BIOSTRATIGRAPHY OF KOHAT FORMATION, KOHAT BASIN, KHYBER PAKHTUNKHWA

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A thesis is submitted to Bahria University, Islamabad in partial fulfillment of the requirement for the degree in B.S Geology.

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ABSTRACT

The Eocene Kohat Formation formed in the Kohat basin of the Himalayan Fold and Thrust Belt in Northern Pakistan for extensive bio-stratigraphic and micropalaeontological examination , an outcrop of the Eocene Kohat Formation was measured from the bannu road section , District Kohat northern Pakistan. According to the variance in lithology a total of 16 samples were taken from the bottom to the top . A total of 18 thin-sections were obtained from these samples. The thin sections study revealed bio- stratigraphic detail , leading to the identification of three foraminiferal genera: (Nummulites, Assilina, and Alveolina). Different diagenetic features, such as micritization and recrystallization are also observed.

ACKNOWLEDGEMENTS

In one way this BS research work is a testament to my affection of mountains.In countless more means it imitates the support and caring of the people who influenced our life and this work.

Our heartful thanks are due to our Supervisor Mr. Mumtaz Ali Khan, Assistant Professor, Earth & Environmental Sciences, Bahria University Islamabad campus.As he had been great throughout the period of thesis work. He has helped us to the best as he can, to finish our thesis in time. It was him who has insisted us to go through the rigorous thesis work and gave us an insight of what is called “the maximum utilization of resources”.

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CHAPTER 1

INTRODUCTION

1.1 General Statement

The marine Kohat Formation was formed in the Kohat basin of Northern Pakistan's Himalayan Fold and Thrust Belt. Early Eocene collisions and subsequent sea level shifts in the Himalayan Fold and Thrust Belt removed the Kohat Basin from the open sea , leading in the deposition of thick clays of the Panoba Formation and evaporite deposits of Bahadurkhel Salt and Jatta Gypsum. The Kuldana Formation was formed by clastic influx from the north and west during the middle Eocene. The carbonate sequence of the Kohat Formation was deposited in Kohat and parts of Potohar and Kala Chitta during the Middle Eocene sea incursion. In the geology of the area, the Kohat Formation occupies an important stratigraphic position. It is an ideal target for biostrati-graphical investigations due to its widespread distribution, widely accessible outcrops, well-defined underlying and overlaying contacts, and diverse faunal assemblage. Limestone, marl, and shale make up the majority of the formation. The formation was separated into three members by Meissner et al. In order of superposition, these members are: Kaladhand member, Sadkal member, and Habib Rahi Limestone member. On the grounds the uppermost Habib Rahi Limestone Member in the Kirthar Formation as its bottom member, Cheema et al. advocated that the formation be reduced to the two lower members, the Kaladhand and Sadkal Members. Later, Pakistan's Stratigraphic Committee raised the Habib Rahi Limestone Member to formation status, limiting it mostly to the Sulaiman Province in the Upper Indus Basin. Throughout its length, the formation has a diverse foraminiferal assemblage. The formation's central section is exceptionally fossil-rich. Larger benthic foraminifera (LBF) are the most numerous biota and play an important role in determining the formation's age and environment of deposition.

1.2 Aims And Objectives

The current research is aimed to achieve the following objectives;

- To identify the faunal assembelage of Kohat Formation
- To assign Kohat Formation with biofacies based onb recognized faunal assembelage
- To demarcate the diagenetic changes in the Kohat Formation

1.3 Location And Accessibility

The research Area is located in District kohat on bannu road that connects Peshawar city through Kohat pass .Detailed study on compact and hard rcks of limestone carried out. Longitudes 71° 30' 53.15" E to 71° 30' 52.38" E and latitudes 33° 31' 41.42" N to 33° 31' 40.98" N define the project area .

Figure 1.1 Map showing the location of study area (Google map)

1.4 Materials And Methods

The Kohat Formation's roadside sections was chosen for careful measurement and sampling in order to describe the fossil assemblage and daiagenetic changes. The Bannu road Section was chosen from the northern Kohat Basin , keeping in mind the formation's east-west distribution. From the outcrop 16 samples were taken. These samples were appropriately packaged , numbered , and sent to the Institute of Geology's rock cutting and thin section making facility of Charsadda lab, to detect and characterise the facies assemblage , a total of 18 thin sections were obtained for microscopic investigation. For illustration, the well-preserved foraminiferal specimens were photographed.

Table 2.1 Showing details of sample collected from location.

Sample No.	**Longitude(° E)**	**Latitude(° N)**	**Distance interval(meters)**
1.	71° 30' 53.15"	33° 31' 41.42"	3.8
2.	71° 30' 53.22"	33° 31' 41.31"	2.2
3.	71° 30' 53.24"	33° 31' 41.22"	3.1
4.	71° 30' 53.28"	33° 31' 41.17"	6.9
5.	71° 30' 53.12"	33° 31' 41.00"	2.75
6.	71° 30' 53.14"	33° 31' 40.93"	3.32
7.	71° 30' 53.13"	33° 31' 40.87"	3.95
8.	71° 30' 53.11"	33° 31' 40.82"	5.1
9.	71° 30' 53.00"	33° 31' 40.69"	3.01
10.	71° 30' 53.01"	33° 31' 40.56"	3.07
11.	71° 30' 52.99"	33° 31' 40.46"	5.35
12.	71° 30' 52.88"	33° 31' 40.35"	3.93
13.	71° 30' 52.74"	33° 31' 40.20"	3.73
14.	71° 30' 52.64"	33° 31' 40.11"	2.44
15.	71° 30' 52.46"	33° 31' 39.95"	2.61
16.	71° 30' 52.38"	33° 31' 39.89"	2.04

1.4.1 Geological Field Work

A fieldwork is carried on bannu road-side section of district kohat . This study endeavour is primarily based on data gathered during fieldwork . We took geographical location coordinates with the help of GPS.

The samples were taken at random intervals from a total distance of 55 meters to account for the rock's modest lithological and facies variations.

The majority of the methods used were standard , such as sample collection by hammers and stratum identification. By identifying diverse fossil assemblages in thin slices, the collected field data was sorted, evaluated, and presented.

Figure 1.2 Showing GPS Field tool.

Figure 1.3 Unconformable contact between Murree and Kohat Formation due to thrusting.

