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Biostratigraphy of Qala e Jafar Yekavalang district Bamiyan Province

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ABSTRACT

Distinguishing of the geologic age from sedimentary rock layers has been one of the important and basic tasks for geological sciences. The objective is to determine the geological age of the sedimentary layers within the Qala e Jafar of Yekawlang district of Bamiyan province by using fossils. In this study, more than 8 fossil specimens were collected and identified over the sedimentary layers of the study area. Different genus and species of Bivalves, Brachiopods, Echinodermata, Corals, and Gastropods were recorded and presented from Qala e Jafar sedimentary layers. Among them, three index fossils determined the relative age of strata, namely: Pholadomya and Carneithyris Subcardinalis. According to the guide fossils and using the assembly fossils aging method, the second sedimentary layer is aged Maastrichtian, and the third layer is aged Campanian. The specifications and living features of the recorded fossils derive a warm oceanic environment in the Late Cretaceous.

Keywords: Biostratigraphy, Sedimentary Layers, Chronology, Fossils

1. Introduction

Qala e Jafar is located in Yekavalang district, Bamiyan Province, which is one of the villages of Band e Amir. This area is located 72 kilometers northwest of the center of Bamiyan, and its height is 2909 meters above sea level. The northern region is 19-34-49 and is located between the Hindu Kush and Baba mountains. Basically, major rock of constructed formation of Qala e jafar region are sedimentary rock and layers. Sedimentary rocks make up nearly 80% of the outer surface of the earth's solid crust. According to (Folk 1980) theory. Meanwhile our main information from the fields of stratigraphy and most of our knowledge about tectonics and structural geology is based on the study and knowledge of sedimentary rocks (Nichols, Gary 2009). So basically, fossil are used as guide to study the sedimentary layers those fossil are to be called index fossil, An Index fossils is one that is particularly useful Index fossils are used

by geologists and paleontologists as significant aids to determine the correlation and age of rock sequences Geologists use both large fossils or 'macrofossils' and microscopic fossils or 'microfossils' as indices to define and identify geologic periods (Prothero, Donald et al 2004). Macrofossils have the advantage of being easy to see in the field, but they are rare (Benton, Michael et al 2009). Microfossils are very commonly used by oil prospectors and other industries interested in mineral resources when accurate knowledge of the age of the rocks being looked at is needed. Three general gateways are allowing scientists to date geological materials and answer the question "how old is the fossil or rock?" First, the relative age of a fossil can be determined (Benton, Michael et al 2009). Relative dating puts geologic events in chronological order without requiring that a specific numerical age be assigned to each event (Kemp.T.S (1999)). Second, it is possible to determine the numerical age of fossils or earth materials. Numerical age estimates the date of a geological event and can sometimes reveal quite precisely when a fossil species existed in time (Prothero, Donald et al 2004). Third, magnetism in rocks can be used to estimate the age of a fossil site. This method uses the orientation of the earth's magnetic field, which has changed through time, to determine ages for fossils and rocks. Afghanistan, a country with complicated geology, has experienced many geological events in the earth's history. Those events included magmatism, tectonics, volcanic eruptions, natural hazards, climate change, extinction, and the appearance of animals, particularly marine animals lived in the new – Tethys Sea. Most of the events were accompanied by the absence of vegetation cover which made the territory an interesting subject for geological research for both Afghan and foreign geologists (SH, Abdullah, Chmyriov 2008). Geological aging in the field of geology is an essential task. Normally the aging task is done using two widespread approaches: absolution, and relative. Scientists have established a set of principles that can be applied to sedimentary and volcanic rocks that are exposed at the Earth's surface to determine the relative ages of geological events preserved in the rock record. Usually, index fossils are used to determine the age of rocks and sedimentary layers, as index fossils occur for a limited interval of time and they are common and easily identifiable (Prothero, Donald et al 2004). Unlike relative dating methods, absolute dating methods provide chronological estimates of the age of certain geological materials associated with fossils and even direct age measurements of the fossil material itself (Tucker M.E et al 2002). To establish the age of a rock or a fossil, researchers use some type of clock to determine the date it was formed. Geologists commonly use radiometric dating methods, based on the natural radioactive decay of certain elements such as potassium and carbon, as reliable clocks to date ancient events. Most of the geological research in the country has been carried out by scientists from outside of the country and has been published as reports. The greatest parts of these reports are still considered secretive to which the researcher and students have limited access. Furthermore, due to the unsuitable situation in the country, limited studies in the field of geology have been conducted. Absolute age dating is expensive and requires more facilities which we are facing with shortages. Alternatively, relative age dating using index or assembly fossils is applied. To consider all the problems and shortcomings in this regard, limited investigations have been also conducted on the fossils in Afghanistan. The fossils were not explained in detail and their genus with their species was not identified either. According to the recorded fossils, the age of the sedimentary layers was identified as well. The findings of this work will help other researchers for further study of the fossils in Afghanistan and give detailed information about the paleontology of Bamiyan Province. Resultant, the main intentions of this study are:

