HIGH RESOLUTION BIOSTRATIGRAPHIC ANALYSIS OF THE DANIAN STAGE, PER FAT SECTION, DUHOK AREA, KURDISTAN REGION, NORTH OF IRAQ

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ABSTRACT

The occurrence of the Danian Stage at Kurdistan Region of Iraq, particularly in the high folded zone, was a debatable subject by many authors. Most of the previous studies believe that it is poorly preserved. This study reviews the Danian sequence at Per Fat of Duhok area using high resolution biostratigraphic analysis of the planktic foraminifera. The Danian stage sequence in the studied locality is represented by the marlstone, shale, and marly limestone rock types of the Aaliji Formation. Occasional iron oxides and microscopic glauconites intervals are characteristics. The thickness of the Danian sequence is about 29.71 m. The sequence is underlined by the Upper Cretaceous Shiranish Formation, and overlies by the green-olive clastic sediments of the Paleocene Kolosh Formation. Biostratigraphic zonation of the identified foraminiferal assemblages shows the occurrence of the four Danian Planktic foraminiferal biozones and three subzones including Guembelitria cretacea partial-range zone (P0); Parvularugoglobigerina eugubina total range zone (Pa); Parasubbotina pseudobulloides partial-range zone (P1); Globanomalina archaeocompressa partial-range subzone (P1a), Subbotina triloculinoides interval subzone (P1b), Globanomalina compressa-Praemurica inconstans interval subzone (P1c); and Praemurica uncinata interval zone (P2). This indicates a complete sequence of the Danian stage is preserved in the Per Fat section of Duhok area.

Keywords: Danian; Biostratigraphy; Aaliji; Kurdistan; North of Iraq

INTRODUCTION

The Danian is the oldest stage of the Paleocene Epoch. It engrosses about 4.4 m.y. begins before 66 m.y. ago, and ends at the begging of Selandian Age before 61.6 m.y. ago. This stage was

introduced for first time by Desor (1847); Vandenberghe et al. (2012) and Gradstein et al. (2020). Al-Omari (1995) recorded the Danian aged rocks in the northwest of Iraq for the first time. Also, (Al-Omari, 1970) through his study for the Mesozoic/Cenozoic boundary in three oil wells: Butmah-9, Ain Zalah -16 and 17 at northwestern Iraq confirmed that the Aaliji Formation yielded typical world-wide recognized foraminifera of Danian Age. The existence of Danian stage as represented by the Aaliji Formation in the high folded zone of northeast Iraq was a controversial subject even between basic geological literature on Iraq such as Bellen et al. (1959); Buday (1980) and Jassim and Goff (2006). Previous studies regarding the existence of the Danian Stage in Iraq implemented by the geological survey of Iraq teams mainly in the Western Desert of Iraq, including Al-Mutter (1976); Karim (1977); Al-Mubarak and Amin (1983); Al-Bassam (1987) and Al-Bassam et al. (1990).

Ghafor (1988) studied the planktic foraminifera and biostratigraphy of the Aaliji Formation and its nature of contact with the overlies Shiranish Formation at Tel-Hajar well no. 1, Sinjar area. He found no real Danian deposits in this locality. Al-Omari et al. (1994) studied the planktic foraminifera and their biostratigraphy for the Aaliji Formation in Mushorah well No. 1, Northwestern Iraq. Also, Al-Omari (1995) investigate the Aaliji Formation through his study to the biostratigraphy of the upper Cretaceous and lower Tertiary (Lower Paleogene) in Butmah well No. 9, North West Iraq. According to (Jassim and Buday in Jassim and Goff, 2006) The greater thickness of the Aaliji Formation in NW Iraq reaches 470 m, which is gradually decreases towards the N and NE of Iraq due to passes into the clastic Kolosh Formation. They, also, stated that the lower contact of the formation is unconformable except where the Aaliji Formation occurs as tongues within Kolosh Formation, which is confirmed in the current study.

