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Lithostratigraphy and sea level reconstruction of late Santonian-early Paleocene in the Central Alborz, Iran; using foraminifera

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Abstract

Late Santonian-early Paleocene sediments have been investigated at the Galanderud section, northern Iran to identify the lithostratigraphy and sea level reconstruction in this section. This section mainly consists of green and gray marl and limestones, and the base of the section overlies the Turonian sediments, and Miocene sandstone overlies the Paleocene sediments in the top of the section with a huge gap of erosional unconformably. We applied a multi-proxy research by using plankton and benthic foraminifera assemblages to monitor the sea level changes during these time period. Based on our data, five zones have been recognized indicating outer neritic-upper bathyal paleodepth for this section and fluctuation of sea level during late Santonian-early Paleocene age.

Keywords: Lithostratigraphy, reconstruction, Santonian-early, Paleocene, foraminifera.

Introduction

Galanderud outcrop located in the south of Royan city (36°31′30″ N, 51°45′30″ E) and southwestern of Noor province (Figure-1). The modern benthic foraminifera assemblages are great marker and widely used to show the sea level fluctuation from intertidal to the deep see environment. The relationship between fossil and modern benthic foraminifera make them great proxy to understand the past environment in the Late Cretaceous succession. Additionally, planktic foraminifera compare to benthic foraminifera show higher abundance with increase in depth that is very helpful to understand the sea level change and reconstruct the paleodepth[1-3].

The aim of this paper is to understand the lithostratigraphy and sea level change in the Galanderud section (Northern Alborz, Iran) by using planktic and benthic foraminifera across the late Santonian to the early Paleocene.

Materials and methods

This outcrop includes the ~440 m thick succession range with the late Santonian to early Paleoceneage (Figures-2,3,4,5). Samples were disaggregated in tap water and using 10% H_2O_2 and washed through 125µm and 63µm sieves and dried the residue samples at 50-degree. Then, the samples above the >125 µm fractions were examined under a binocular microscope. At least 300 specimens of foraminifera were picked from the > 125 µm fractions.

The overall preservation of planktic and benthic foraminifera indicates good preservation of these fauna, and other fauna such as inoceramid and echinoids are also abundant in this section.

Results and discussion

Lithostratigraphy: Western to eastern Alborz divided into the three main zones. These zones are i. West Alborz zone and Azarbayjan, ii. Central Alborz zone including south-central Alborz, north-central Alborz, and anti-Alborz, and the last zone was defined as Kopet-Dagh basin[3]. The Galanderud section in the central Alborz has been selected for this study. This section is characterized by lithology of limestone, marly limestone, and marl[2,4-7]. Galanderud Section show a range of Late Santonian-early Paleocene (Figure-4). Late Santonian-early Paleocene strata are consisting of grey pelagic marls, interbedded with marly limestones that are rich in foraminifera, echinoids, ostracods and inoceramids[2,5].

Lithostratigraphy of the Galanderud section (440m) in Alborz mountain can be divided into six units as follow: i. Unit A (40 m): Pink limestone with interbedded green marl, green marl limestone, and brown and gray limestone (Figure-2,3). ii. Unit B (35m): Green-gray marl limestone, and brown marl interbedded with limestone. iii. Unit C (44m): Hard green marl interbedded with limestone. iv. Unit B (140m): Green marly limestone, gray marl, and gray marl with interbedded marly limestone (Figure-2). v. Unit C (160m): Gray to brown marl with echinoids and inoceramids (Figure-2,3). vi. Unit C (21m): Hard marly sandstone to sandstone (Figure-2,3).

Sea level changes: The comparison between fossil and recent planktic and benthic foraminifera, based on morphology, abundance and their upper-depth limits in different environment can help us to define the sea level changes during the late Santonian-early Paleocene[8-23]. In this study, paleobathymetric and sea level changes were evaluated based on benthic foraminiferal depth marker, planktic foraminifera percent and planktic foraminifera genera from late Santonian through early Paleocene. Distribution of bathymetric marker species in benthic foraminifera are based on Van Morkhoven et al[8]; Alegret and Thomas[9]; Alegret et al[11]; Coccioni and Marsili[24] and Frontalini et al[25] (Table-1). Additionally, based on planktic foraminifera shapes and isotopic studies two different groups of depth dweller have been identified (Table-2)[11,26]. The first group is "Mixed layer dwellers" that consist of simple morphologies species and biserial and spherical shape tests such as Pseudoguembelina and Heterohelix, and the second group is deep dwellers that mostly have complex shapes with keels and dominated with Globotruncana and Globotruncanita. Also, planktic foraminifera are more abundant with increasing in-depth compare to benthic foraminifera that can be used as a great proxy to understand the sea level changes[27-31]. In this research five different zones have been recognized.