Figure 1.4 Road side section of *K*ohat *F*ormation.

Figure 1.5 Showing Kohat limestone.

Figure 1.6 Nummulitic bed exposed in limestone.

1.4.2 Lab work

After the sample collection we sent the sample for making of thin section to Abdul wali khan university , Charsadda. We studied the samples thin sections under an up to-dated microsope and took much photomicrographs of our thin sections.

Figure 1.7 showing Discoplain

Figure 1.8 showing Press Machine

Figure 1.9 showing Grinding Machine.

CHAPTER 2

TECTONIC SETUP OF THE STUDY AREA

2.1 Introduction

The Himalaya orogeny which came into being due to the collision between Eurasian Plate and Indian Plate. This collision is considerably the youngest one and engendering features that are associated with continent-continental collision thoroughout the planet from Early Eocene (Gansser, 1964; LeFort, 1975; Fraser et al., 2001).

Indus-Tsangpo Suture marks the boundary between Indian and Eurasian Plate (Ganssner, 1981) but in Pakistan it is further divided into Main Karakoram Thrust (MKT) and Main Mantle Thrust (MMT) and located to the North of Pakistan (Tahirkheli et al., 1979). Indian plate splitted from Gondawanaland around 130 Ma ago (Johnson et al., 1976) which leaded to the termination on Neo-Tethys existed between the plates (McKenzie & Sclater, 1976). The rocks that compose Kohistan Arc (KIA), a geological feature that was created as an Island Arc and it is situated to the north of MMT (Jan and Asif, 1983; Windley, 1983). Then there was a collision that took place between Indian plate and the Kohistan Arc, it was along MMT and was happened during Eocene (TahirKheli, 1982). Powell et.al, 1979 mentioned, KIA subducted under KIA and this subduction was entirely continuous and was owing to an edge which was thought to prominently formed due to the remains of KIA. The age of MMT which was again repercussion of this collision is esitimated to be 50-65 Ma (Smith et al., 1994 & Chamberlain and Zeitler, 1996).

2.2 Structural setting and Geometry

The regional structure is dominantly consisting of four faults the MKT, MMT followed by Main Boundary Thrust (MBT) and the Salt Range Thrust (SRT). There are different school of thoughts on the presence of Trans Indus Range Thrust (TIRT) in Pakistan.This regioinal structure is responsible for the division of Himalayas into five blocks in Pakistan. Starting from north towards south first comes The Karakorum Block (KB), KIA, Northern Deformed Fold and Thrust Belt (NDFTB), Southern Deformed Fold and Thrust Belt (SDFTB) then finally Punjab Foredeep (PF) (Ahmad et al., 2004).

The KB is located on the southern edge of the Eurasian plate and has all three type of rocks. Towards the north of KB, lies Pamir and Kohistan Ladakh Arc (KLA) to its south. It was about 70-100 Ma ago when the collision between KB and KLA occurred which resultantly formed the southern border of Eurasian plate .

Moreover, MKT serves as the southern boundary of KB. It apparent evidence that the impact among KB is situated to the north and the KIA to the south . The MKT is also known as Northern Suture, a name devised by Pudsey et al., (1985).

Respectively, the KIA as mentioned earlier that it was formed owing to the movement of Indian Plate towards north ultimately subduction under Eurasian Plate that has occurred during Late Jurassic to Cretaceous. KIA is a suture zone that delineates the Indian Plate and KIA. It is recognized with the presence of blueschist and has a thickness of around 40 km having orientation E-W mainly contains igneous (volcanic & plutonic) rocks with less quantity of sedimentary rocks and these rocks are metamorphosed to some extent which is again the evidence of presence of a suture (Hamidullah and Onstot, 1992).

MMT is situated to north of NDFTB. It is the last thrust in Pakistan that is composed of lower crust. Fault plane is dipping towards north having the dip range 25-45° (LeFort, 1975; Bard, 1983 & Malinconico, 1986).

Zeitler et al. 1982, observed the division tracks of MMT and proposed that the movement has stopped since Eocene and about 15 Ma ago from the edges of the block. However, junction has not stopped as MMT is still expanding at a rate of 5 mm/ year which has also faced continent-arc-continent collision.

The NDFTB has MMT in the north and MBT in south and contain rocks of all three types, distorted. MBT is the evidence of amplification of Himalayan deformation towards south and extends while fronting NDFTB and falling from the Hazara Kashmir Syntaxis, northeast and Orakzai in KP, southwest.

The MMT transports the rockos of Paleozoic and NDFTB rocks in hanging wall and when it comes to footwall, it comporises of rocks of Miocene that are post-collisional folded rocks (Khan, 2011). MBT is responsible for the narrowing down of northern sutures of the Kalachitta and Hazara Series (Seeber et al, 1979 and Yeats and Lawrence, 1984).

The associated SDFTB is densely consisting of fluvial deposites and its orientation E-W trending. With the help of Indus River, sub-division of SDFTB occurs having Kohat Basin to the and Potwar Basin is on its east. The southern edge of SDFTB is a highly deformed and indicates its origin from salt range and TIRT which is responsible for bringing the strata belonging to Cambrian to Paleocene adjacent to Punjab Foredeep (Ahmad, 2003).

Our study are is situated in Kohat-Kotal ranges that have different sets of structure. This area is tectonically evolved by the presence of numerous folds and faults who presence is linked with compressional stresses owing to the northward drift of Indian Plate. The MBT and Akhurwal Back thrust (ABT) are considered to be the significant faults in this study area. These faults are responsible for bringing the Jurassic age rocks above the Miocene rocks towards south and Paleocene rocks towards north.

Ghauri, et al. (1983) have divided this area into three parts considering nature and style of deformation the are interestingly variable in stratigraphy of study area.