1. to scout the fossils and their diversity sedimentary layers of Qala e jafar, Bamiyan province.
2. to separate and sequester index fossils between all the fossils detected in the area.
3. to reveal the age of strata by using index macrofossils and
4. to determine the past environment and historical geology of Qala e jafar an oceanic place.

1.1 Hypothesis or Research question

1. How is paleo geological condition according to related fossil's environment?
2. What are the age of relative sedimentary layer at the region?
3. What were the dominant climate and environment at region according to related fossils exist there?
4. How the sequel would help other researcher at area.

1.2. Finitude and problem of the study.

1. Less past geological study of Yekawlang district specially Qala jafar area.
2. Sample collection is very difficult and risky because very high and straight, columnar layer it needs to special equipment to climb.
3. Less number of paleontological research in Afghanistan.

1.3 Geology of the Area

The field of study is located in N 34^{o} 50' 57" and E 067^{o} 11' 50" with 3084 m elevation from the sea level. The mountain relief of the region is rarely different from the rest of the region. The mountains slope here are very steep, the ridges are narrow, saw-like. The sedimentary layers in Qala e Jafar correlate with Mesozoic Era and specifically with the cretaceous period. Rocks, aged cretaceous, can be seen in many areas of Afghanistan and so on in Bamiyan Province (SH, Abdullah, Chmyriov 2008). The Lower Cretaceous is observable

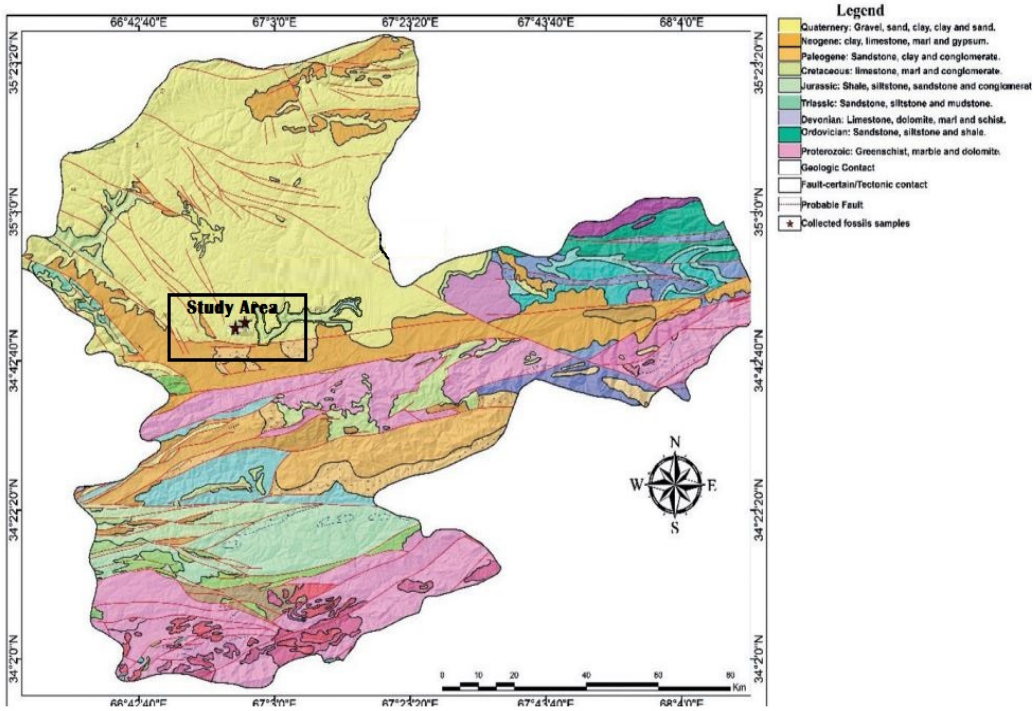


Figure-1: A part of simplified Geological map of collected fossil (Nero, Mohammad Arif et al 2021)