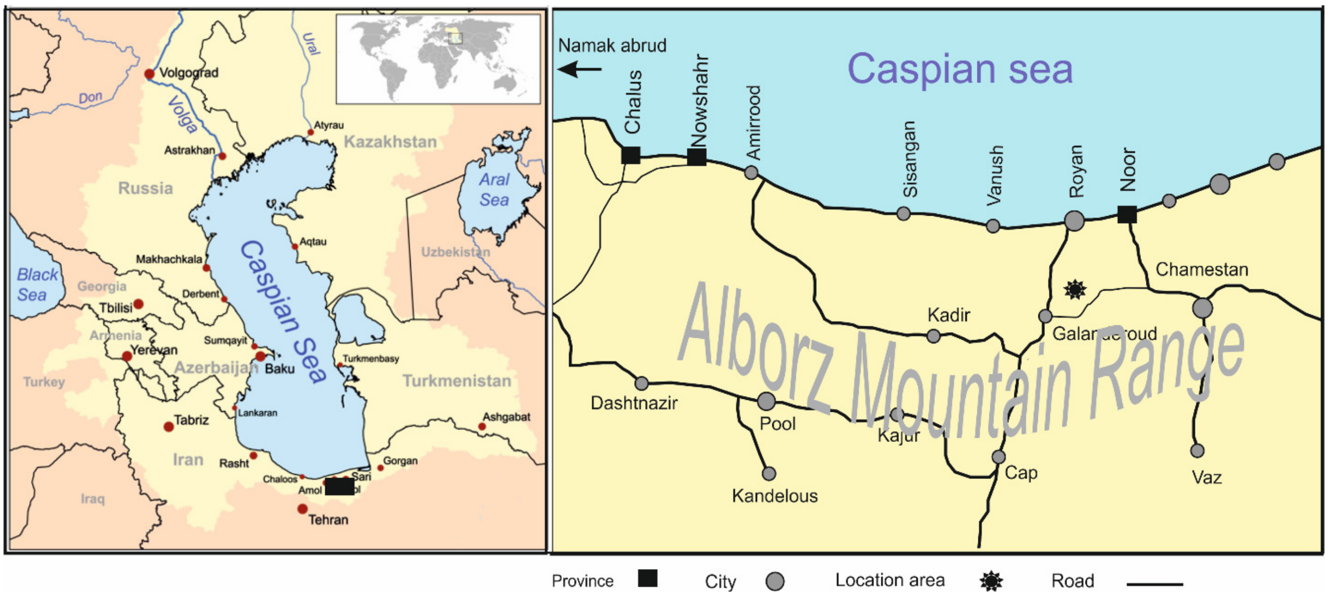

Figure-1: Location map of the studied area in Alborz mountain, Northern of Iran.


Figure-2: Turonian marl and limestone sequences at the base of section.

