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Foraminifera Turnover during the late Cretaceous-early Paleocene at the Sheraswar area- Erbil (Iraqi Kurdistan Region)

Research project

Submitted to the department of the Earth Sciences and Petroleum in partial fulfillment of the requirements of the degree of BSc. In Earth Sciences and Petroleum

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April-2024

Acknowledgements

As students ،we would like to express our warm gratitude and appreciation to **Dr. Dana Noory Ridha** who worked tirelessly with us to create this beautiful research that tirelessly worked with us to help us find the references and other things. We also thank our very dear **Mr. Omed** when making the samples ،it was helpful to keep our samples safely.

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Abstract

Sixteen samples were collected from the late Cretaceous to early Palaeocene successions in the Sheraswar area (Northern Erbil). The outcrop of these successions is located in the southwestern limb of the Safin anticline, and it includes the Shiranish, Tanjero, and Kolosh formations. The lithology is typically made up of marlstone and calcareous shale at the bottom and clastic rocks like siltstone and sandstone interbedded with extremely thin bedded limestone in the middle. Clastic sediments become more abundant as one progresses upward. Previous studies characterized the depositional environment as deep marine for the Shiranish Formation and turbidite deposits for the Tanjero and Kolosh formations. The thickness of the studied section is 51.9 mt. The current study focuses on faunal turover during the late Cretaceous to the early Paleocene. consequently selective sample collection done for the studied formations (Shiranish ، Tanjero and Kolosh) in the Sheraswar area. Observing of faunal turnover were satisfied through studying a range of most abundant benthic and planktonic foraminifera. It is been noted that *Cibicidoides* sp.1, *Oridorsalis* sp.1 and *Gavelinella monterelensis* have high abundance in both Shiranish and Tanjero formations, but suddnly they rapidly declined and disapeared within Kolosh Formation. It does mean that these species were more indicative and coexisted during the late Cretaceous. Species such as *Prebulimina reussi, Anomalinoides* sp.1 and *Osangularia* sp.1 recorded in both Shiranish and Tanjero formations. All types of *Heterohelix* are reported in the Shiranish Formation, but appears again Tnjero Formation. Species such as *Subbotina* and *Morozovella* were more indicative during the Paleocene (Kolosh Formation). The above selective distribution and turnover of foram species may have been impacted by climatic changes during the late Cretaceous and early Paleocene.

1-Introduction

1-1 Preface:

Sixteen samples are collected from the late Cretaceous to early Paleocene successions near the Sheraswar area. The outcrop of these successions situated in the south western limb of Safin anticline including Shiranish, Tanjero and Kolosh formations. The lithology is usually composed of marlstone and calcareous shale at the bottom and clastic rocks such as siltstone and sandstone interbedded with very thin bedded limestone in the middle. Towards the upper part the clastic sediments become more common. The previous works limited the depositional environment as a deep marine for the Shiranish Formation and turbidite deposits for both Tanjero and Kolosh formations.

Phanerozoic experienced five mass-extinctions, the most recent one recorded at 66.04 Ma, the Cretaceous/Paleogene (K-Pg) extinction (Raup and Sepkoski 1982; Wooldridge 2008).

Hildebrand et al. (1991) suggested that 180-km-diameter circular structure in the Yucatán Peninsula (Mexico) created as the impact of asteroid collision. Many other hypotheses confirmed the impact of bolide collision (e.g. Schulte et al. 2010; Mateo et al. 2020).

As a result of large igneous province (LIP) of the Deccan Traps in India a large global sea level fluctuation and climatic changes happened (e.g. Keller et al. 2020; El –Sabbagh et al. 2004; Kaiho et al. 2016).

According to Alvarez et al. (1980) the Cretaceous-Paleogene transition of the deep-sea sediments in Italy, Denmark, and New Zealand proposed an extraterrestrial cause for the K-Pg extinction.

A little attention has been received in Iraq and Kurdistan Region regarding to the K-Pg boundary. Evidencing the subaerial exposure confirming the Danian missing (i.e., Al-Omari 1966; Al-Qayim and Al-Shaibani 1989; Al-Hadidi and Ahmed 2019). In contrast, other studies have confirmed the complete K-Pg transition deposition in both the Kurdistan Region (north of Iraq) and the western desert of Iraq (i.e., Sharbazheri et al. 2009; 2011; Salih et al. 2013; Al Nuaimy et al. 2020; Mousa et al. 2020; Bamerni et al. 2021).

1-2 Location of study area:

Shera Swar is located on the main road between Salahadin and Shaqlawa at a distance of 42 kilometers from Erbil. The formations are out cropped in this section are Tanjaro, Shiransh and Kolosh Formation. The coordination of the studied section is 36° 24'13.79" N, 44° 14 '21.40" E.

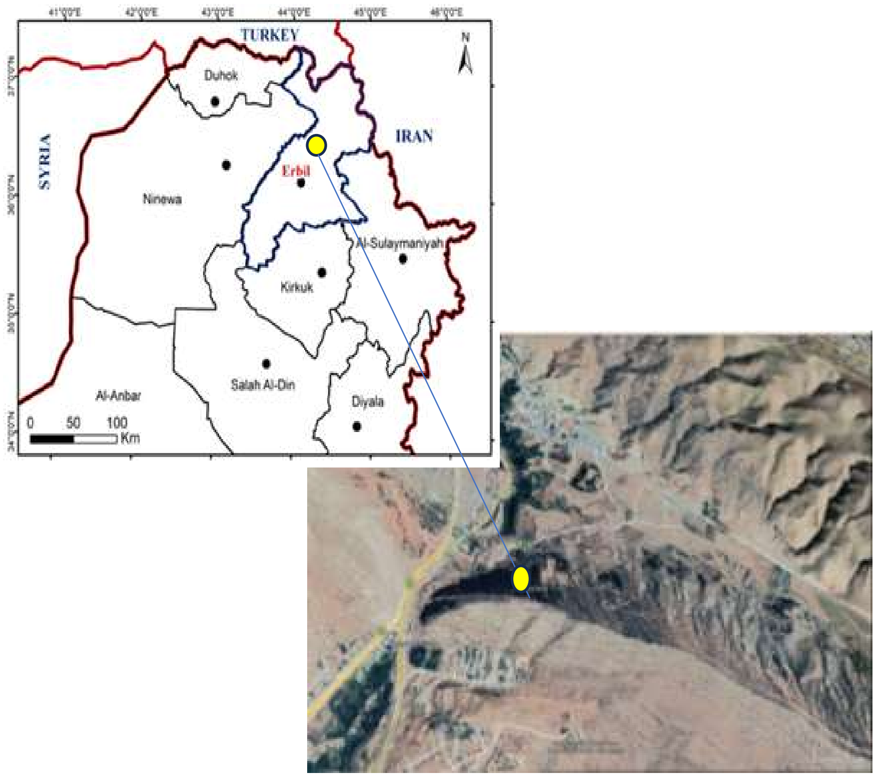


Figure1. 1: Location of the study area, shown on google earth.

1-3 Tectonic setting:

Tectonic setting of the Sheraswar area in the Kurdistan region is primarily influenced by the collision between the Arabian Plate and the Eurasian Plate. This region is situated within the broader framework of the Zagros Fold and Thrust Belt, which extends from southeastern Turkey through northern Iraq and into western Iran (Alavi, 2007).

Specifically, Sheraswar lies within the High Folded Zone of the Safin anticline. This area is characterized by intense deformation, including folding, faulting, and uplift, resulting from the ongoing convergence of the Arabian and Eurasian Plates. The collision has caused the sedimentary rocks in the region to undergo significant compression, leading to the formation of anticlines, synclines, and thrust faults.

The tectonic activity in the Sheraswar area has resulted in the uplift of mountain ranges and the development of complex geological structures. The region experiences frequent seismic activity as a result

Safin anticline is affected by two different folding phases of Alpine orogeny in Upper Cretaceous and during or after Late Miocene. There are two folding systems in Safin anticline: Cretaceous folding system and Tertiary folding system. They are likely to be formed by a combination of orthogonal flexure (neutral surface) folding and flexural-slip folding.