Aaliji Formation has been proved to extend to Duhok area and lies at subsurface section of Khanke oil well no. 1, drilled by DNO Oil Company in 2006. The formation consisting of 130 meters of marlstone, shale interbedded with limestone and few streaks of sandstone with brown-light grey color, occurs between depth from 1349 – 1479 meter (Bamerni, 2010). The sedimentary environment of the Aaliji Formation in selected wells from the north of Iraq is a deep bathyal environment. Recently, AL-Hyaly and Al-Badrani (2019) concluded the age of the Aaliji Formation to be Middle Paleocene – Early Eocene, through their study of the calcareous nannofossils biostratigraphy of K-116 well, northern Iraq. The current study aims to approve the occurrences of the Danian stage of the Aaliji Formation at Duhok area throughout the investigation

of its planktic foraminiferal assemblages and high resolution biostratigraphic analysis and zonation.

GEOLOGICAL SETTINGS

The studied Per Fat section is located about 18.7 km to the north-west of Duhok city, with low relief outcrop exposed on the northern limb of Bekhair anticline at Long. 37°57'07" N; Lat. 42°57'41" E (Fig. 1). The studied blocks are located within the Zagros Basin, high folded zone on the unstable shelf of the northeastern Arabian platform (Mamasen *et al.*, 2019).

Fig. 1. A Tectonic map (after Sharland *et al.*, 2001) B-geological map showing the location of the studied Per Fat section, Duhok (Sissakian, 2000)

Stratigraphically, it includes outcrops extending in age from the Late Cretaceous to Pliocene and including tectonic Megasequences AP9, AP10 and AP11 (Jassim and Goff, 2006). Rock units exposed within Bekhair anticline are from the oldest includes the Upper Cretaceous dolomitized detrital limestone of the Bekhme Formation, the outer shelf-basinal sediments of the Shiranish

Formation. The Paleogene units are represented by the basinal marlstone of the Aaliji Formation, and the dark green siliciclastics of the Kolosh Formation and the reefal carbonate of the Sinjar Formation the subcontinental red siliciclasts of the Gercus Formation, the shoals' carbonates of the Avanah Formation and the dolomitic platform carbonate of the PilaSpi Formation. The detailed description of these units is given systematically by Bellen et al. (1959).

The Aaliji Formation is firstly described by Bellen et al., (1959) from Meidannki area in northwest of Syria at Long. 36°29'25" N and Lat. 36°53'32" E. Later on, a supplementary type locality had been chosen in Iraq at Kirkuk-109 at drilled depth (758.2-925.3 m), with 167.1 meters in thickness. The Aaliji Formation in its supplementary type locality in Iraq, is generally of grey and light-brown argillaceous marls, marly limestone and shales with occasional microscopic fragments of chert and rare glauconite. It is underlined by the Shiranish Formation with paraunconformity characterized by a complete change of fauna and lithology, and overlain by the middle Eocene Jaddala Formation again with unconformity and complete change of fauna and lithology. This formation includes the offshore sediments of the Paleocene and lower Eocene sedimentary cycle (Bellen et al., 1959).

MATERIALS AND METHODS

Many field trips were conducted, and 38 samples were collected in a ditch along with the exposure of the formation which has a thickness of 29.71 m. All samples were treated according to a new technique for retrieving calcareous microfossils from lithified lime deposits following (Lirer, 2000). Samples were washed in abundant water, sieved through the standard sieves according to ASTM (60, 80, 100, 120 and 230 Mesh) and dried with room temperature. After this procedure, the residue should be free of inorganic matter and the foraminifer clean and ready to be examined under reflected binocular-microscope. The identification of the Danian planktic foraminiferal assemblages recorded in this study followed mainly the classification scheme (Toumarkine and Luterbacher, 1985; Berggren et al., 1995; Berggren and Norris, 1997 and Olsson et al., 1999) among others. In this study, we adopted the foraminiferal zonal schemes of Petrizzo and Soldan (2008) and Wade et al. (2011).

RESULTS AND DISCUSSION

Lithostratigraphy

In the current study, the obvious color change, thin yellow-red laminar, and the sedimented bitumen beads were good physical indicators to determine the base of the Danian of the Aaliji Formation in

the studied section (Bellen et al., 1959). Aaliji Formation in the studied Per Fat section, consists mainly of buff brown – light grey marl and shale, interbedded with hard marly limestone, the sediments of the formation rich of iron oxides with different proportions, and microscopic glauconites noticed especially in the upper part. The lower contact with the pelagic marlstone of the upper Cretaceous Shiranish Formation, which is known as the K/Pg. boundary, defines its lower boundary (Fig. 2). While the upper glauconitic-marly limestone bed and the first green-olive sandstone bed above it defines the boundary with overlaying the Kolosh Formation (Fig. 2).

