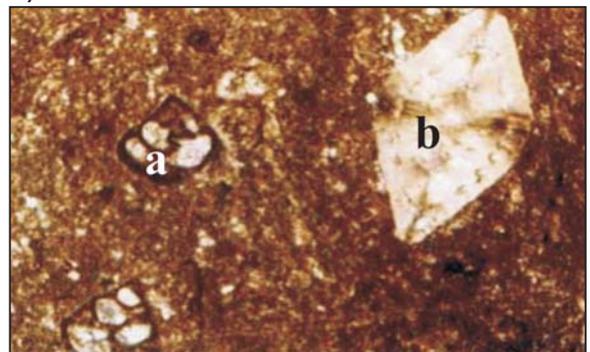


Photo 8- a) Vertical section of *Textularia sp.*  
b) Axial section of *Nummulites mamillatus*