Tectonically, Safin anticline is divided into four transversal blocks. They are Sulawka block, Shaqlawa block, Zebarok block and Sulan block. Each of them has its own structural, stratigraphic and geomorphologic characteristics. Safin anticline and the associated structures are formed as a result of the regional horizontal compression stresses in the NE-SW direction during Alpine orogeny. Moreover, the study area is affected by vertical stresses, which are produced by the movements of basement blocks that developed Safin anticline (Doski ,2002 unpublished report).

1-4 Aim of the study:

The main objective of the current study is to examine the climatic changes and its impact on the fossil assemblages during the late Cretaceous and Early Palaeocene. Using fossil as a proxy for climatic fluctuations still ambiguous and need more detailed investigations to answer all changes experienced by the Neo-Tethys during that time in our region. The impact of the asteroid collision on the ecosystem was so intensive that affect directly all creatures around the world during the latest Cretaceous. Most fossil assemblages turned over and a new species had emerged.

2- Methodology

2-1 Field work:

The current study focuses on faunal turover during the late Cretaceous to the early Paleocene. consequently selective sample collectios required from three different formations (Shiranish ، Tanjero and Kolosh) in the Sheraswar area.

The equipment used at the duration of this fieldtrip were as follows:(bag sample ،pencil ، foot،hummer،notebook). In each form ،we received several samples ،and recorded the lithology and length(m). The Shiranish Formation consisted of marl and shale,Tanjero Formation consisted of marl,silt, fine grained sand and thin bedded limestone ،and Kolosh Formation consisted of silt and sand.The thickness of the studied succesions are: Shiranish Formation 14.3m, Tanjero Formation 22.6 and Kolosh Formation 15m.

2-2 Lab work:

After preparing the samples in the field, samples were wieghed then putted it into a beeker submerging in a clean water. Soda powder were added and boiled for five hours or more depending on the lithologic differences. Water have been spilled and added H_2O_2 for 24 hours, then washed and sieved (a stainless steel U.S. Standard Sieve No. 230 with mesh openings of 63 microns is recommended). The reminder were dried up and then built it in four different sizes, and picked in under microscope randomly not in one size then we put it on the a slide and created data.

Figure2. 1: Some outcrops show the measurement the studied formation successions.

3- Stratigraphy

3-1 Lithostratigraphy:

3-1-1 Kolosh Formation:

Dunnington (1952 in Bellen et al., 1959) first describes the Kolosh Formation type section in Koya, which is located in the northern Iraq in the high folded zone. Its age ranges from the Palaeocene to the early Eocene, with a thickness of 777 meters. The formation is consisting of limestone with calcareous silt, shale interlayers, thin sandstone, siltstone, marlstone, and less common conglomerate. These layers alternate rhythmically. They more resemble flysch like sediments (Dunnington, 1958).

One of the widely clastic strata discovered throughout northern Iraq is the Kolosh Formation. Due to its lithological characteristics, the formation was described by many researchers as flysch deposits. The clastic unit of the fore-deep depozone is represented by the Kolosh Formation (Znad, 2013).

Kolosh Formation is out croped in the study area and overlies Tanjero Formation. The studied section of the Kolosh Formation consists of siltistone, olive green siltstone and fine sandstone. The lower part commonly composed of olive green siltstone and towards the tops the lithology is composed of coarse grained siltstone and very fine sandstone. Only the lower most part of the formation has been studied with a thicknes of 15mt.

3-1-2 Shiranish Formation:

The upper part of Shiranish Formation has been studied (14.3 mt.) in Sheraswar near Shaqlawa area (Campanian-Maastrichtian). Lithology of the upper part of the Shiranish Formation consists of grey marl and calcareous shell with thin bedded limestone towards its boundary with Tanjero Formation.

Henson (1940 in Van, Bellen et al., 1959) first described Shiranish Formation in Shiranish Islam, NW Iraq, where it takes its name. Shiranish Formation is composed of 225m thick, thinly-bedded shales, marl, argillaceous to marly limestone. It passes conformably and gradually down into Bekhme Formation, overlain by silty shales and thin sandstones of Kolosh Formation. In other parts of northern Iraq (SE Dokan), the Formation consists of marl with Late Campanian Planktonic foraminifera assemblage grading to middle Maastrichtian shales (Abawi, 1982).

3-1-3 Tanjero Formation:

The formation in the studied section consists of 22.6 meter of thin bedded yellowish blue marly limestone interbedded with blue marl in the lower part, whereas the upper part consists of thin yellow limestone and yellowish blue marly limestone interbedded with gray marl and silt. The foraminifera species are extracted from three samples of friable sediments in the studied section. The result shows that the planktonic and benthonic foraminifera have a medium to high abundance and high diversity. The proposed depositional environment of the Tanjero Formation is a deep shelf and slope environment depending on field observation, foraminiferal content of friable rocks, and microfacies analysis of carbonate rocks (Abid et al., 2022).

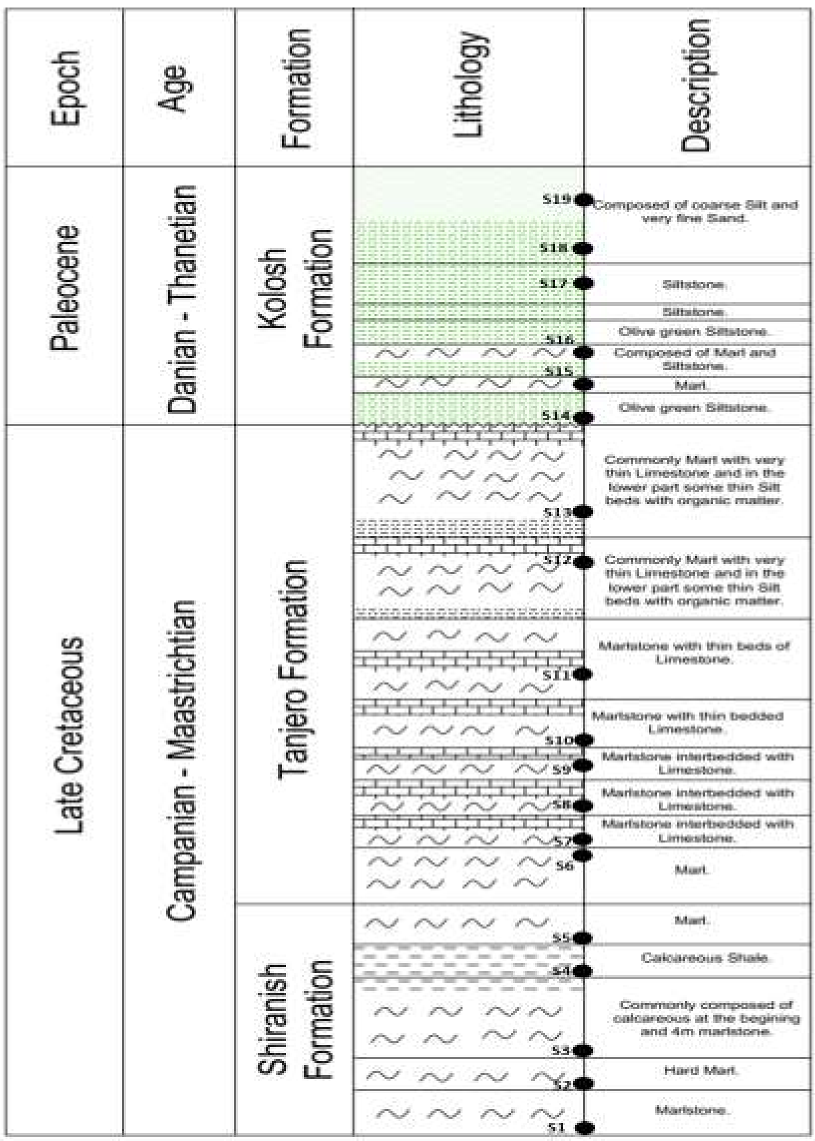


Figure3. 1: Stratigraphic column of the studied area shows the distribution of the deposited formations with their age and lithologic descriptions. (note: the collected samples have been shown by black dots)

3-2- Biostratigraphy

Almost 25 genera of benthic foraminifera have been identified among them 50 different species have been recognized. The planktonic foraminifera also been extracted and identified. Twenty (20) genera of planktonic foraminifera been identified involves 42 different species. According to their destribution the foram species have grouped into different assemblages some of them considered to be indicative for the croped out formations boundary.