Fig. 2. Field photos from Per Fat section a. The color change at base of the Aaliji Formation and contact with the Shiranish Formation, b. Top of the Aaliji Formation

The Aaliji Formation in the current study, shows all the identical lithological characteristics of the type section and first description of the type locality in Iraq, the color variation, lithology, and existence of the sedimented bitumen at the base (Figs. 3 and 4), in addition to intervals of rare glauconite especially at upper part that might be good indication for a hiatus with the overlies Kolosh Formation. This unit is used to be considered as the lowermost and basinal part of the Paleocene sediments (Bellen et al., 1959), and as a part of the Kolosh Formation (Al-Qayim and Al-Shaibani, 1989). Its limited thickness and immediate occurrence above the Shiranish and below thick Kolosh-proper clastic may be the reason for considering it as a part of the Kolosh Formation in some studies.

Fig. 3. Google earth image of the color variation of the exposed formations at Per Fat section, Duhok

Fig. 4. Resedimented bitumen beads above the K/Pg. Per Fat, is characteristic of the Aaliji Formation

BIOSTRATIGRAPHY

Thirty planktic species of foraminifera belong to ten genera (*Guembelitra Cushman*, *Globoconusa* Khalilov *Parvularugoglobigerina* Hofker, *Woodringina* Loeblich & Tappan, *Parasubbotina*

Olsson, Hemleben, Berggren & Liu, *Globanomalina* Haque, *Eoglobigerina* Morozova, *Chiloguembelina* Loeblich & Tappan, *Subbotina* Brotzen & Pozaryska, and *Praemurica* were recognized in this study. In addition, some minute, simple biserial forams of the late Cretaceous were identified from the Danian sequence of the Aaliji Formation. These are survivors from the Cretaceous. The planktic foraminiferal association in the base of the Danian generally poorly recorded, it includes some continuous extension of dwarf forms (minute-sized) of biserial and simple planktic foraminiferal taxa of the Late Cretaceous such as *Heterohelix globulosa* (Ehrenberg); *H. striata* (Ehrenberg); *H. punctulata* (Cushman); *H. labelosa* Nederbragt; *H. navaroensis* Loeblich; *Hedbergella monmouthensis* (Olsson et al., 1999); *Pseudoguembelina costulata* (Cushman) and *Ps. kempensis* Esker (EL-Sabbagh et al., 2004). Those mentioned Cretaceous fauna were disappeared at the base of the well-defined Danian zone of *Parasubbotina pseudobulloides* P1 in this study. The stratigraphical distribution of all identified planktic foraminiferal species had been demonstrated by the range chart of Fig. 5. Correlation with similar studies from Iraq and the surrounding regions in addition to some international studies also conducted to affirm biozonation recognition (Figs. 6 and 7). Based on the stratigraphical ranges of the recorded planktic foraminifera and the datum markers, the Danian section of the studied succession is subdivided into four biozones, and three sub-biozones of the planktic foraminiferal species (Fig. 8). A description of the recognized planktic foraminiferal zones and subzones is given below, from base to top:

P0 – *Guembelitra* Cretacea Partial-Range Zone

Definition: Is a biostratigraphic interval, characterized by the partial range of *Guembelitra cretacea* Cushman, occurs between the very top Mass extinction of the tropical-subtropical planktic foraminifera of the Late Cretaceous genera, represented by the top of *Plummerita hantkeninoides* Total Range Zone (CF1), to the First Appearance Datum (FAD) of *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva).

Remarks: This zone is a very short extension, and it distinguished by very small-sized assemblages, mostly concentrate in less than 230 mesh-size, occurs at the base of the Aaliji Formation above the K/Pg. contact and below the FAD of *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva), it extends for only 3 cm, represented by samples (1 & 2).

Age: Earliest Paleocene (Earliest Danian).

Pa – *Parvularugoglobigerina Eugubina* Total Range Zone

Definition: Pa is a biostratigraphic interval, characterized by the total range of the nominated taxon *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva).