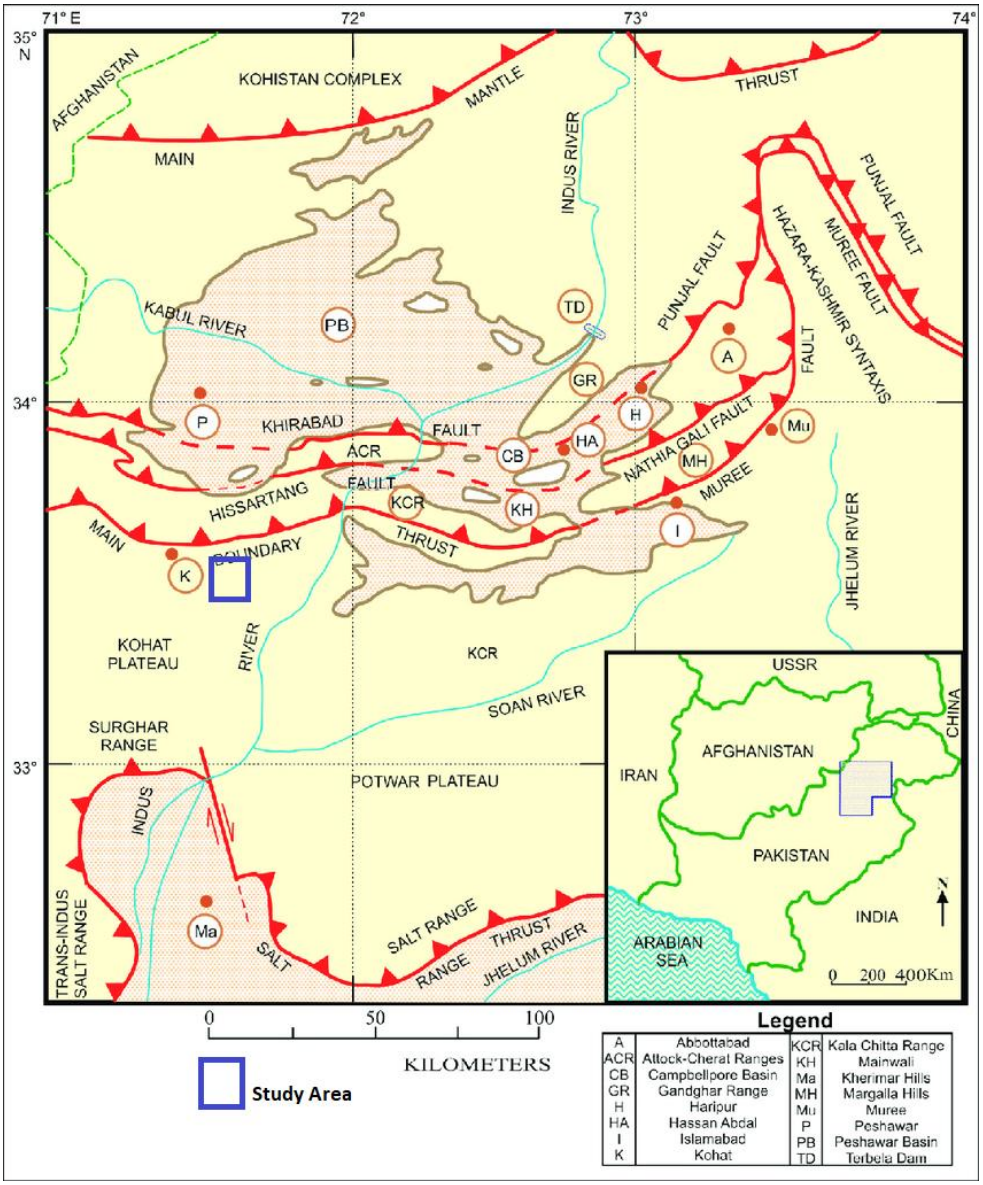


Figure 2.1 Tectonic Map of Northern Pakistan, showing major structural boundaries and location of study area (Hylland et al. 1988).

CHAPTER 3

STRATIGRAPHY OF KOHAT BASIN

3.1 Introduction

Our study area is located in Kohat sub-basin. There, MBT is respobile for delineating from stratigraphy of Kohat-Kotal. Kohat Basin cotains sedimentary packages that are bedded massive and are aging from Miocene to Eocene. Different contacts and relationships can be seen throught the area between different formations. Following is the stratigraphy which generally described;

3.2 Panoba Formation

It is the northwestern limb of Tanda Dam syncline that contains the Panoba Formation. The type locality of this formation is Ambad Band Village. The lithology is still distinctive even if the the weathered surface across the surface appears to be pale yellow. Fossil record was absent hence no fossils were collected. Eocene is the age of this formation (Charles et,al. 1974).

3.3 Kuldana Formation

The name Kuldana Formation was the old name given to the Kuldana Series of Middlemiss (1896) by Latif (1970), which was later on accepted by Stratigraphic Committee Pakistan (SCP) (Fatmi, 1973). It relates the southward movement and largely contian red shales, sandstones, and conglomerates. It belongs to continental fluvial when it comes to origin and semi-arid basin when it comes to deposition.

Its lithology contain purple to brown and pale yellow shale with interclation of beds of sandstone and gypsum. There is no fossil record found in this formation hence barren of fossils and has thickness of some meters (Charles et,al. 1974).

It is short of clues to decide about its lower contact however, it is evident to say that the the upper contact of this formation was conformable and is overlain byKohat Formation. It was deposited in shallow marine environment. Its age is Early to Middle Eocene.

3.4 Shekhan Formation

Davies (1926) named the Shekhan Limestone after outcrops near Shekhan Nala, just east of Kohat. Eames (1952), classified the Shekhan Limestone into four sections: These foure sections from bottom to top are starting with Lower Shekhan Limestone, then comes the Middle Shekhan Limestone, followed by Upper Shekhan Limestone finally the Gypsiferous Beds. These subdivisions went unnoticed for a long time(Charles et,al. 1974).

Shekhan formation consists of limestone that is partially yellow and grey is dominant to purely grey. It is very dense, bedding is thin to massive and is nodular. Foraminifera is the fossil that is present in this formation. Lower contact is inconclusive however the upper contact with Eocene beds is conformable

3.5 Bahadar Khel Salt And Jatta Gypsum

The Kohat quadrangle, Gee's (1945) Kohat Saline Series, are the facies associated with Panoba Shale and Shekhan Lst.

The Bahadur Khel Salt (BKS) is giving due to the presence of Bahadur Khel salt quarry (latitude 33°09'54" N., longitude 70°59'53" E.), about 51 miles south of Kohat. The Jatta Gypsum is given due the presence of Jatta salt quarry (latitude

33°18'34" N., longitude 71°17'30" E.), about 26 miles south-suthwest of Kohat in the Kohat quadrangle.