3-2-1 Assemblage Zone A:

The current study focused on the distribution of both benthic and planktonic foraminifera. This assemblage zone include samples 1- 6 which consists of the species belongs mostly to Shiranish Formation. Include *Cibicidoides* sp.1, *Oridorsalis* sp., *Gavelinella monterelensis*, *Gavelinella eriksdalensis*, *Bolivina* sp.1, *Bolivina incrassata gigantea, Lenticulina* sp., *Praebulimina reussi, Gaudryna* sp.1, *Cibicides* sp., *Tritaxia* sp.1, *Gyrodina* sp.1, *Gyrodina* sp.2, *Bolivinoides milliaris, Anomalinoides* sp.1, *Anomalinoides* sp.2*, Asterigerina* sp.1, Unknown sp.1, Unknown sp.2, Unknown sp.3, Unknown sp.4. Planktonic forams have been collected in this zone are mosly confined to the Shiranish Formation consists mainly of *Globotrancana arca, Pseudoguemblina costata, Pseudoguemblina plapebra, Heterohelix* sp.1*, Heterohelix* sp.2*, Heterohelix* sp.3, *Chlioguemblina* sp.1, *Pseudotextularia elegans, Hetrohelix globulosa, Globotruncana contusa ,Planohetrohelix vistulaensis, Planohetrohelix globulosa, Hetrohelix* cf. *Americana, Pseudoguemblina* sp.1, *Globigerinelloids* sp.1, *Globigerinelloides mariddensis, Planohetrohelix planata, Hedbergella planispira, Globotruncanita stuaritiformis, Globotrancana rostta, Hetrohelix hohenemensis.*

3-2-2 Assemblage Zone B:

This zone consists of species which distributed within samples 6- 12 almost restricted within Tanjero Formation. Benthic species belongs to this zone are Unknown sp.5, Unknown sp.7, Unknown sp.6, *Anomalinoides* sp.3, *Lenticulina* sp.2, *Lenticulina* sp.3, *Cibicides* sp.3, *Melonis* sp.1, *Melonis* sp.2, *Melonis* sp.3, *Dentalina* sp.1, *Dentalina* sp.2, *Dentalina* sp.3, *Glandulina laevigata, Nodusaria* sp.1, *Nodusaria* sp.2, *Osangularia* sp.1, *Osangularia* sp.2, *Rosalina nitens, Pleurostomella* sp.1, *Spiroplectinella dentata*, *Astacolus* sp.1, *Astacolus* sp.2, Undefined sp.1. Planktonic foraminifera are *Hetrohelix trochospiralis, Rugoglobigerina rugosa, Globohetrohelix paraglobulosa, Globorotalia* sp.1*, Rugoglobigirina macro, Archaeoglobigerina australis, Paraspiroplecta navarroensis, Microhedbergella miniglobularis, Hedbergella infracretacea, Planohedbergella multispira, Hedbergella* sp.1, *Hedbergella* sp.2*, Hedbergella* sp.3.

3-2-3 Assemblage Zone C:

The current zone represent all species that have distribution within Kolosh Formation (from samples 14-17). Benthic foraminifera are *Triloculina* sp.1, *Anomalinoides affinis*, *Anomalinoides zitteh, Lenticulina* sp.3, *Melonis* sp.2, *Osangularia* sp.2, *Stilostomela* sp.1. Planktonic foraminifera are *Parasubbotina pseudobulloides, Morozovella volascoensis, Globanomalina compressa, Subbotina triloculinoids, Morozovella* sp.3*, Morozovella* sp.1*, Morozovella* sp.2*, Globanomalina pseudomenardii*.

4- Results and discussion

4-1 Species abundance and diversity:

The curve (Figure 1.4) shows the relative abundance of both planktonic (blue arrow) and benthic foraminifera (red arrow) and diversity using Shannon index. In the first three samples both values of abundance are relatively close to each other. The values started to show big variations starting from samples 4 to 7 (Tanjero Fn.). Slightly offset values have been detected near the Tanjero Formation, this could be coinsided with depositional environment offset between Shiranish Fn. and Tanjero Fn. Values become more similar from samples 8 to 12 until it shows a big offset during the deposition of the Kolosh Formation (samples 14 and 15). This big fluctuation variations may be affected by a big climatic shifts during the late Cretaceous until the Paleocene.

The diversity is increased during the late Cretaceous for benthic forams, while the planktonic foraminifera diversity dropped down suddnly during the deposition of the Tanjero Formation. Jaff and Lawa (2019) recorded diversity offset of planktonic foraminifera with benthic foraminifera abundance during the late Cretaceous in Dokan and Azmar section which is also observed at the current study.

Below table shows the percentages of planktonic foraminifera and the depositional environments. The current study planktonic abundance ratios dropped suddenly in two times at the lower part of both Tanjero and Kolosh formations. This dropping may indicate the rapid environmental changes or some mistakes during the picking processes. In fact, the first probability is more realistic as Shiranish Formation is deeper than Tanjer Formation, and the second drop around the sample 14 and 15 is gradual.

Table4. 1:Planktonic foraminifera Percentages versus the depositional environments according to Grimsdale and Morkhoven (1955) and Olsson and Nyong (1984) (in Abid et al., 2022)

Grimsdale and Morkhoven (1955)	Olsson and Nyong (1984)
Inner shelf <15%	
Middle shelf 15–30%	Middle shelf 8–30%
Outer shelf >30–50%	Outer shelf>30–70%
Upper slope>50–75%	Upper slope>70–90%
Middle slope> 75–90%	Middle slope> 90%
Abyssal and hadal>90%	