Remarks: This zone is characterized by the increase in diversity and abundance of Danian cosmopolitan planktic foraminifera include *Guembelitra cretacea* Cushman, *Woodringina hornerstowensis* (Olsson et al., 1999), *Eoglobigerina eobulloides* Morozova, *Chiloguembelina midwayensis* (Cushman), *Eoglobigerina edita* (Subbotina), *Globoconusa daubjergensis* (Bronnimann), *Parvularugoglobigerina perexigua* Li Qianyu, McGowran and Boersma, *Globoanomalina archaeocompressa* (Blow), *Woodringina claytonensis* (Loeblich & Tappan), *Chiloguembelina cubensis* (Palmer), *Eoglobigerina fringa* (Subbotina), *Chiloguembelina trinitatensis* (Cushman and Renz), *Globoanomalina australiformis* (Jenkins), *Parvularugoglobigerina umbrica* (Luterbacher & Premoli Silva), *Guembelitra trifolia* (Morozova), *Globoanomalina chapmani* (Parr), *Globoanomalina ehrenbergi* (Bolli), *Globoanomalina planocompressa* (Shutskaya). In addition, some minute-sized, simple Late Cretaceous taxa such as *Heterohelix globulosa* (Ehrenberg); *H. striata* (Ehrenberg); *H. navaroensis* Loeblich; *Hedbergella monmouthensis* (Olsson et al., 1999); *Pseudoguembelina costulata* (Cushman); *Archaeoglobigerina blowi* Pessagno and *Rugoglobigerina hexacamerata* (Bronnimann). This Biozone extends for 68 cm. between samples (3-9).

Age: Earliest Paleocene (Earliest Danian).

P1 – *Parasubbotina Pseudobulloides* Partial-Range Zone

This interval defines by the Last Appearance Datum (LAD) of *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva) to the FAD of *Praemurica uncinata* Bolli. This zone subdivided into three subzones in the current study, they are:

P1a – *Globoanomalina Archaeocompressa* Partial-Range Subzone:

Definition: Biostratigraphic interval between the LAD of *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva) and FAD of *Subbotina triloculinoides* (Plummer).

Remarks: This subzone characterized by common of *Eoglobigerina eobulloides* Morozova and *Parasubbotina pseudobulloides* (Plummer) in addition to abundance foraminifera of the previous Pa Zone, and it witnesses a decrease in number of *Guembelitra* Cushman specimens, it extends between samples (11-17), and It is 8 m in thickness.

Age: Early Paleocene (Early Danian).

P1b – *Subbotina Triloculinoides* Interval Subzone:

Definition: biostratigraphic interval between the FAD of *Subbotina triloculinoides* (Plummer) and the FAD of *Globanomalina compressa* (Plummer) and/or *Praemurica inconstans* (Subbotina).

Remarks: This subzone is characterized by the abundance of *Parasubbotina pseudobulloides* (Plummer), *Globanomalina archaeocompressa* (Blow), *Globanomalina planocompressa* (Shutskaya). Its thickness is 6 m, between samples (18-23).

Age: Early Paleocene (Danian).

P1c - *Globanomalina Compressa–Praemurica Inconstans* Interval Subzone:

Definition: Biostratigraphic interval between the FAD of *Globanomalina compressa* (Plummer) and/or *Praemurica inconstans* (Subbotina) to the FAD of *Praemurica uncinata* Bolli.

Remarks: The most recognizable event in this subzone is the disappearing of *Eoglobigerina eobulloides* Morozova, and *Globoconusa daubjergensis* (Bronnimann) at the top of this interval. It occurs between samples (24-33) for 10 m thickness.

Age: Early Paleocene (Danian).

P2 - *Praemurica Uncinata* Interval Zone (Part):

Definition: P2 defines as biostratigraphic interval between the FAD of *Praemurica uncinata* Bolli and the FAD of *Morozovella angulata* (White).

Remarks: Remarkable feature of the zonal assemblages is the first record of subangular margins of the nominate taxon, and common to rare occurrence of *Parasubbotina pseudobulloides* (Plummer), *Subbotina triloculinoides* (Plummer), and *Praemurica inconstans* (Subbotina). It extends for 5 m (the exposed part of this zone) between samples (34-38).

Age: Early Paleocene (Latest Danian).

Based on the identified planktic foraminifera, and according to the determined biozones and their correlations with similar international studies, the Danian stage is completely preserved within the pelagic sediments of the Aaliqi Formation in the studied succession in Per Fat section of Duhok area.