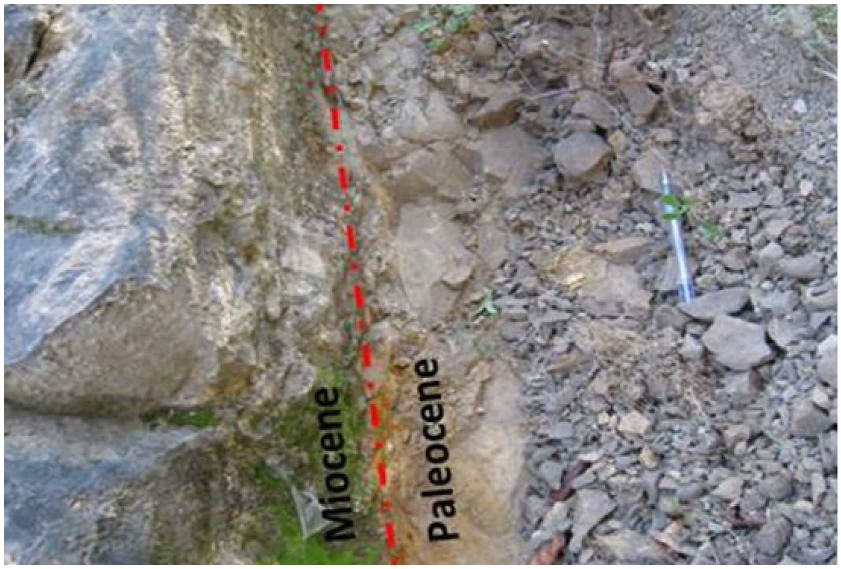

Figure-3: Unconformity between the Paleocene and Miocene sediments at top of the section.

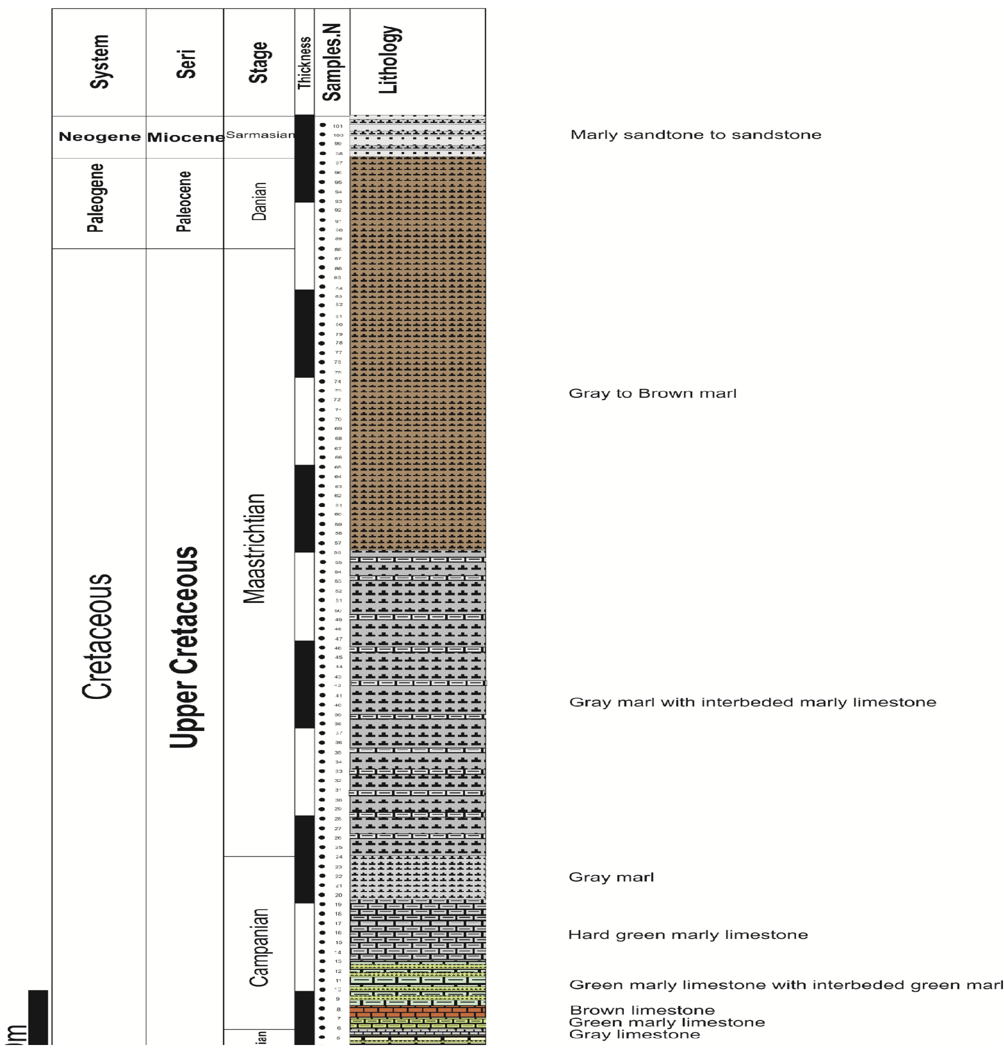

Figure-4: Lithostratigraphic column of late Santonian-early Paleocene in the Galanderud section.