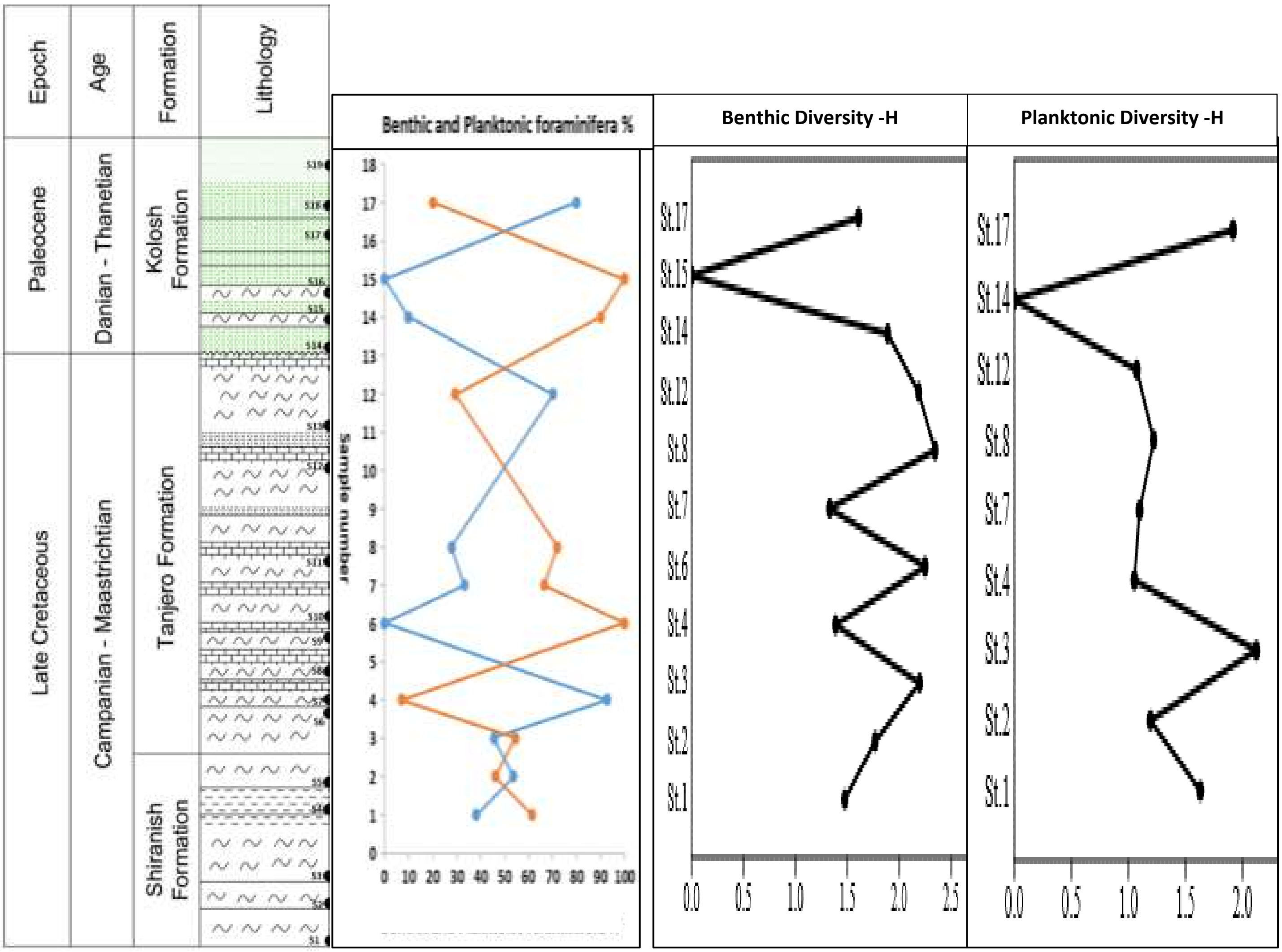


Figure4. 1:Trends of foraminiferal abundance %, planktic and benthic foraminiferal species diversity using Shannon index for the all studied formations in the Sheraswar section, NE Iraq.

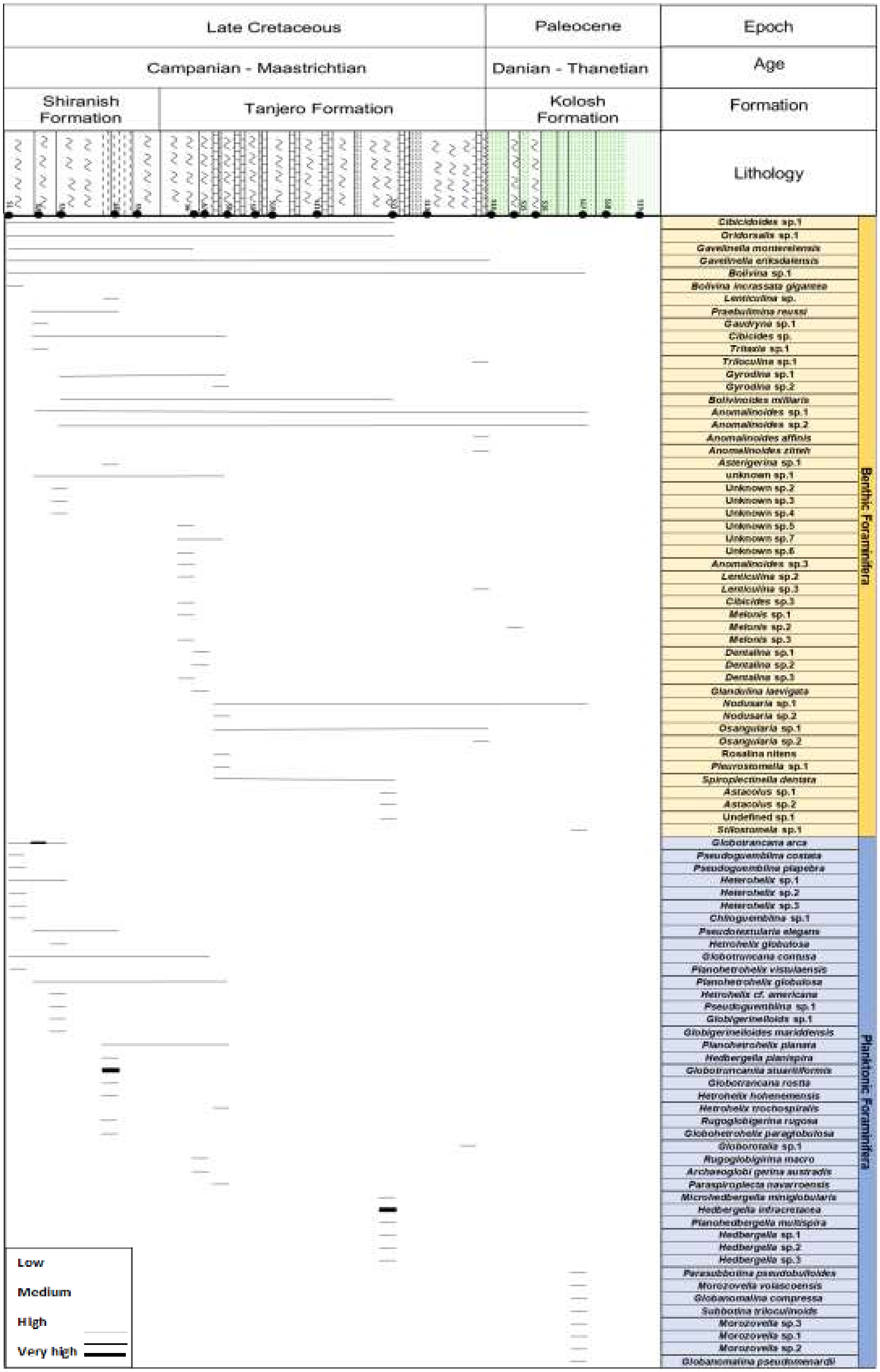


Figure4. 2: Range chart of ninety-two foraminifera species encountered at Sheraswar area, Northern Erbil Governorate. The abundance shown in a small box at the bottom left from low to very high abundance.

4-2 Faunal composition:

Both benthic and planktonic foraminifera abundance were tested to reveal their fluctuation during the late Cretaceous to early Paleocene. Most abundance species have been chosen to testify the climatic variations on their accumulation. Below are the results of the most abundance species of both benthic and planktonic foraminifera:

4-2-1 Benthic foraminifera:

Relative abundance of nine most abundance species were chosen. It is been noted that *Cibicidoides* sp.1, *Oridorsalis* sp.1 and *Gavelinella monterelensis* have high abundance in both Shiranish and Tanjero formations, but suddnly they rapidly declined and disapeared within Kolosh Formation. It does mean that these species were more indicative and coexisted during the late Cretaceous (Figure 1.6). *Gavelinella monterelensis* recorded by Jaff and Lawa (2019) and it limited to late Campanian assemblages.

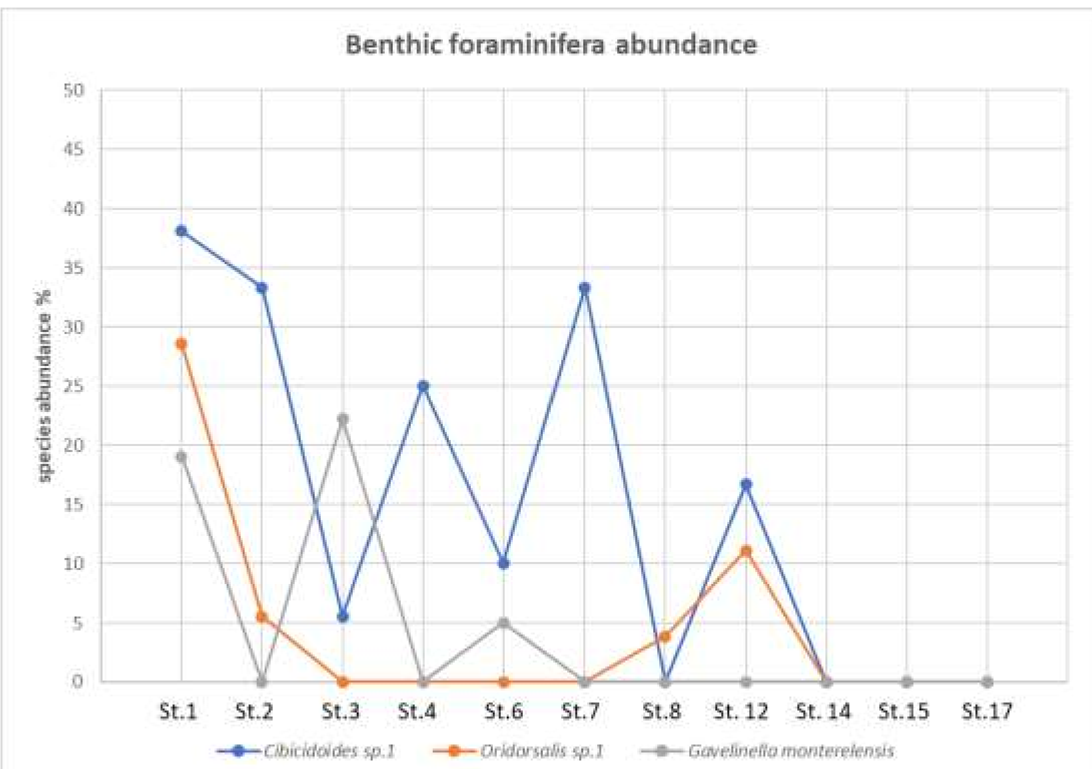


Figure4. 3: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous.