in northern parts of Afghanistan with an oceanic origin. Brachiopods, Bivalves and Ammonites are the main fossils of lower Cretaceous sedimentary layers in the country (Figure 1). Upper Cretaceous sediments cover a vast area of oceanic origin (Nero, Mohammad Arif et al 2021). In southern parts of Afghanistan, there are oceanic – continental sediments with Geosynclinal and Orogeny origins. Gastropods, Foraminifera, Brachiopods, Corals and Crinoids are the main fossils found in Upper Cretaceous sediments. According to the previous studies by different geologists, Bamiyan Province was left behind by the Tethys Sea around 25 – 30 million years ago (Kemp.T.S. (1999). As is clear in sea regression muds are covered by sands and subsequently, sands are covered by conglomerate. This is true in the Jurassic system in Afghanistan, especially in the North Afghanistan Platform where there are sandstone, argillite, and conglomerate sediments. Also, in Suleiman – Kirtar F. R. sandstones, siltstone, Argillite, and shale can be observed (Stevens, Calvin H, et al 1997). If Bamiyan was the last place that Tethys Sea regressed it, so that; there should have been Paleogene sediments on Cretaceous limestone as well that has gone under erosion. That is why the 30 million years layer of Paleogene sediments are absent in Qala e Jafar Stratigraphy (Nero, Mohammad Arif et al 2021).

1.4. Lithostratigraphy of study area

The age and composition of Hindu Kush sediments are varied. The oldest sediments are from Proterozoic that is called Fulul (فولول) series and have limited extension (Nero, Mohammad Arif et al 2021). The Fulul sediments contain Geo– synclinal, Mesozoic volcanic and terrestrial, and Cenozoic Terrestrial Sediments (Figure 2)

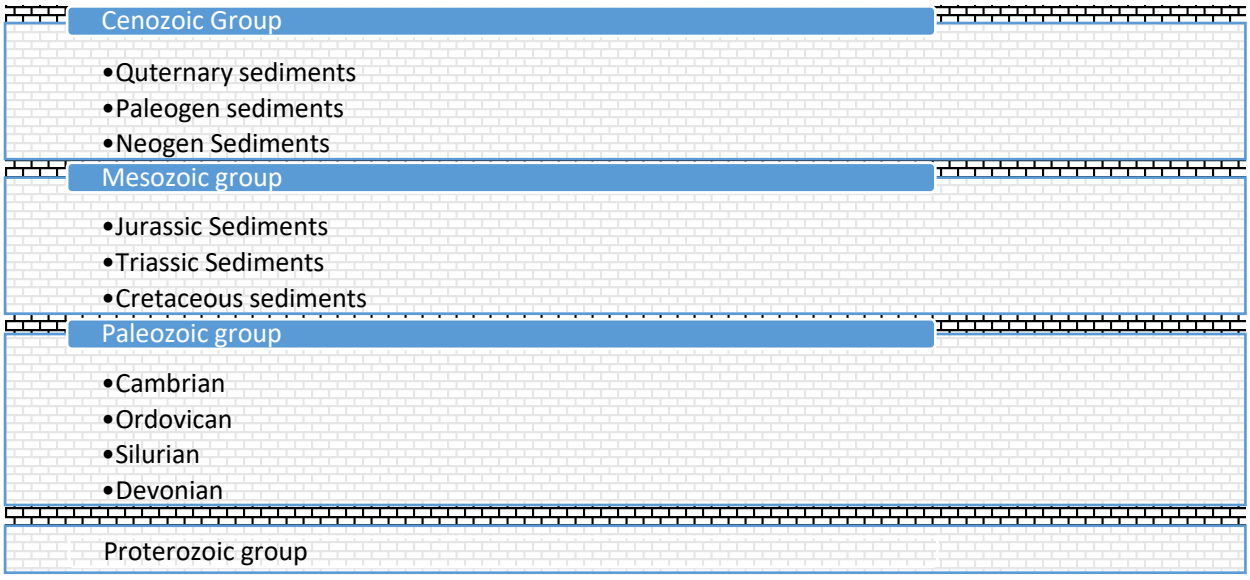


Figure-2: A brief exhibition of Bamiyan province stratigraphy (Nero, Mohammad Arif et al 2021).