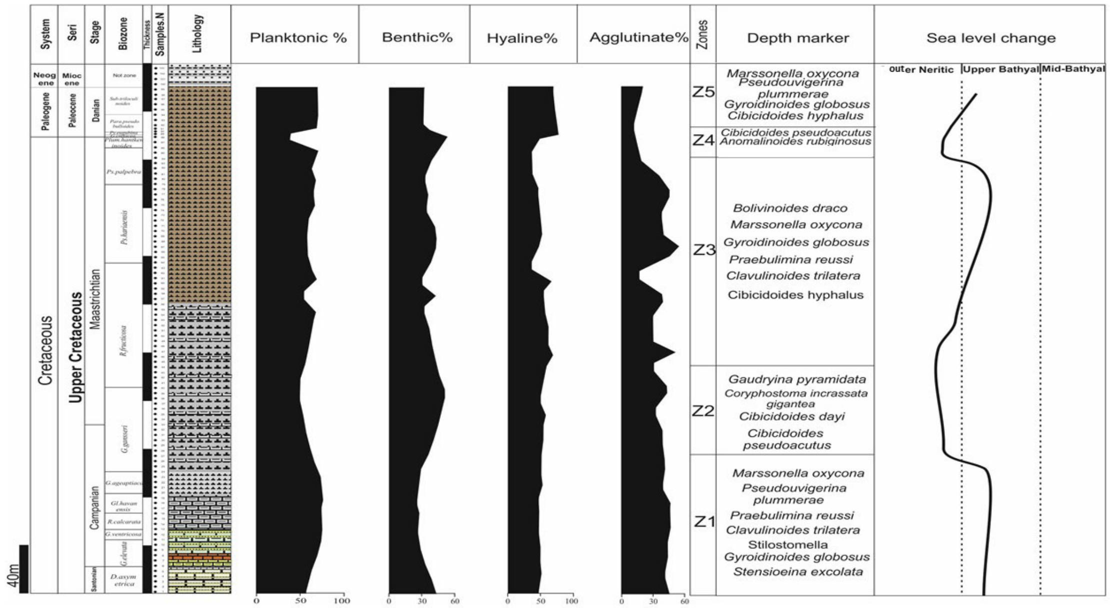

Figure-5: Distribution of planktic foraminifera, Hyaline/Agglutinate tests, benthic foraminifera depth marker and sea level changes in the Galanderud section.

Table-1: Distribution of bathymetric marker species from the Galanderud section (Iran) based on Alegret et al[28], Alegret and Thomas[10], and Coccioni and Marsili[24].

Depth-related species	Common distribution
Cibicidoidesp-seudoacutus	Outer neritic
Bolivinoidesdraco	Outer neritic and bathyal; upper-middle bathyal
Clavulinoidestrilatera	Bathyal and abyssal; middle bathyal
Coryphostomaincrassate	Outer neritic and bathyal
Eouvigerinasubsculptura	Upper and middle bathyal; most common upper-middle bathyal
Gaudryina pyramidata	Bathyal-abyssal; lower bathyal and abyssal; upper-middle bathyal
Gyroidinoides globosus	Middle bathyal-abyssal; bathyal-abyssal
Marssonellaoxycona	Middle bathyal (500-1500 m)
Pulleniacoryelli	Bathyal
Praebuliminareussi	Bathyal to abyssal; middle bathyal (500-1500 m;)
Pseudouvigerina-plummerae	Most common upper-middle bathyal
Sitellacushmani	Upper-middle bathyal; less common lower bathyal
Spiroplectammina-spectabilis	Bathyal
Stensioeinaexcolata	Outer neritic and bathyal

Table-2: Classification of late Cretaceous planktic foraminiferal species. Modified from Li and Keller[26], Abramovich et al[11].

Depth	Mixed layer dwellers	Thermocline dwellers
Planktic foraminifera genera	Pseudoguembelina Rugoglobigerina Heterohelix Pseudotextularia Globigerinelloides	Leaviheterohelix Globotruncanella Globotruncana Globotruncanita Racemiguembelina

Zone-1 (*Dicarinella asymetrica* biozone until *Globotruncana aegyptiaca* biozone): At the first zone, benthic foraminiferal assemblages from the basal part of the section are dominated by *Marssonella oxycana*, *Pseudouvigerina plummerae*, *Gyroidinoides globosus*, *Praebulimina reussi*, *Clavulinoides trilateral*, and *Cibicidoides hyphalus* that show upper bathyal paleodepth for this part of the section based on Table 1. Also, higher abundance of planktic foraminifera (70%) compare to benthic foraminifera and dominance of Globotruncana and Globotruncanita genera (> 40%) as deep dweller shows this part of the section deposited in the deep part of the ocean (Figures-5 and 6).