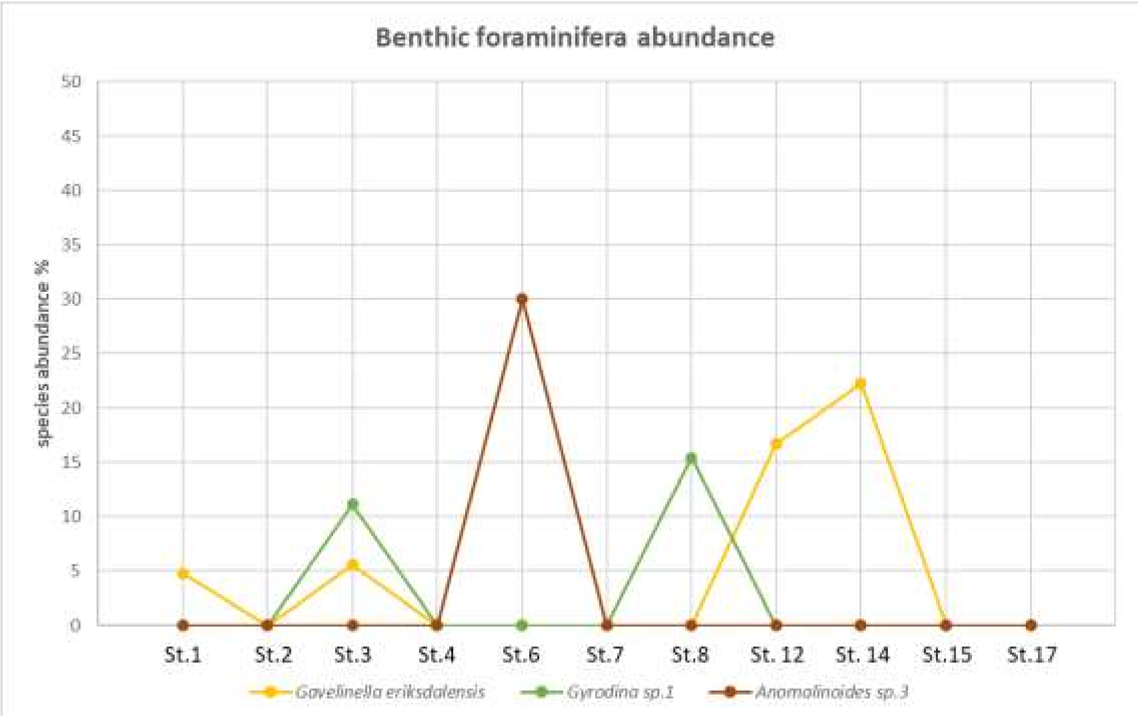


Figure4. 4: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous and early Paleocene.

Some other species such as *Gavelinella eriksdalensis*, *Gyrodina* sp.1 and *Anomalinoides* sp.3 picked in different time it may be responding differently to the climatic changes during around the late Cretaceous and the early Paleocene. Here *Gavelinella eriksdalensis* recorded highest peak during the early Paleocene. This species may be responding to new climatic configurations during the Paleocene (Figure 1.7).

Species such as *Prebulimina reussi, Anomalinoides* sp.1 and *Osangularia* sp.1 recorded in both Shiranish and Tanjero formations (Figure 1.8). *Anomalinoides* sp.1 started to record the highest abundance during the early Paleocene (St.17). Jaff and Lawa 2019 found *Prebulimina reussi* in the Shiranish Formation (Azmer section) and they considered to have a late Campanian age.

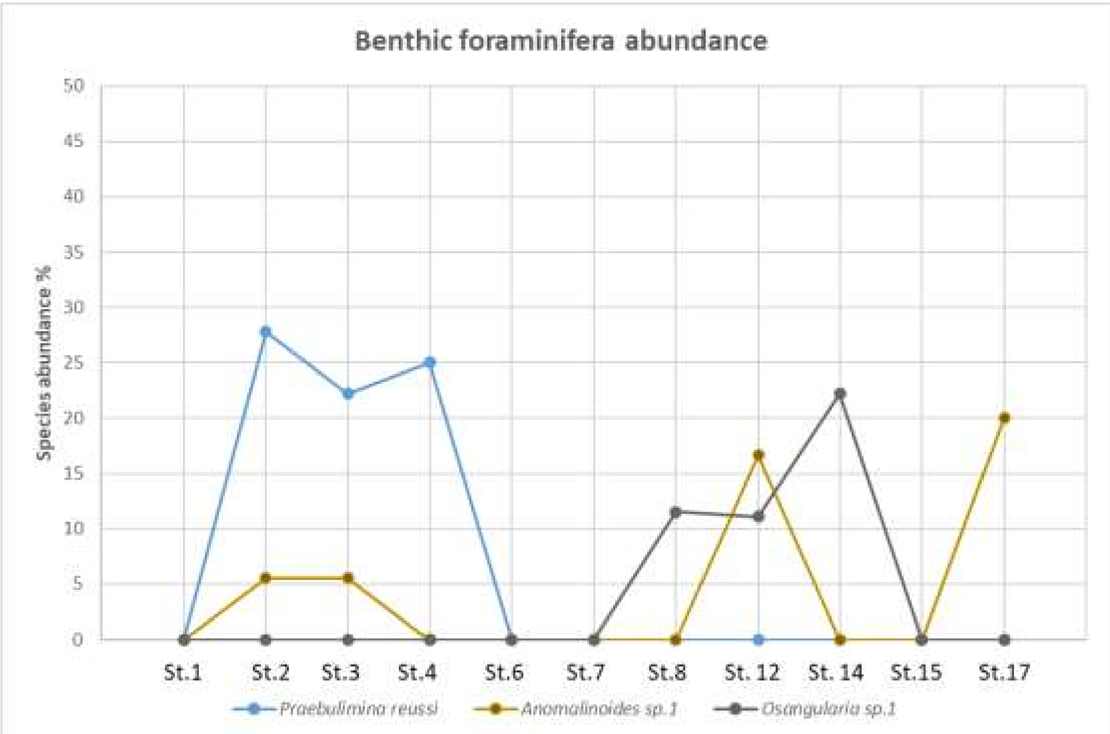


Figure4. 5: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous and early Paleocene. Species such as Osangularia sp.1 only recorded in the Tanjero Formation.

4-2-2 Planktonic foraminifera:

Relative abundance of different planktonic forams been tested. Each species ranged diffrently during the late Cretaceous to early Paleocene. These species are index for proper range of time such as *Globotrancana arca* and *Globotrancanita stuaritiformis* have found in the Shiranish Formation, while *Hedbergella infracretacea* are restricted to Tanjero Formation (Figure 1.9). Almogi-Labin et al. (1986) recorded *Gl.arca* from Campanian to late Maastrichtian. *Globotrancana arca* has found in Tanjero Formation according to Abid et al. (2022).

All types of *Heterohelix* are reported in the ShiranishFormation and it has a highest peak in St.3, but appears again in St.8. Species such as *Subbotina* and *Morozovella* were more indicative during the Paleocene (Kolosh Formation). Apearing of some species and disapearing the others means the faunal turnover during the latest Cretaceous, where no *Heterohelix* species been recorded during the early Paleocene (Figure 1.10).