Jatta Gypsum is bedded to enormous and hard, with strata ranging from greenish-white to grey. After weathering the color changes into to grey with small portion of red color, purple, and green as well. Thicknesses is variable as it is from some feet to 140 feet. The thickest exposure has the thickness of around 320 feet. Its bedding is moderate to massive having white color and black hue. It also contains salt crystals that are very clear free from impurities. The BKS's has conformable upper contact with Jatta Gypsum (Charles et,al. 1974).

3.6 Kohat Formation

Eames (1952) used the names Kohat Shales and Kohat Limestone, while the SCP (Fatmi, 1973) coined this term of Kohat Formation. It was classified into three members by Meissner et al. (1968), with the Kaladand Member being the lower one, the Sadkal Member being the higher one, and the Habib Rahi Member is also exposed exposed here in this area.

It dominantly consists of limestone and shale interbeds. It is composed of limestone with calcareous clay which is dirty. This limestone ranges from medium to thick beds. It is brecciated as well as weathered at various places.

It is overlain by Murree Formation with which its contact is unconforambale. It is underlain by Kuldana Formation and contact with it is conformable. It has the abundance of fossils and considering those very fossils the age assigned to this formation is Middle Eocene (Charles et,al. 1974).

3.7 Murree Formation

Wynne (1874) named and plotted the Murree series near Murree (lat 33°54' N., long 73°27' E.) in Rawalpindi District. Although SCP has accepted Murree Formation as the formal name, it is unknown when the term "formation" rather than "series" was first used to identify these rocks.

It is composed of purple-grey and red clays that are dark in color having sandstone in minor portion whose color ranges from gray to green. It has intra-formational conglomerate that secondary. Its age is Early Miocene (Charles et,al. 1974).

Table 3.1: Localized stratigraphy of Kohat basin of Eocene age.

Age	**Formations**	**Lithological description**
Early Miocene	Murree Formation	Sandstone, conglomerate.
Eocene	Kohat Formation	Limestone, Shale, Sandstone.
	Shekhan Limestone	Limestone, gypsum beds at top.
	Jatta Gypsum	Gypsum.
	Bahadur Khel Salt	Salt, probably underlain by panoba shale.
	Panoba shale	Shale.

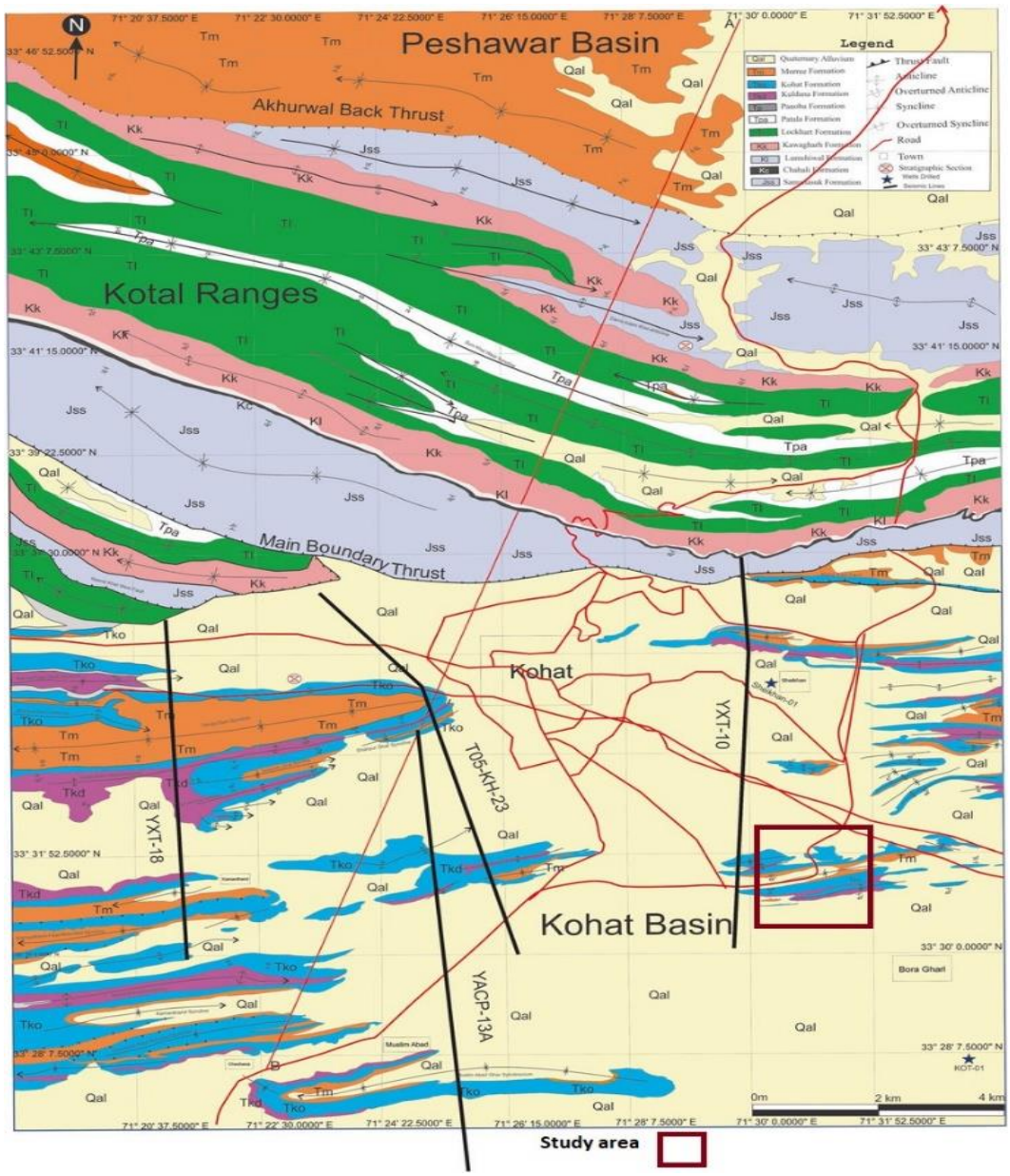


Figure 3.1 Geological map of study area at the scale of 1:50,000, Khyber Pukhtunkhwa, Pakistan (Yaseen, M., Wajid, S., Rehma, G. 09 February 2021)