2. Methodology

This research is done in all accepted methodology such as theoretical study, field-based study and laboratory analyzing which the researchers are given benefits all of them.

2.1 Theoretical study

This method was applied in the early stage of the work. The relevant resources including journal papers, conference proceedings, published reports, books were reviewed to determine the problem statement and find out the research gap. Desk studies enabled us to set the major objectives of the study. All the data achieved from palaeontology methods were compared with more than ninety different reports and scientific articles from all around the globe. So, to validate and authenticate the results, it was needy to match these research results with them. This also helped to correlate the historical geology of other places with Afghanistan. Besides, different books like Historical Geology Tectonic Evolution of Tethyan Region. And different reliable and credible websites were used. By using different published stuff, it was possible to determine the genus and species of the found fossils from the sedimentary layers and by using those as index- fossils, the relative and absolute age of the strata were determined.

2.2 Field based study

Data collection at field were conducted to collect the selected fossil samples. Specimens were cleaned and packed with paper and carried to the faculty of Geosciences Kabul University. The fossils were excavated by the geologic hammer. The materials for the research consisted of more than 8 fossil samples and 3 rock samples which were collected from sedimentary layers in Qala e Jafar.

2.3 Laboratory Analysis

The rock samples were studied by macroscopic procedure to identify the relative mineralogical composition and rock types. The rock samples were determined according to their physical properties. The reaction of the rock against Hydro–Chloric Acid (Hcl), color, and other physical properties of the rocks helped to determine them. The fossils found in the sedimentary layers; first, their Phylum was determined according to their appearance. Subsequently, according to their physical properties and by comparing their features and appearance with other fossils from the same phylum. The stratigraphy of the Bamiyan Sedimentary Layer is summarized from the same phylum and class, their order and genus were specified. Consequently, the age of strata was matched with the age of fossils, to determine the absolute age of sedimentary layers.

3. Output and Result

3.1. Petrographical studies

As the rocks reacted well when Hydro – Chloric Acid (Hcl) drops so that, the samples from the first (up to down) layer was identified as limestone. The samples from the second layer were specified Marl.

3.2. Paleontological studies

The fossils which were collected from the field identified according to their physical appearance and the results were compared with other reports to validate them. 8 different species of Bivalves, two different species of Brachiopods, and one species of Gastropods were identified. Also, fossils of Crinoids and Corals were identified, but they were not used for aging the strata. The fossils' specifications are as follows and the results are shown in (Table-1).

Analysis and consideration. The fossils collected from Qala e Jafar region of Yekawlang district Bamiyan province are divided into two collections. The first collection includes **bivalves, brachiopods, and corals**, while the second collection represents **Inoceramus Nivalves and Gastropod**. It is important to mention that the first sedimentary strata in the area is limestone – conglomerate, the second strata are limestone and the third layer is marl, from top to bottom layers (Table-1). The fossil collections were found in the second and third layers respectively. During the field sampling, also its important to confess that there are no fossils were found in the lower layers. All the specimens were studied according to their physical appearance and their comprised sedimentary rocks and then compared with other reports and scientific articles about fossils from other countries. The specimen of Carneithyris subcardinalis, which is the index fossil of Maastrichtian (Nero, Mohammad Arif et al 2021). and the specimen of Cataceramus – Balticus, the index fossil of Campanian helped us to claim that the second sedimentary layer age is Maastrichtian (72.1 to 66 million years ago) and the third strata was formed during Campanian (83.6 to 72 million years ago) in the Late Cretaceous Period (Nero, Mohammad Arif et al 2021). Geologists have established a set of principles that can be applied to sedimentary and volcanic rocks that are exposed at the earth's surface to determine the relative ages of geological events preserved in the rock record. The principle of superposition builds on the principle of original horizontality. The principle of superposition states that in an undeformed sequence of sedimentary rocks, each layer of the rock is older than the one above it and younger than the one below it. Accordingly, the oldest rocks in a sequence are at the bottom and the youngest rock is at the top. (Nero, Mohammad Arif et al 2021) Sometimes the sedimentary layers are disturbed by events, such as fault movement.