Here all *Hedbergella* species been recorded during the late Cretaceous, especially in St.12, where the highest ratio recorded. In contrast most *Globotruncana* recorded high abundance in the Shiranish Formation, while decreased towasrds the latest Cretaceous (Tanjero Formation). It has only reported in sample St.7 with lower abundance then disapeared (Figure 1.11). Al-Khalaif and

Al- Mutwali (2020) found both *Subbotina triloculinoides* and *Morozovella velacoensis* in the Kolosh Formation near the Duhok area.

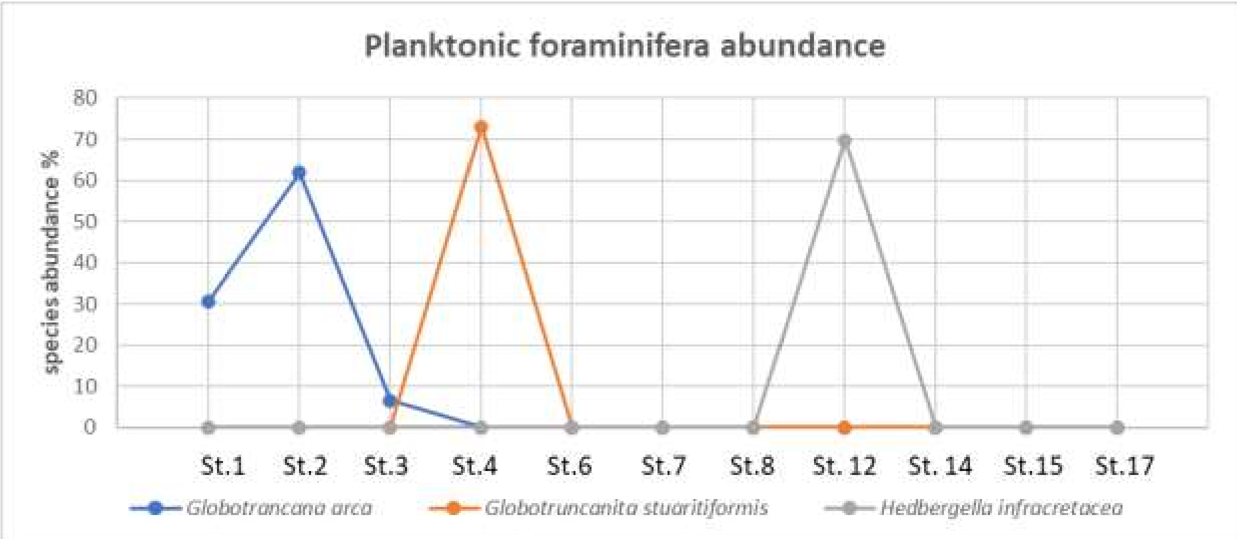


Figure4. 6: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous. Species such as Hedbergella infracretacea only recorded in the Tanjero Formation.

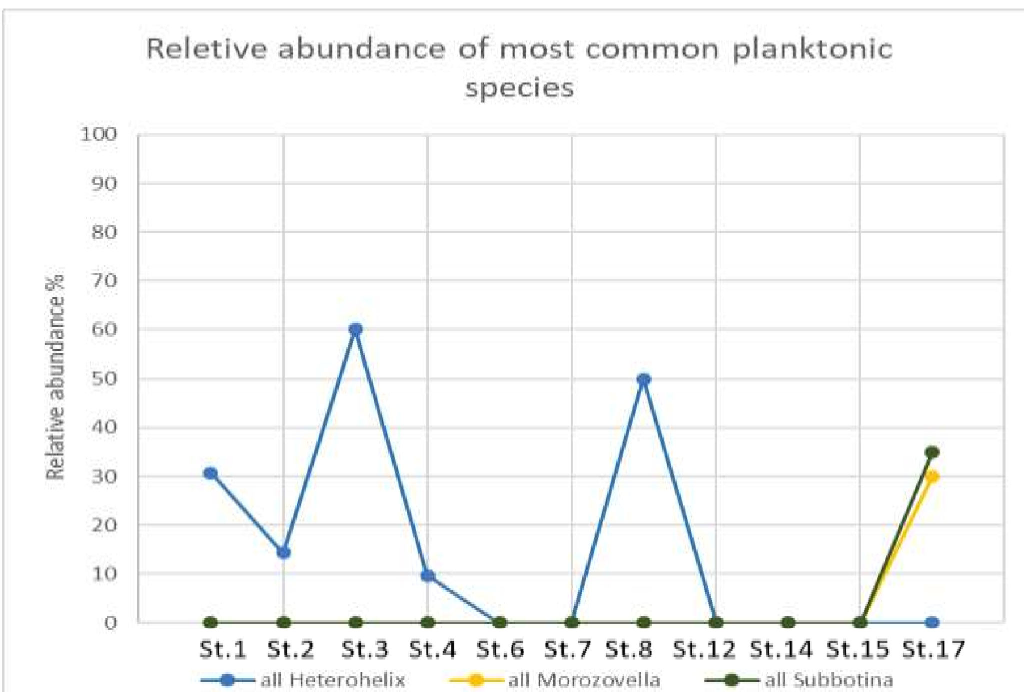


Figure4. 7: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous and early Paleocene. Species such as Subbotina only recorded in the Kolosh Formation.

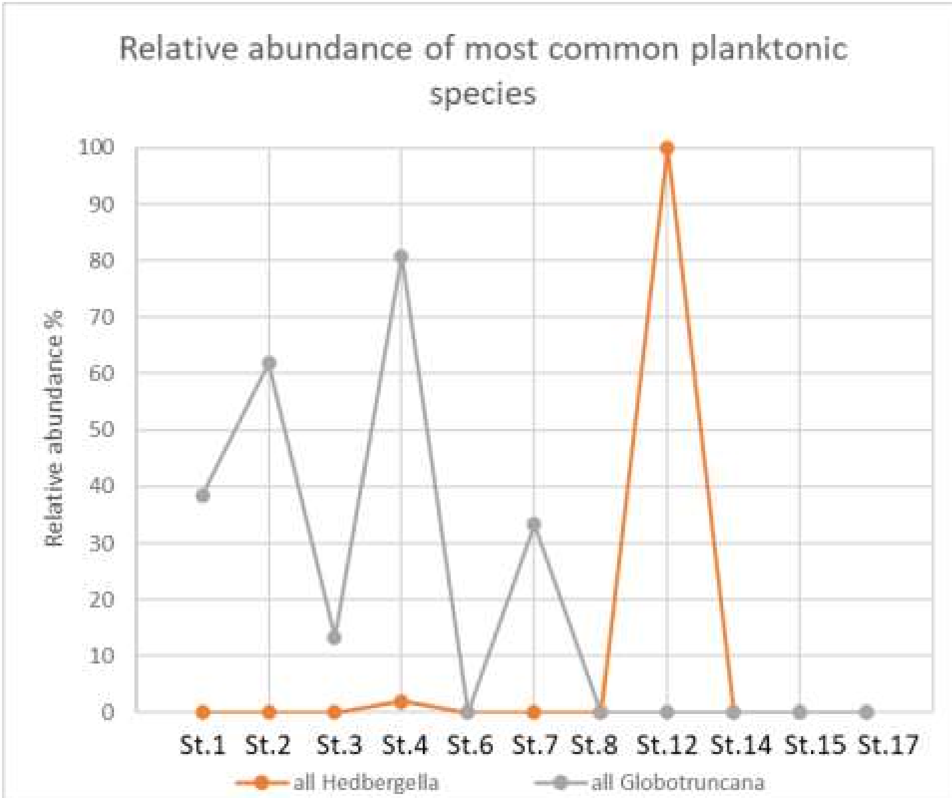


Figure4. 8: Relative abundance of most abundance species. High abundance reported during The Late Cretaceous. Species such as Globotruncana flourished during the deposition of Shiranish Formation, While Hedbergella were more indicative species of Tanjero Formation.