Zone-2 (*Gansserina gansseri*biozone): At the second zone, benthic foraminiferal are dominated by *Cibicidoides dayi*, *Gaudryina pyramidata*, *Cibicidoides pseudoacutus* and *Corypho stoma incrassatagigantea* that show outer neritic paleodepth for this part of the section based on Table-1. Also, decrease in abundance of planktic foraminifera (from 70 to 50%), and decrease in abundance of Globotruncana genera (~20%) and increase in abundance of Heterohelix (>40%) and Pseudoguembelina (~10%) as mixed dweller fauna shows sea level fall in this part of the section. This data indicates sea level fall toward outer neritic at this biozone. Also, Agglutinate /Hyalin ratio decrease that shows increase of terrigenous material and sea level fall in this part (Figures-5 and 6).

Zone-3 (*Racemiguembelinafructicosa* biozone until *Pseudoguembelina palpebra* biozone): At the third zone, benthic foraminiferal are dominated by *Marssonella oxycana, Bolivinoides draco, Gyroidinoides globosus*, *Clavulinoides trilateral* and *Cibicidoides hyphalus* show upper bathyal paleodepth for this part. Also, increase in abundance of planktic foraminifera (~65%) and Globotruncana genera (~35%) and decrease in Heterohelix (<20%) and Pseudoguembelina (<5%) show sea level rise in this part of the section (Figures-3 and 4). Additionally, Agglutinate /Hyalin ratio increase in this part that show decrease of terrigenous material and sea level rise in this part (Figures-5 and 6).

Zone-4 (*Plummeritahantkeninoides* biozone until *Guembelitriacretacea* biozone): At the forth zone, benthic foraminiferal are dominated by *Cibicidoidespseudoacutus* and *Anomalinoides rubiginosus* that normally belong to outer neritic paleodepth. Also, decrease in abundance of planktic foraminifera, and Globotruncana (<20%), and increase in abundance of Heterohelix (>40%) and Pseudoguembelina (>15%) show sea level fall in end of Maastrichtian. This data indicates sea level fall toward outer neritic at end of Maastrichtian (Figures-4 and 5). However, we cannot use the planktic foraminifera percent and Globotruncana genera due to the mass dead of planktic foraminifera along the Cretaceous-Paleogene boundary and earliest Paleocene (Figures-5 and 6).

Zone-5 (*P. eugubina*biozne until *Subbotinatriloculinoides* biozone): Finally, at the last zone, benthic foraminiferal assemblages from the top part of the section are dominated by *Marssonellaoxycana*, *Pseudo uvigerina plummerae*, *Gyroidinoides globosus* and *Cibicidoides hyphalus* that show outer neritic-upper bathyal paleodepth for this part of the section Also, planktic foraminifera are recovering in this part of section, and we cannot use them for understanding the sea level changes. In this part, some deeper species increase that includes *Gyroidinoidesglobosus* (upper and middle bathyal), and *Marssonellaoxycona* (outer neritic -upper bathyal and middle bathyal) that indicate sea level rise and outer neritic and bathyal paleodepth (Figures-5 and 6). These data suggest that the late Maastrichtian and early Paleocene sediments at the Galanderud section were deposited in the outer neritic and upper most bathyal paleo depth.