Stage	Age (Ma)	Chron	Polarity	Planktonic Foraminiferal Zones This Study (Per Fat Section - Duhok) Kurdistan Region of Iraq, 2020		Abawi et al., 1982; Abdel-Kireem, 1986 Northern Iraq	Sharbazeri, 2008; Sharbazeri et al., 2011 Sulaimaniyah/ Kurdistan Region.	Hammoudi, 2011 Shaqalawa, Northern Iraq.	Al-Banna et al., 2012 Aqra and Bekhme, Northern Iraq.	Salih et al., 2013 Duhok Dam, Northern Iraq.		
Danian	61.4	C27n		Praemurica uncinata (Part) P2		G. rotalia. uncinata	Not Studied	Not Studied	P. uncinata P2	Not Studied		
		C27r		Parasubbotina pseudobulloides P1	Globanomalina compressa-Praemurica inconstans P1c	Globorotalia trinidadiansis			P1		P1b	Parasubbotina variante
		C28n			Subbotina triloculinoides P1b	Globorotalia pseudobulloides	P1a	Parasubbotina pseudobulloides				
		C28r							Globanomalina archaeocompressa P1a		S. trivialis P1a	P1a
	64.8	C29n		Parvularugoglobigerina eugubina Pα		Hiatus	Parvularugo. eugubina Pα	Parvularugo. eugubina Pα	Not Studied or Hiatus	Parvularugo. eugubina Pα		
		C29r		Guemelitritia cretacea P0			Guemb. cretacea P0	Guemb. cretacea P0		Guemb. cretacea P0		
	66.04											
	Legend: P0: Guemelitritia cretacea Partial Range Zone Pα: Parvularugoglobigerina eugubina Total Range Zone P1: Parasubbotina pseudobulloides Partial Range Zone P1a: Globanomalina archaeocompressa Partial Range Zone P1b: Subbotina triloculinoides Interval Zone P1c: Globanomalina compressa-Praemurica inconstans Interval Zone P2: Praemurica uncinata Interval Zone Cr: reverse polarity Cn: normal polarity											

Fig. 6. Correlation of the Danian planktic foraminiferal biozones at the studied section with other localities from Iraq, (Wade et al., 2011)

Stage	Age (Ma)	Chron	Polarity	Planktonic Foraminiferal Zones-This Study (Per Fat Duhok- Kurdistan), 2020.	Caron, 1985 - General	Berggren et al., 1995 Berggren & Pearson, 2005	Li & Keller, 1998a Keller et al., 2004	Li & Keller, 1998b El Kef Tunisia	Olson et al., 1999 Huber et al., 2008	El-Sabbagh et al., 2004 Egypt	Darvishzad et al., 2007 Southwestern Iran.	Petrizzo & Soldan, 2008 Paleocene Revision	Wade et al., 2011 Paleocene Revision	Hewady et al., 2017 Egypt	Asgharian Rostami et al., 2018 (northern Alborz) Iran	Metsana-Oussaid et al., 2019 - Southwestern Tethys (Algeria)
Danian	61.4	C27n		P2	Not S.	P2	Not Studied	Not Studied	P2	Not Studied	Not Studied	P2	P2	P2	Not Studied	P2
		C27r		P1c	<i>Mo. pseudobulloides</i>	P1c	P1d	P1c	P1c		P1c (2) <i>P. inc.</i>	P1c	P1c	P1c		P1c
		C28n		P1b		P1b	P1c (2) <i>P. inconstans</i>		P1b	P1	<i>Parasubbotina pseudobulloides</i>	P1b	P1b	Hiatus	P1b	P1b
		C28r		P1a		P1a	P1c (1) <i>P. varianta</i>		P1a			P1a	P1a		P1a	P1a
	64.8	C29n		P1a	<i>P. eugubina</i>	P1a	P1b <i>P. eugubina</i>	Hiatus	P1a	Pα	P1a (1)	Pα	Pα	Hiatus	Pα	Pα
		C29n		Pα		P1a (2)	P1a (1)		Pα							
		C29r		P0		P0	P0		P0		P0	P0	P0		P0	P0
66.04																
Legend: P0: <i>Guembelitra cretacea</i> Partial Range Zone P1b: <i>Subbotina triloculinoides</i> Interval Zone Cr: reverse polarity Pα: <i>Parvularugoglobigerina eugubina</i> Total Range Zone P1c: <i>Globanomalina compressa</i> - <i>Praemurica inconstans</i> Interval Zone Cn: normal polarity P1: <i>Parasubbotina pseudobulloides</i> Partial Range Zone P2: <i>Praemurica uncinata</i> Interval Zone P1a: <i>Globanomalina archaeocompressa</i> Partial Range Zone																