Table 1: Collected fossil sample explanation

Fossil Number -1			
Sample -1	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Dysodontes	
	Order	Autolamellibranchs	
	Family	Bivalave	
	Genus	Pholadomya	

	Species		
	Size	9X6cm	
	Approx. age	Maastrichtian stage – Upper Cretaceous	

Description

The samples collected from the area is Pholadomya genus has a tin cortex, without teeth on its cortex radial and concentric lines can be seen, and these lines form can be seen in cretaceous period but from cretaceous onward the number and species are decresses. The anomalodesmatanas are predominantly suspension-feeding marine forms with prismato – nacreous shell and reduced detention. (Benton, Michael et al 2009)

Fossil Number-2

Sample -2	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Gastropods	
	Order	Littorininmorpha	
	Family	Tylostomatidea	
	Genus	Tylostoma	
	Species	Tylostomata	
	Size	5X7 cm	
	Approx. age	Campanian stage – upper cretaceous	

Description

Tylostomatidea is an extinct family of fossil sea snails, marine Gastropod Mollusca in the superfamily Stromboidea, the true conchs, and their allies.

Fossil Number-3			
Sample-3	Kingdom	Animalia	
	Phylum	Brachiopod	
	Class	Rhynchonellata	
	Order	Terebratulida	
	Family	Gibbithyrididae	
	Genus	Carneithyris	
	Species	Carneithyris subcardinalis	
	Size		
	Approx. age	Maastrichtian stage – upper cretaceous	

Description

The specimen is an outer mold. The shell is completely missed, but a small part was left that by using it, the color of the shell was compared with other sources. The pedicle valve is bigger than the brachial one. Both valves are convex. Only one specimen of the species was found (Benton, Michael and Harper, Daved. A.T. 2009). This species of Brachiopods can be used as an index fossil because they lived shortly and widely in the upper Cretaceous.

Fossil Number -4			
Sample -4	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Bivalve	
	Order	Tylostomatidea	
	Family	Tylostoma	
	Genus	Carneithyris subcardinalis	
	Species	Neithea Regularis	
	Size	7.5X8.5	
	Approx. age	Campanian stage – Upper cretaceous	

Description			
Tylostomatidea is an extinct family of fossil seasnails, marine Gastropod Molluscs in the superfamily Stromboidea, the true conchs, and their allies.			
Fossil Number-5			
Sample -5	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Bivalves	
	Order	Pictinoida	
	Family	Pectinidae	
	Genus	Neithea	
	Species	Neithea Striastocstata	
	Size		
	Approx. age	Maastrichtian-Late Cretaceous	
Description			
The fossil shows an outer mold. It is equilateral and the left valve looks convex. The other valve is missed. Neithea is an extinct genus of bivalve mollusks that lived from the Early Jurassic to the early Paleocene (Benton, Michael et al 2009)			
Fossil Number-6			
Sample-6	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Bivalves	
	Order	Pictinoida	
	Family	Pectinidae	
	Genus	Pecten	
	Species	Merklinia Variablis/Pecten Variablis	