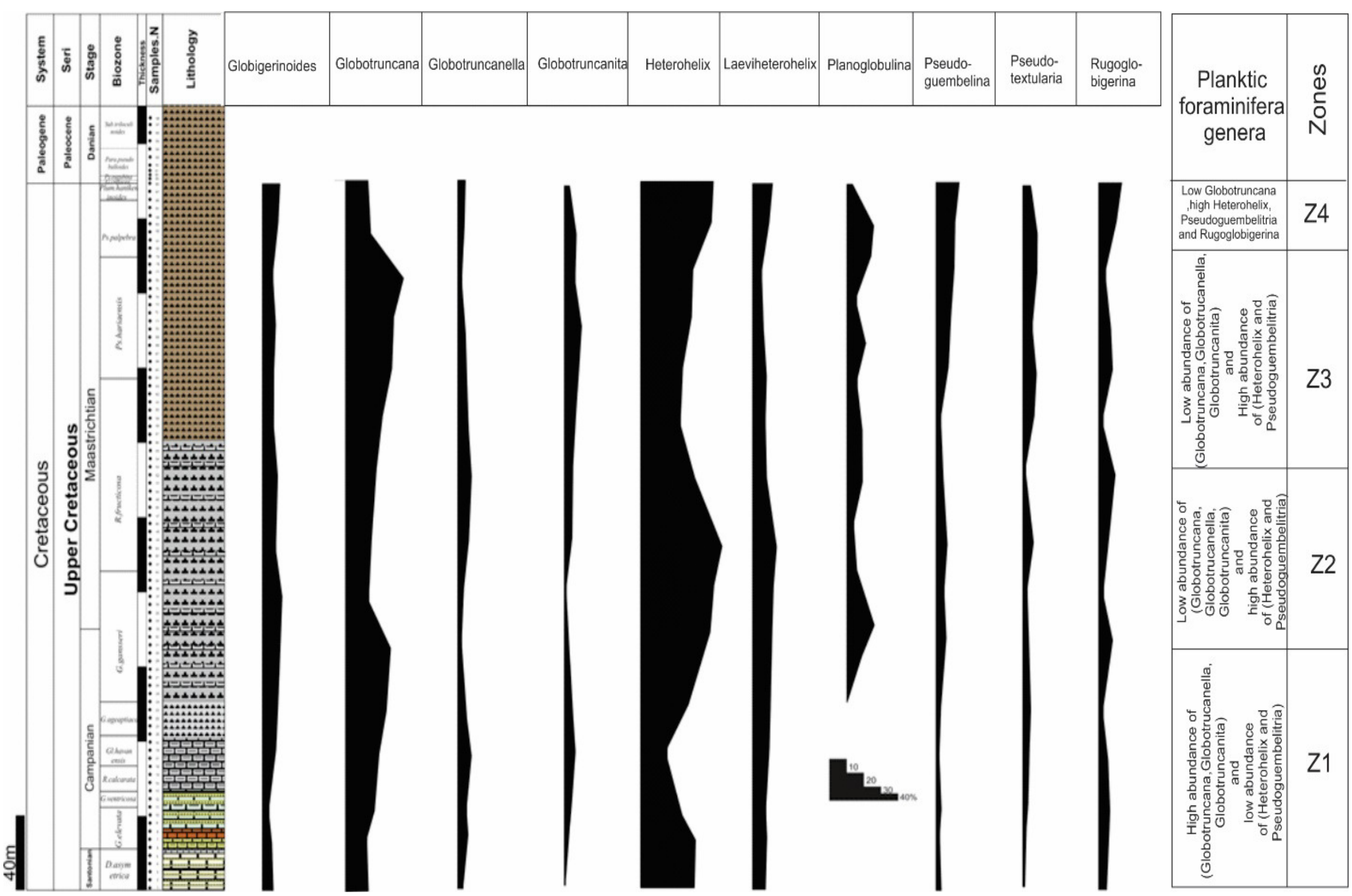

Figure-6: Distribution of planktic foraminifera genera in the Galanderud section.