Fig. 7. Correlation of the Danian planktic foraminiferal biozones of the studied section with other regional localities (Wade et al., 2011)

Stage	Age Ma.	Chron	Polarity	Planktonic Foraminiferal Biozones This study (Per Fat, Duhok) 2020	Datum Markers		SEM Microphotographs of the Index Zonal species of this Study (Per Fat, Duhok) 2020	
					Chronologic Age (Berggren & Pearson, 2005)	Chronologic Age (Wade et al., 2011)		
D a n i a n	61.7	C27n		(P2) – <i>Praemurica uncinata</i> Zone (Part)	▲ FO <i>P. uncinata</i> 61.4 Ma.	FO <i>P. uncinata</i> 62.1 Ma.		
	62							
		C27r		(P1c) – <i>Globanomalina compressa/Praemurica inconstans</i> Subzone	▲ FO <i>G. compressa</i> 62.9 Ma.	FO <i>G. compressa</i> 63.5 Ma.		
	64.4							
		C28n		(P1b) – <i>Subbotina triloculinoides</i> Subzone	▲ FO <i>S. triloculinoides</i> 64.3 Ma.	FO <i>S. triloculinoides</i> 64.7 Ma.		
		C28r						
		C29n		(P1a) – <i>Globanomalina archaeocompressa</i> Subzone	▲ FO <i>P. eugubina</i> 64.97 Ma.	FO <i>P. eugubina</i> 65.2 Ma.		
	65							
		C29r		(Pa) – <i>Parvularugoglobigerina eugubina</i> Zone	▲ LO <i>P. eugubina</i> 68.8 Ma.	LO <i>P. eugubina</i> 65.2 Ma.		
	66.04			(P0) – <i>Guembelitra cretacea</i> Zone	▲ FO <i>P. eugubina</i> 64.97 Ma.	FO <i>P. eugubina</i> 65.46 Ma.		
				LO of Most Late Cretaceous taxa	▼			

Cr: reverse polarity
Cn: normal polarity
▼ LO: Last Occurrence
▲ FO: First Occurrence

1: *Guembelitra cretacea* Cushman 1933 2: *Parvularugoglobigerina eugubina* (Luterbacher and Perinoli Silva 1964) 3: *Parasubbotina pseudobulloides* (Plummer 1927) 4: *Globanomalina archaeocompressa* (Blow 1979) 5: *Subbotina triloculinoides* (Plummer 1927) 6: *Globanomalina compressa* (Plummer 1927) 7: *Praemurica inconstans* (Subbotina 1953) 8: *Praemurica uncinata* (Bolli 1957)

Fig. 8. The main proposed planktic foraminiferal datum planes of the Danian age, Per Fat section-Duhok area, and the magnetostratigraphic scale (Wade et al., 2011) with biochronostratigraphical ranges of the index Planktic foraminiferal species

CONCLUSIONS

A high-resolution biostratigraphic analysis of the planktic foraminiferal assemblages of Per Fat section, Duhok area, shows that:

- 1- The 29.71 m of buff brown-light grey in color, marl, marly limestone and shale, with bitumen beads and glauconitic horizon of the lower most part of the Kolosh Formation at the studied section is belong to the Aaliji Formation. It includes a complete succession of the Danian stage.
- 2- Based on the ranges of the planktic foraminiferal species, four main biozones and three subzones were recognized belong to the Aaliji Formation. They are: P0-*Guembelitra cretacea* Partial Range Zone (3 cm.); Pa-*Parvularugoglobigerina eugubina* Total Range Zone (68 cm.); P1-*Parasubbotina pseudobulloides* Interval Zone, which subdivide into three subzones: P1a-*Globanomalina archaeocompressa* Partial Range Subzone (8 m.), P1b-*Subbotina triloculinoides* Interval Subzone (6 m.), P1c-*Globanomalina compressa/Praemurica inconstans* Interval Subzone (10 m.); and P2-*Praemurica uncinata* Interval Zone (5 m.).
- 3- Depending on this, the age of the Aaliji Formation at this locality correspond to the whole Danian age.

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