	Size	9x7	
	Approx. age	Maastrichtian- Late cretaceous	

Description

This fossil is an index – fossil. It appeared at 70.6 mya and disappeared in 66mya, in the Late Cretaceous. The got valve is a concave one. The size cannot be explained as some parts of it are missing in excavation. To estimate, the size is around 7cm × 9cm. The fossil is an outer mold and the umbo is straight. «Merklinia Variabilis, despite its name, is not very variable: the rib number varies from 9 to 12 but is almost always 11; the ribs are subdivided and on each side of the principal ribs there are 1 to 3 side-riblets. This species seems to be limited to the Northern European'slhite Chalk («Schreibkreide»). It is found in Turonian to Lower Maastrichtian strata in Great Britain, Campanian to Upper Maastrichtian in Limburg (Belgium - The Netherlands) (not, however, in Hainaut, Paris Basin), Senonian to Maastrichtian in North Germany, Turonian to Maastrichtian in Denmark, Senonian in Saxony and Czechoslovakia (very rare in these areas, but the number of specimens could be small because of the limited occurrence of marine Senonian deposits), Campanian to Maastrichtian in Poland and Maastrichtian of Süestern Ukraine (Takahashi, et al 2010)

Fossil Number -7

Sample -7	Kingdom	Animalia	
	Phylum	Eleutherozoa	
	Class	Ecinoderms	
	Order	Asterozones	
	Family	Asteroidea	
	Genus	Star fish	
	Species	Spatangus	
	Size	6X6.5 cm	
	Approx age	late Cretaceous	

Description

The specimen includes outer mold. So that, there is nothing to show the inner structure or specifications. Starfish are common on beaches today, and their biology made them hugely successful. Asteroids appeared first during the early Ordovician. (Benton, et al, 2009). Most specimens collected from other European outcrops are juveniles which are similar to juveniles from the type of area near Asterias.

Fossil Number-8

Sample-9	Kingdom	Animalia	
	Phylum	Mollousca	
	Class	Bivalves	
	Order	Praecardioda	
	Family	Inoceramidae	
	Genus	Inoceramus	
	Species	Cataceramus-Balticus	
	Size	9x12Cm	
	Approx. age	Campanian-Upper Cretaceous	

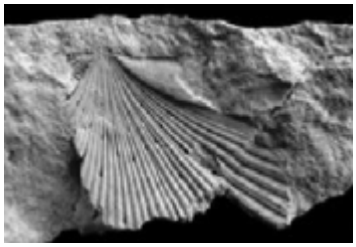
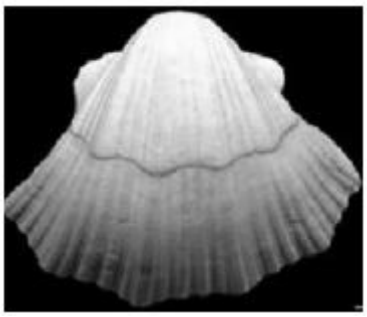
Description

The results were achieved from one left valve external mold and one internal mold. Portions of the wings, the interior organs, and ventral margins are missing. The beaks hinged toward each other. The shape is somehow elongated oval and equivalve but inequilateral. The samples are compared with the bivalves found in Ultrahelvic; Austria from Upper Cretaceous, Campanian (Thomas M.Claybourn, et al, 2019). Because they exhibit a widespread biogeographic distribution and short species longevity, their role as biostratigraphic index fossils for the correlation of Mesozoic marine strata, particularly in the Late Cretaceous, is well established (Takahashi, et al 2010). So that, Cataceramus – Balticus is the index fossil of Campanian. Inoceramids had a thick shell paved with "prisms" of calcite deposited perpendicular to the surface, which gave it a pearly luster in life. Most species have prominent growth lines which appear as raised semicircles concentric to the growing edge of the shell. Paleontologists suggest that the giant size of some species was an adaptation for life in the murky bottom waters, with a correspondingly large gill area that would have allowed the animal to survive in oxygen-deficient waters. The right image is the Inoceramus from Bamiyan Province which is compared apparently with another specimen from another area (Arian, Hamidullah, 2020).

That cut across layers after the rock were deposited. This is the principle of cross-cutting relationships. The principle of faunal succession states that different fossil species appear and disappear in the same order and that once a fossil species goes extinct, it disappears and cannot reappear in younger rocks (Nero, Mohammad Arif et al 2021). Fossil species that are used to distinguish one layer from another are called index fossils (Prothero, Donald et al 2004). Index fossils occur for a limited interval of time. Usually, index fossils are fossil organisms that are common, easily identified, and found across a large area. Because they are often rare, primate fossils are not usually good index fossils. Organisms like pigs and rodents are more typically used because they are more common, widely distributed, and evolve rapidly