4-3 Rarefaction curves:

The rarefaction curve is used to compare the relative composition of two or more samples in order to assess the completeness of the samples. Comparing the diversity of two or more samples of varying sizes is done using rarefaction (Hammer et al., 2001). a single column or several

of counted individuals of various species are necessary, and samples from similar environments and taxonomy categories must be included (Hammer et al., 2001). According to Prothero (2013), rarefaction analysis is used to compare samples of two different sizes and ensure that any differences are actual and not the result of sampling process.

As shown in the figures below the diversity increased rapidly at the beginning until it becomes more flattened when fewer new taxa added. At the below figures (Figure 1.12 & Figure 1.13). It has been shown that the diversity of benthic foraminifera ranged between 4- 12 taxa, while planktonic diversity ranges between 4-10. For most samples that have a higher abundance a higher diversity has been recorded. When about twenty (20) specimens are counted for benthic foraminifera, the curves become increasingly flattened (Figure 1.12).

The curves for planktonic foraminifera flatten out at around 15–22 specimens, except for samples St.8 and St.12, where the curves reach 45 individuals or more.

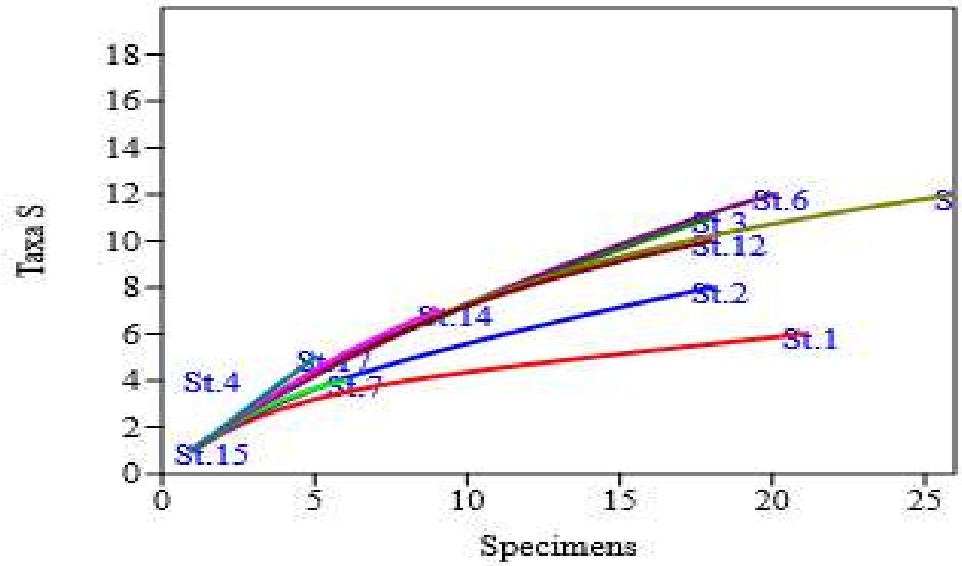


Figure4. 9: Rarefaction curve of eleven samples for the studied formations. The numbers appear at the curve are the samples. The vertical axis represents the benthic foraminifera diversity, while the horizontal axis represents the number of collected specimens.

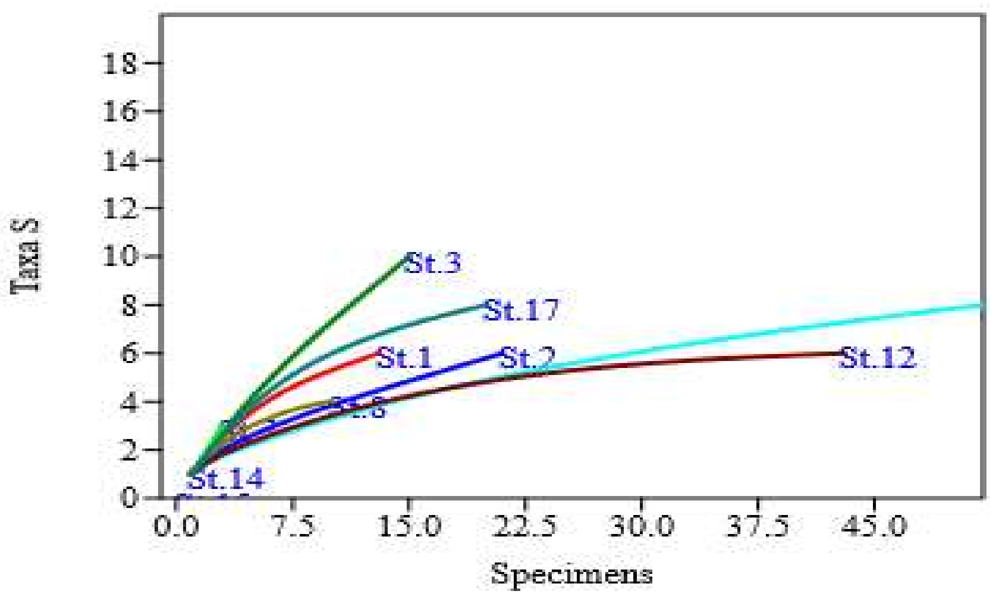


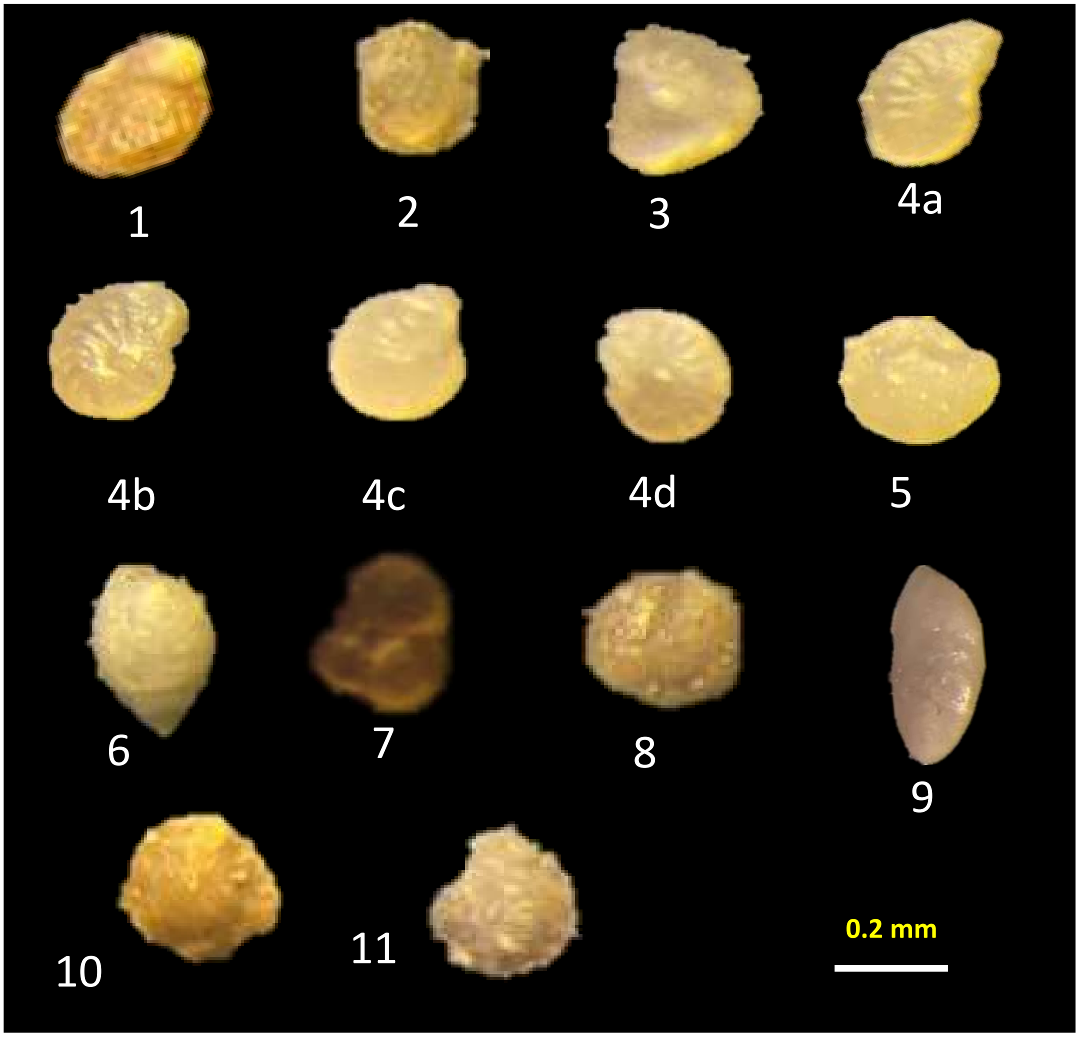
Figure4. 10: Rarefaction curve of eleven samples for the studied formations. The numbers appear at the curve are the samples. The vertical axis represents the planktonic foraminifera diversity, while the horizontal axis represents the number of collected specimens.