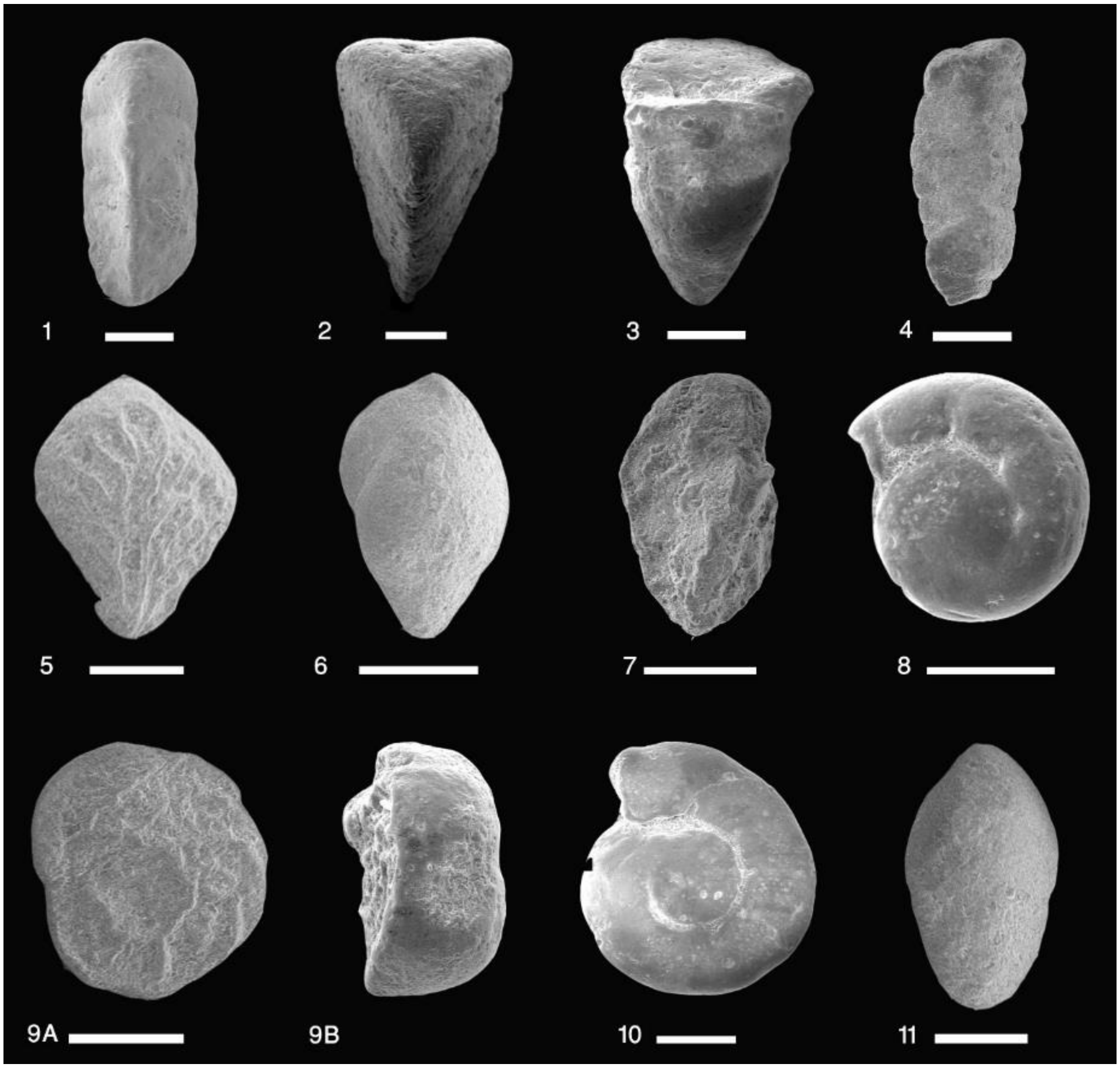

Plate-1: SEM illustrations of benthic foraminifera across the late Santonian-early Paleocene at the Galanderud section. Scale bar=200 µm. 1. *Clavulinoidestrilatera* (Cushman), 2. *Gaudryinapyramidata* (Cushman), 3. *Marssonellaoxycona*(Reuss), 4. *Spiroplectamminaspectabilis* (Grzybowski), 5. *Bolivinoidesdraco* (Marsson), 6. *Praebuliminareussi* (Morrow), 7. *Pseudouvigerinaplummerae* (Cushman), 8. *Gyroidinoidesglobosus* (Hagenow), 9. *Stensioeinaexcolata* (Cushman), 10. *Cibicidoidespseudoacutus* (Nakkady), 11. *Coryphostomaincrassata* (Reuss).

Conclusion

This section mainly consists of green and gray marl, marly limestone and limestones. We used a high-resolution study based upon benthic foraminifera depth marker, hyaline and agglutinate tests in benthic foraminifera, planktic foraminifera percent, planktic foraminiferal genera. Based on our data, five zones have been recognized, and we suggested outer neritic and upper most bathyal depths and fluctuation of sea level for this section during late Santonian-early Paleocene age.

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