(Abdullah S.H et al 1977- Reprint, 2008). According to the fossils that were found in the area of study, the historical geology, past environment, and the evolution of life in the cretaceous period can be explained. As is clear, the existence of brachiopods, bivalves, corals, and crinoids prove that the area was covered by an epicontinental ocean that did not have more than 200 meters depth; in the other words, the area of study was a shelf that the sunshine could influence the sea water' so that, many animals abounded there. For instance, Fossil crinoids indicate that the rocks containing their remains were formed in a marine environment, they suggest the former existence of shallow water conditions. Besides, the fossils that are recorded in Qala e Jafar, show that the sea covered the area was warm and the temperature might be more than 30 degrees of Celsius; it means that the area was located in a tropical region of the earth. To compare the Paleoenvironment of the area with other regions in the same altitude, experienced the same climate and similar fauna were recorded in all of them. For instance, similar Inoceramus Bivalves were recorded in Austria as in Qala e jafar (Treloar P.J., et al 1993). This comparison shows that both areas experienced transgression of sea, similar climate, and similar fauna. Also, Poland recorded similar Bourgueticrinidae crinoids in Late Cretaceous crinoids from southern Poland (Annie V. Dhondt, 1984). To focus on the lithology of the area, the first layer is formed by the conglomerate, the second strata is Limestone and the third layer is composed of Shale/ Marl and consequently, the final strata outcropped, is sandstone. According to the lithology of the area, the area was transgressed by the Tethys Sea. A thin tongue of marine limestone indicates brief incubation of the sea, whereas local beds with gypsum and halite crystals casts attest to a rather arid climate.

Table 2- Adaptations of the collected sample of fossils related to Bivalves from Qala e Jafar (Left) with fossils from other places

		Bivalvai (Pecten) Neithea Striastocostata (Von Hagenow 1833) Maastrichtian (99 to 66 million years ago) Left Image: Bamiyan Right Image: Haccourt-Belgium
		Bivalvai (Pecten) Neithea Striastocostata (Goldfuss 1833) Maastrichtian (84.9 to 66 million years ago) Left Image: Bamiyan Right Image: Bulgaria

		Bivalvai (Pecten) Neithea Striastocostata (Goldfuss 1833) Maastrichtian (84.9 to 66 million years ago) Left Image: Bamiyan Right Image: Bulgaria

Table-3: Adaptation Bivalves, Brachiopod and Gastropods classes of collected fossil from Qala e Jafar area with other places

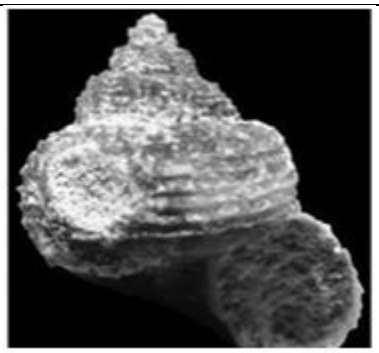
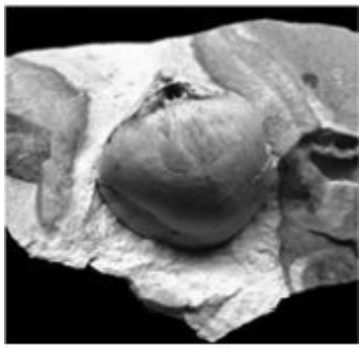
		Gastropod (Dexetral) Periaulux rimosus (Binkhorst 1833) Campanian (0.00 to 66 million years ago) Left Image: Bamiyan Right Image: Bulgaria
		Brachiopod Careithyis subcardinalis (Sahni 1925) Maastrichtian (70.6 to 66 million years ago) Left Image: Bamiyan Right Image: Bulgaria

Table-4: Adaptations of the collected fossils from Bivalves, and Echinodermata classes from Qala e Jafar.