CHAPTER 4
BIOSTRATIGRAPHY

4.1 Introduction

The branch of stratigraphy known as biostratigraphy is concerned with the identification and organisation of strata based on their fossil content. Biostratigraphic units, or zones, are strata with distinct fossil material. Following William Smith's observation that "the same strata were always found in the same sequence of superposition and contained the same fossils, " biostratigraphy emerged independently in England and France shortly after 1800. Range zones , interval zones, lineage zones, assemblage zones, and abundance zones are the five types of biostratigraphic zones recognised by biostratigraphers. The recognition of geologic time intervals by fossils is known as biochronology . Any organism's fossils indicate a specific period of geologic time known as a biochron. Biostratigraphy is commonly used as a method of stratigraphic correlation, which is the process of identifying the age or stratigraphic location of stratified rocks in different areas using biostratigraphy. Biostratigraphy became the major basis for generating the relative geological timeline due to its utility in stratigraphic correlation.

The Kohat Formation features a rich assemblage of foraminifera and is well exposed at several locations around the Kohat Basin. In the northern section of the basin, following Meissner (1968), a triple divide of the Kohat Formation can be seen: the Kaladhand member, the Sadkal member, and the Habib Rahi Limestone member in order of superposition. In the middle and southern regions of the basin, however, this separation does not exist. The Shekhan Nala portion and the Hangu section of the Kohat Formation, which are located in the northeastern and northwestern parts of the basin, respectively, were examined in depth for foraminiferal assemblage(Amir Yasin and Mohsin Munir . 2007 Vol. 42: 15-24).

Kohat Formation is fossiliferous and mainly contain forminifera, Assilina and Alveolina.

The formation's age thus verified as late early Eocene to early Middle Eocene based on the faunal assemblage.

4.3 Systematic paleontology

4.3.1 Genus: Nummulites Lamarck, 1801

4.3.1.1 Nummulites atacicus

Remarks:

In the Kohat Formation, this species is uncommon. Only in the centre of the formation can you find it. Megalospheric types with bigger proloculus are the most common. The pillars aren't as well developed as they may be. The marginal chord has a good amount of preservation and is extremely noticeable.

a)  b) 

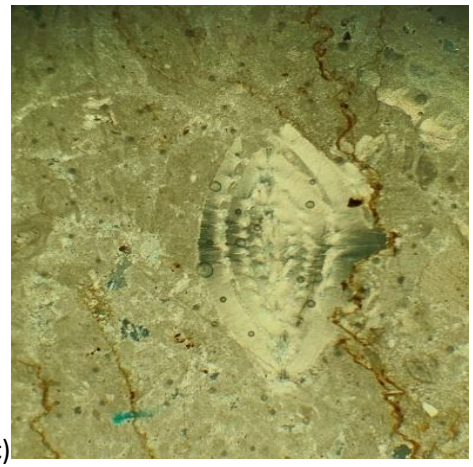
c)  d) 

Figure 4.1 (a-d) Axial view of Nummulites atacicus; (b) micritization of N.atacicus.

4.3.1.2 Nummulites globulus

Remarks:

In the Kohat Formation , there are only a few individuals of this species. It is distinguished by a shell that is highly biconvex and more globular in shape. The umbilical pillars are prominent and well-developed.The shell's wall is usually quite thick.

a)  b) 

c) 

d) 

Figure 4.2 (a) equatorial view of Nummulites globulus recrystallization; (b-c) Axial view of N.globulus; (d) recrystallization of axial view of Nummulite globulus.

4.3.1.3 Nummulites subirregularis

Remarks:

Only a few specimens of this species have been discovered in the Kohat Formation. This is the first time this structure in northern Pakistan has been reported. It is distinguished by its relatively thin shell and thin walls.

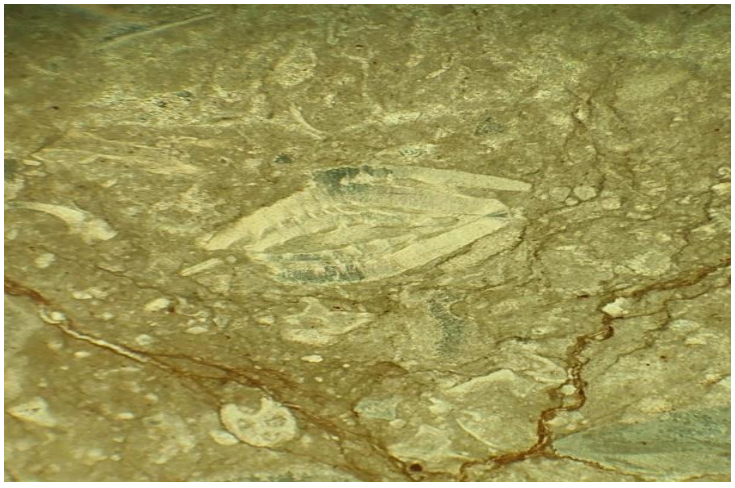
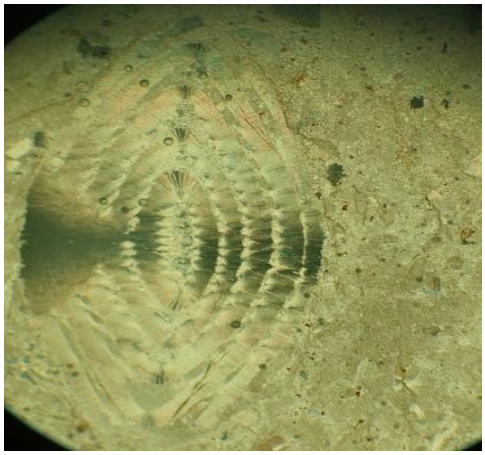
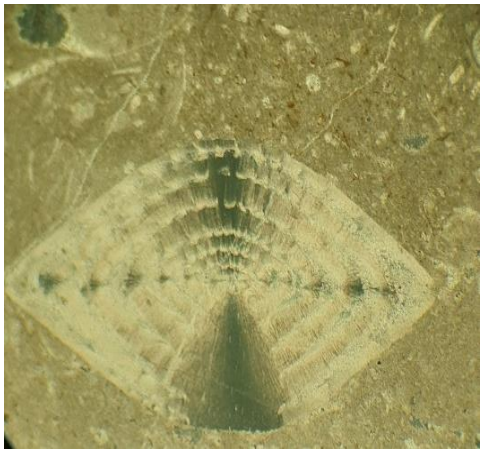


Figure 4.3 Nummulites subirregularis with some micritization.