5- Conclusion

Many parameters have been tested for both benthic and planktonic foraminifera, among them species abundance and diversity, faunal composition, and rarefaction curves. The following important conclusion have been addressed:

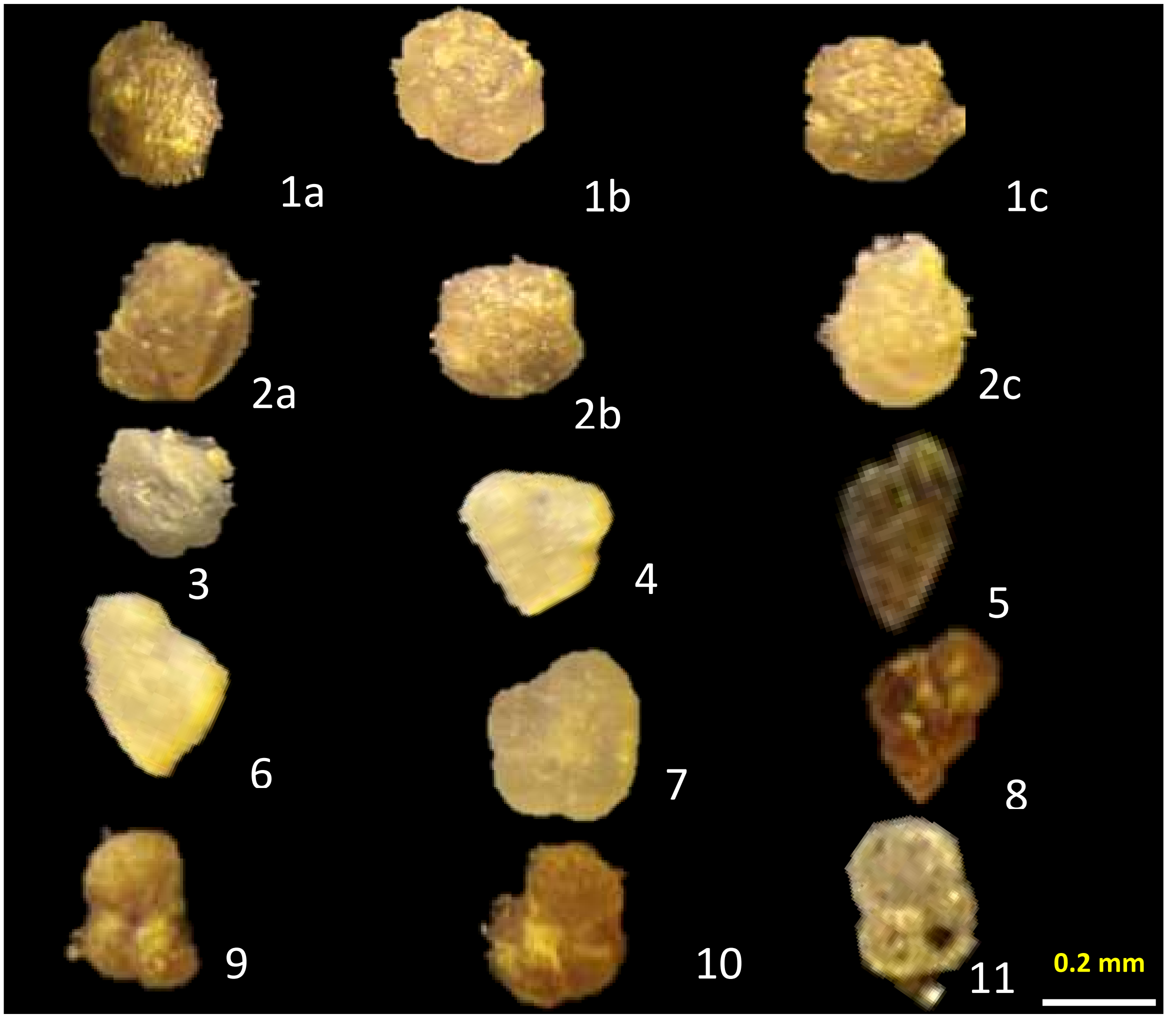
- The current study planktonic abundance ratios (%) dropped suddenly in two times at the lower part of both Tanjero and Kolosh formations. This dropping may indicate the rapid environmental changes or some mistakes during the picking processes. It does show that Shiranish Formation is deeper than Tanjer Formation, and the second drop around the sample 14 and 15 is gradual.
- It is been noted that *Cibicidoides* sp.1, *Oridorsalis* sp.1 and *Gavelinella monterelensis* have high abundance in both Shiranish and Tanjero formations, but suddnly they rapidly declined and disapeared within Kolosh Formation. It does mean that these species were more indicative and coexisted during the late Cretaceous.
- *Gavelinella eriksdalensis* recorded highest peak during the early Paleocene. This species may be responding to new climatic configurations during the early Paleocene.
- all *Hedbergella* species been recorded during the late Cretaceous, especially in St.12 (Tanjero Formation), where the highest ratio recorded. In contrast most *Globotruncana* recorded high abundance in the Shiranish Formation, while decreased towasrds the latest Cretaceous (Tanjero Formation).
- Such as the previous studied, the current study observed that *Subbotina triloculinoides* and *Morozovella velacoensis* has been clearly limited in the Kolosh Formation.
- Rarefaction curves suggest that benthic foraminifera have a diversity of 4-12 taxa, whereas planktonic diversity varies from 4-10. Most samples that have greater abundance exhibit greater variety. When around twenty (20) specimens of benthic foraminifera are counted, the curves straighten out.
- The rarefaction curves for planktonic foraminifera flatten out at around 15–22 specimens, except for samples St.8 and St.12, where the curves reach 45 individuals or more.
- Climate change may have had an effect on the distribution and turnover of foram species in the Late Cretaceous and Early Paleocene.

Plate 1



1. *Cibicidoides* sp.1, (St.4)
2.*Lenticalaina* sp.1, (St.4)
3. *Gaveilinella eriksdalesis,* (St.3) (Brotzen, 1936)
4a-d. *Gavelinella monterelensis*, (St.3) (Marie, 1941)
5. *Gyrodina* sp.1, (St.3)
6 *Glandulina laevigata,* (St.6) (d'Orbigny, 1826)
7. *Rugogolobigerina macroceptala,* (St.6) (Bronnimann 1952)
8. *Unknown* sp .7, (St.7)
9. *Bolivina* sp.1, (St.17)
10. *Osangularia* sp.1, (St.14)
11. *Gavelonella eriksdalensis*, (St.12) (Brotzen, 1936)

Plate 2



1a-c.*Globotrancanita stuartiformis,(*St.4) (Dalbiez, 1955)
2 a-c.*Globotrancana rostta*, (St.4) (Carsey, 1926)
3 *Globotrancana arca*, (St.3) (Cushman, 1926)
4. *Hetrohelix globulosa*, (St.3) (Ehrenberg, 1840
5.*Planoheterohelix planata* , (St.8) (Cushman, 1938)
6 *Planohetrohelix globulosa*, (St.3) (Ehrenberg, 1840)
7. *Hedbergella infracretacea,* (St.8) (Glaessner, 1937)
8. *Paraspiroplecta navarroensis,* (St.8) (Loeblich, 1951)
9. *Parasubbotina pseudobulloides,* (St17) (Plummer, 1927)
10. .*Globanomalina compressa, (*St17) (Plummer, 1927)
11. *Subbotina triloculinoids,* (St.17) (Plummer, 1927)

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