		Bivalve Inoceramus Leone river 84.9 to 66 million years ago) Left Image: Bamiyan Right Image: Usgs

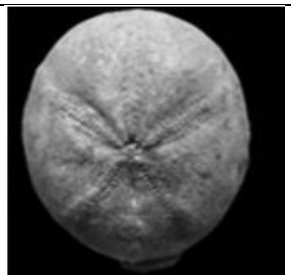
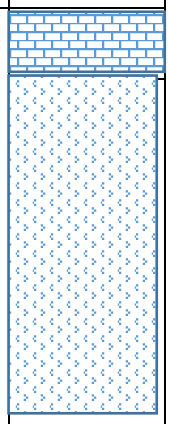
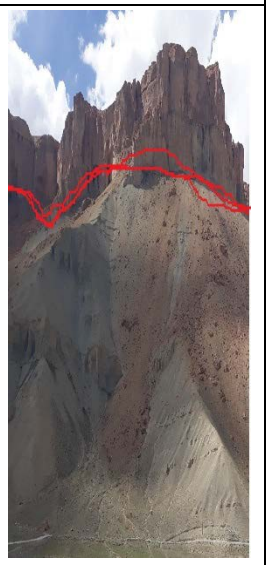
		Echinodermata Hemiaster prunella (Schlotheim1833) Lambert R. 1999 (89.3 to 66 million years ago) Left Image: Bamiyan Right Image: Bulgaria

Table -5: Lithostratigraphy of Qala e Jafar sedimentary layer

Period	Stage	Thickness (Meter)	Fossils	Lithology	
Late Cretaceous	Maastrichtian	10-20			
	Campanian	500-600			

4. Conclusion:

1. The sedimentary strata of Qala jafar of Yekawlang district in Bamiyan province are formed of conglomerate, limestone, and marl, and each sedimentary layer is consisting of different fossils. According to their fossils, the paleoclimate, past environment, and geological history of the area can be explained. 2. Index fossils of Brachiopods and Bivalves helped to determine the age of the layers. Hence, the second sedimentary layer was aged according to Brachiopod, Carneithyris subcardinalis, the guide fossil of Maastrichtian, and the second layer were aged Campanian according to the Inoceramus index fossil, Cataceramus Balticus. 3. In Lower Cretaceous, the sea levels were raised and created epicontinental oceans. New Tethys also incurred the northern parts of Afghanistan, including Band-e-Amir. According to the fossils and sediments that were recorded in Qala e jafar, Sea transgression and regression are easily explicable. 4. Besides, the variety of fossils show the tropic climate in the area; it means that in the Cretaceous Period, Afghanistan was located near the equator. So that, the fossils were compared with different countries, to know if all equatorial countries experienced the same geological events, and the results have shown positive answers. As mentioned in Geology of Qala e jafar, this area was once covered with the New Tethys Sea, so that; there are a variety of oceanic fauna fossils e.g., Brachiopods, Gastropods, Corals, and Crinoids. The most upper layer was eroded. No significant fossil was found in this layer, but further research might

introduce fossils in the second layer of the Qala e jafar region. The third layer has embedded different fauna and most of the fossils found in this layer can be used as index fossils. In the third layer, we could only find Inoceramus bivalve fossils. Inoceramus has the potential to be used as an index fossil, thus by using this fossil, the third sedimentary layer of this area was aged Campanian. Crinoids' fossils in the third layer elicit that these sediments were formed in a shallow sea. Occasionally, crinoids can be a useful guide to the age of the rocks in which they occur. This is the case in the strata of the Late Cretaceous age, known as the Chalk Group, which forms the famous White Cliffs of Dover. Species of Uintacrinus, Marsupites, and Applinocrinus are so abundant over four narrow intervals in the Chalk, that they have been used to define Bio-zones and Sub-biozones.

Table-5: Frequency of recorded fossil at Qala e Jafar Area

Cenozoic	Quaternary		2.5 Ma	
	Neogene		23.0Ma	
	Paleogene		66 Ma	
Mesozoic	Late Cretaceous	Maastrichtian	72.1 Ma	
		Campanian	83.6	
		Santonian	86.3	
		Coniacian	89.8	
		Touronian	93.9	
		Cenomanian	100.5	
	Late Cretaceous	Albian	113	
		Apptian	125	
		Barremiann	129.4	
		Hautervian		
		Valanginian	139.8	
		Berriasian	145	
	Jurassic			
	Triassic			
	Permian			
	Carboniferous			
	Devonian			
	Silurian			
	Ordovician			
	Cambrian			

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