4.3.1.4 Nummulites mammillatus

Remarks:

This species can be found in large numbers throughout the formation. It has a biconvex shell with large umbilical pillars in the centre region that distinguishes it. There is a marginal chord present. However, in comparison to other Nummulites species, it is quite thin. It is detected in lower section of kohat formation and its range is considered to be from lower to middle Eocene

a)  b) 

c) 

Figure 4.4 (a-b) Axial view of Nummulite mammilatus ; (c)micritization of N.mammailatus and recrystallization of calcite.

4.3.2 Genus: Assilina, d'Orbigny 1826.

4.3.2.1 Assilina granulosa

Remarks:

Kohat formation is full of these species and found in middle portion of formation that is shale (Sadkal Member) . The shell has sharp edges and is normally flat. On the surface of the shell, there are many granules. These granules might be rather visible at times .

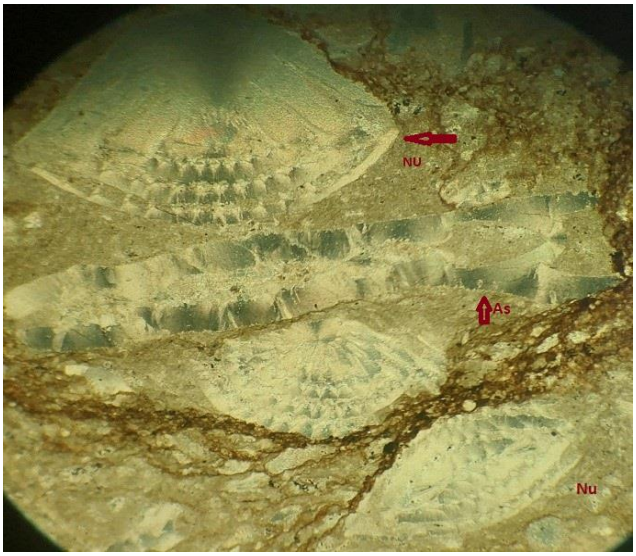


Figure 4.5 Assilina granulosa.

4.3.2.2 Assilina laminosa

Remarks:

In the middle of the formation, there are only a few individuals of this species. The species is distinguished by strong walls and thick borders, with conspicuous laminations visible in cross section.

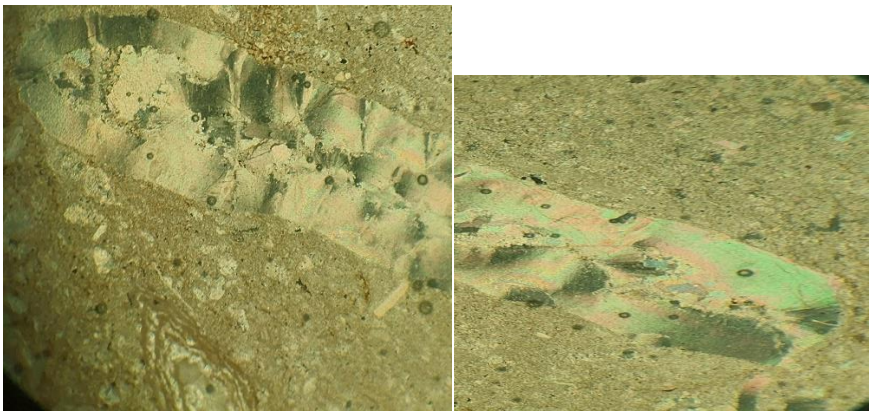


Figure 4.6 Assilina laminosa.

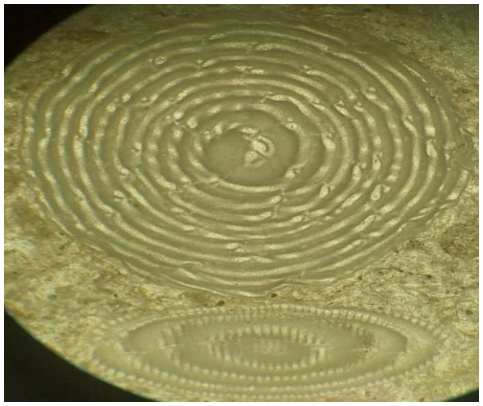
4.3.3 Genus: Alveolina, d'Orbigny 1826.

4.3.3.1 Alveolina elliptica

Remarks:

This species is distinguished by early flosculinization followed by regular whorls.

a)  b) 

c)  d) 

e) 

Figure 4.7 (a-d) Axial view of Alveolina elliptica; (e) equatorial view of Alveolina elliptica.

4.3.3.2 Alveolina stercusmeris

Remarks:

This form lacks the early stage flosculinization that is characteristic of Alveolina elliptica, and the whorls are relatively close together .

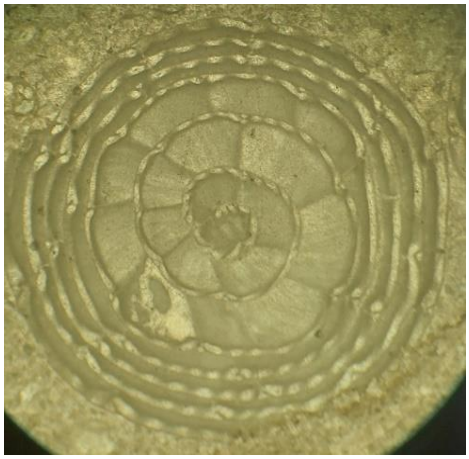
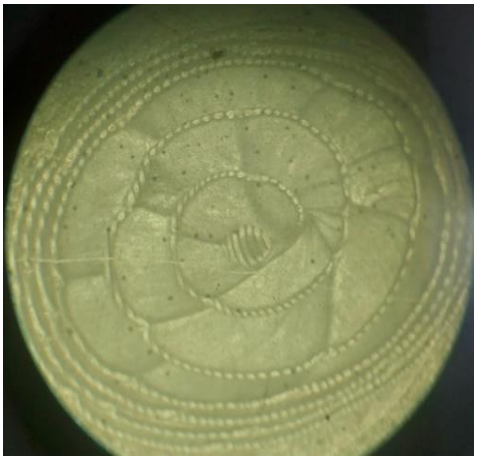
a)  b) 

Figure 4.8 (a) Axial view of Alveolina stercusmeris; (b) Alveolina stercusmeris;showing slightly of-centered equitorial section of early whorls.

4.3.3.3 Alveolina globula

Remarks:

It is detected from uppermost section of kohat limestone and its range is late Eocene.

(a)  b) 

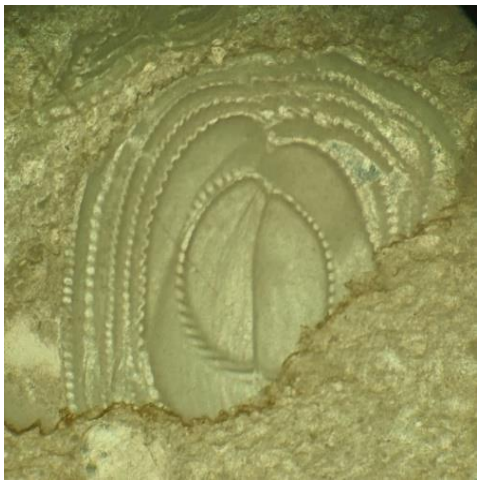
(c) 

Figure4.9 (a) Alveolina globula ;showing off-centereed oblique to axial section with moderate flusculization of early whorls ; (b) A.globula ; slightly off-centred, slightly oblique axial section with large degree of flosculinization of early whorls ; (c)micritization of Equitorial view odf Alveolina globula.

4.3.3.4 Alveolina frumentiformis

Remarks:

It is detected in Kohat Formation. In this formation it is usually present in middle to upper portion.

a)  b) 

Figure 4.10 (a) Alveolina frumentiformis;central axial-section; (b) A.frumentiformis; vertical axial-section.

4.3.3.5Alveolina indicatrix

Remarks:

It is detected in Kohat Formtion, usually in upper part.

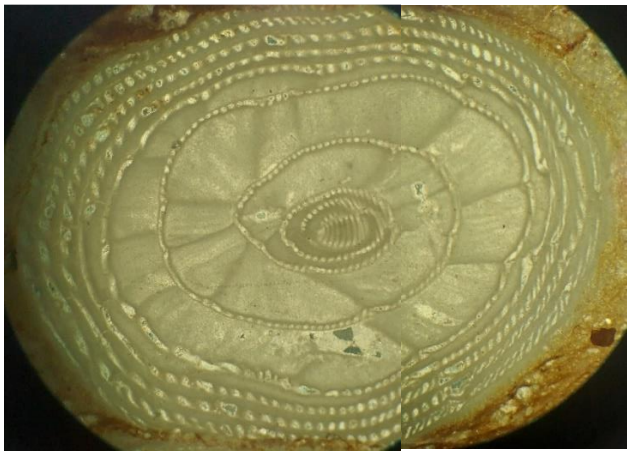


Figure 4.11 Alveolina indicatrix.

4.2 Biofacies

Biofacies is a section of a stratigraphic unit in which the fossil fauna or flora differs markedly from that of the rest of the unit. The thin section study identified three types of larger foraminifera (Nummulites, Assilina and Alveolina).

The following species of larger foraminifera have been encountered during the detailed thin section studyunder microscope with 4x magnification.

- Nummulites mamillatus
- Nummulites atacicus
- Nummulites globulus
- Nummulites subirregularis

Remarks:

Observed in thin sections 1,2,5,7,10,13,14.

- Assilina granulosa
- Assilina laminose

Remarks:

Observed in thin section 9.

- Alveolina elliptica
- Alveolina globula
- Alveolina indicatrix
- Alveolina stercusmeris

Remarks:

Observed in thin sections 7,8,10,12,13,14,15,16.

CHAPTER 5

DIAGENETIC FEATURES

5.1 Introduction

Diagenesis is defined as the changes in the character and content of sediments that occur from the time of deposition until the materials are transported into the domain of metamorphism or are subjected to the effects of atmospheric weathering. In both the accumulation and denudation domains of the metamorphic cycle , a vast number of widely diversified types of occurrences are regulated by elements such as ;

- Physical and chemical processes.
- Tectonic and morphological conditions.

The diagentic features of the Kohat Formation has been studied in order to find out effects of the diagenetic phases inn fossils deposition.

Fossil diagenesis refers to the compaction, early mineralisation and/or replacement of minerals that were formed in later stages. It also includes the overgrowth of minerals that were formed in early stages followed by repeated sessions of dissolution.

5.2 Recrystallization

The transition of the minerals that made up a fossil's original shell or bone into a new material with the same chemical components is known as recrystallization. Calcit , a more stable variant of the same chemical, frequently recrystallizes from aragonite fossil shells . Recrystallization keeps the original fossil's shape , albeit minute features may be lost as new crystals emerge .

This phenomenon is widely observed in Nummulites that are recrystallize by calcite.

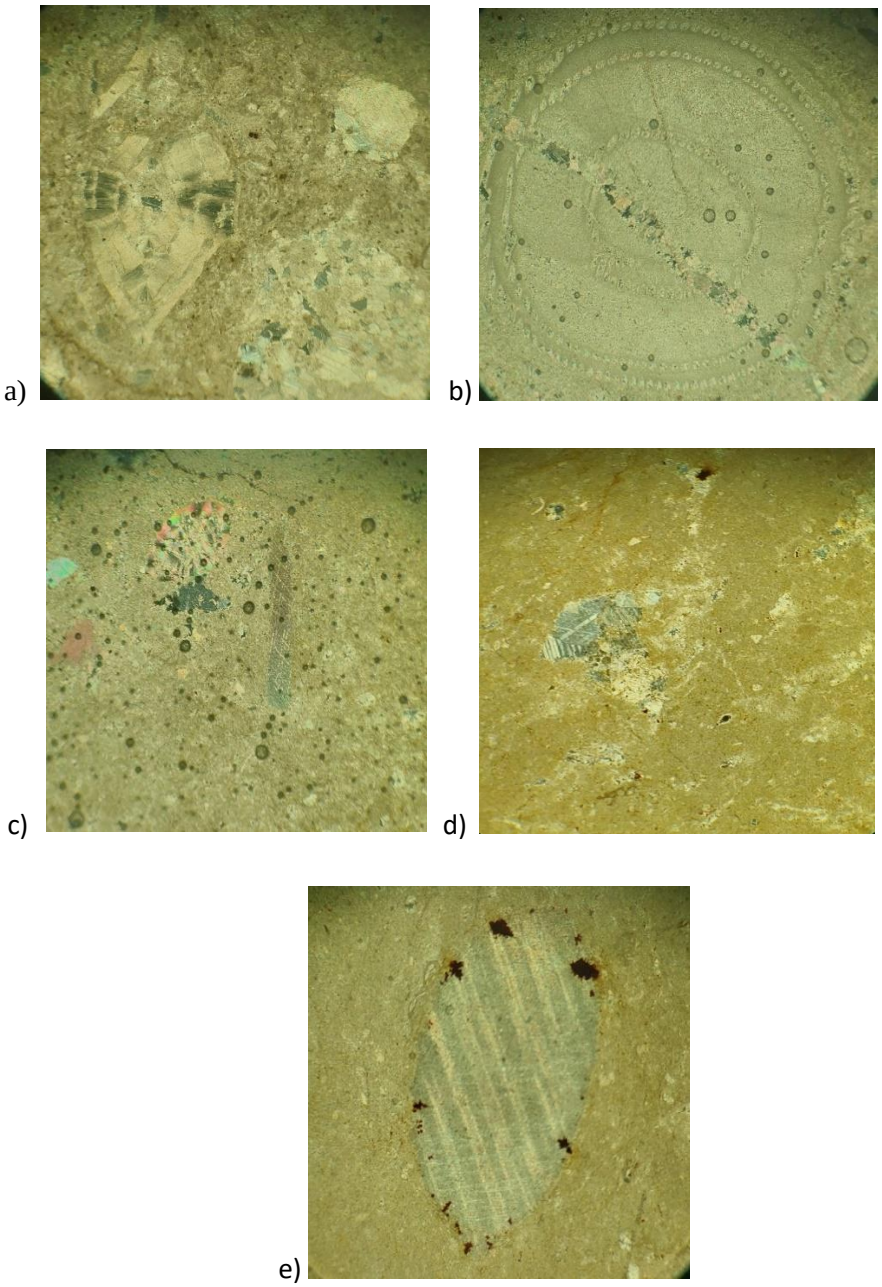
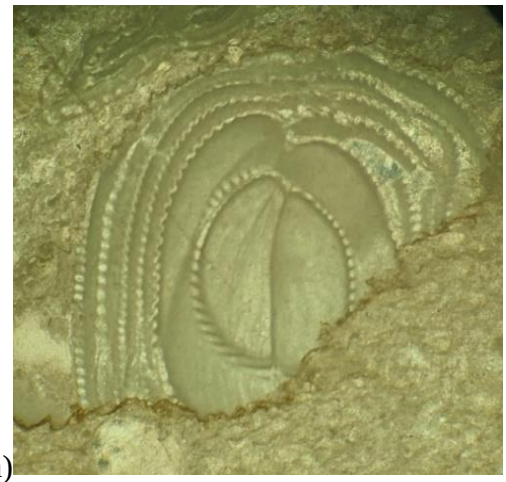


Figure 5.1 (a) Recrystallization of N.mamillatus ; (b) Calcite vein passing through Alveolina;(c) Recrystallization by calcite of nummulite;(d) Recrystallization of calcite;(e) Recrystallization of nummulites by calcite.

5.3 Micritization

Micrite is a type of limestone component made up of calcareous particles as small as four millimetres in diameter that form when lime mud is recrystallized. Micrite is a mud-grade lime carbonate. According to the Folk classification, it is considered to be the carbonate rock that has the abundance of fine-grained calcite. Along with calcite allochems are classed as intramicrite, oomicrite, biomicrite, or pelmicrite, depending on the predominant allochem, according to the Folk classification. Micrite can be found in carbonate rocks as a matrix, micrite envelopes around allochems, or peloids. Chemical precipitation, peloid disaggregation, or micritization can all be used to make micrite. In 1959 , Robert Folk coined the word to represent his classification system for carbonate rocks. Micrite is made up of calcite crystals that are microcrystalline . In the fossils of Kohat Formation , this was seen .

a)  b) 

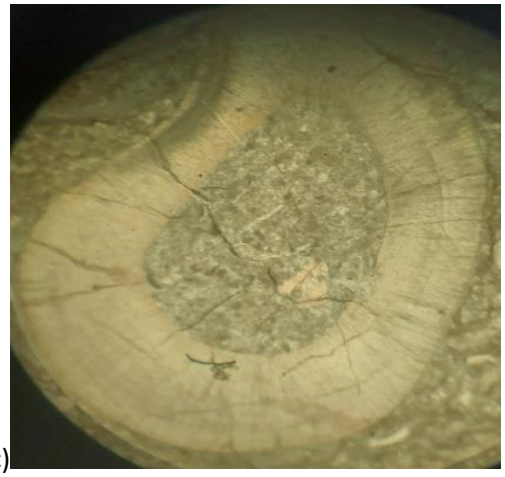
(c)  d) 

Figure 5.2 (a) micritization of Equitorial view odf Alveolina globula ; (b) micritization of nummulite aticicus ; (c) Micritization of nummulite globulus ;showing remaining later whorls ; (d) Micritization Alveolina and Nummulite.

CONCLUSIONS

The current research done to achieve the objectives conclude ;

The faunal assembelages in Kohat Formation that are identified are :

- Nummulites mamillatus
- Nummulites atacicus
- Nummulites globulus
- Nummulites subirregularis
- Assilina granulosa
- Assilina laminose
- Alveolina elliptica
- Alveolina globula
- Alveolina indicatrix
- Alveolina stercusmeris

Biofacies that are recongnized in Kohat Formation belongs to three Generas; Nummulites, Assilina, Alveolina.

The recrystallization and micritization diagentic features are observed.

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BIOSTRATIGRAPHY OF KOHAT FORMATION, KOHAT BASIN, KHYBER PAKHTUNKHWA

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