Calcareous nannofossils from the Abtalkh Formation (Campanian-Maastrichtian), Kopet-Dagh range, NE Iran

Fatemeh Hadavi
Dept. of Geology, Faculty of Science, Ferdowsi University of Mashhad, Iran; HADAVI@ferdowsi.um.ac.ir

Abstract Calcareous nannofossils, present in the Abtalkh Formation of the Kopet-Dagh range (near Chahchaheh village, NE Iran), were examined to document the assemblages, and to determine the age of the formation. The lower portion of the formation can be placed in nannofossil biozone UC14a and the upper part in UC20b^{TP} (equivalent to CC18a and CC25c, respectively).

Keywords Upper Cretaceous, calcareous, nannofossils, Abtalkh Formation, Campanian, Maastrichtian, Kopet-Dagh, NE Iran

1. Introduction

The Kopet-Dagh range, which stretches over nearly 7000m in a WNW-ESE direction east of the Caspian Sea, from the FSU over Iran into Afghanistan, is composed of a gently folded rock succession. It comprises 5000-7000m of Middle Jurassic to Palaeogene strata. The base of this succession is only exposed in the eastern part of this mountain range, on Iranian territory. There exists an anticline, which has been eroded down to pre-Jurassic basement over an area extending for ~20km long and 15km wide. The shallow, glauconitic sandstone in this area is overlain by a thick (2000m) sequence of pelagic marls, chalks and shales, indicating increased subsidence (Davoudzadeh & Schmidt, 1984).

The Kopet-Dagh formed on Hercynian to Early Cimmerian basement, at the southern margin of the Turanian Platform. This belt is composed of a nearly complete and comformable Mesozoic to Cenozoic sedimentary successsion. The sediments were deposited in a gradually subsidising trough, which formed in the Late Triassic. Its shallow-marine Jurassic sequence is >600m thick. Subsidence and marine deposition continued up to the end of the Cretaceous, except during a short period of gentle uplift at the end of the Jurassic. Temporary emergence, without folding, affected the region in the Paleocene, resulting in the deposition of the Pestehligh Red Beds (Afshar Harb, 1979).

The most complete Cretaceous succession in northern Iran is found in the Kopet-Dagh range, comprising marine shales, marly limestones, and subordinate sandstones. This sequence reaches >3000m thick and seems to represent all stages of the Cretaceous (Stocklin, 1968).

The Abtalkh Formation, from its type-locality in the eastern Kopet-Dagh, is composed of pale grey to bluish-green shale and siltstone, widely exposed in the SE Kopet-Dagh. It varies from 700m to 1000m thick, decreasing in thickness from east to south (Afshar Harb, 1979). This formation comformably overlies the Abderaz Formation, and is itself comformably overlain by the predominantly-sandy Nayzar Formation. The lower part of the Abtalkh Formation contains three beds of white, chalky limestone, rich in echinoids and inoceramids. For the present study, samples were collected from the thicker eastern part, close to the village of Chahchaheh on the Kalat road (Figure 1).

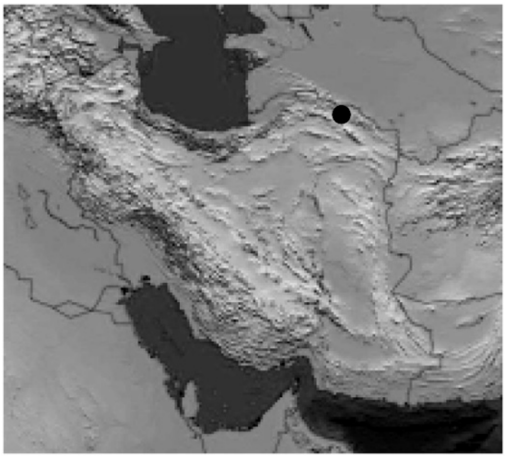


Figure 1: Sample locality, Chachaheh village, Abtalkh

Few studies on Upper Cretaceous calcareous nannofossils have been carried out in Iran (*e.g.* Hadavi & Karami, 2000; Hadavi & Sanati, 2000; Hadavi & Shokri, 2000; Hadavi & Khodadadi, 2002; Hadavi & Notghi Moghaddam, 2002); all are focussed on the Kopet-Dagh range.

Most palaeontological studies of the Cretaceous of the Kopet-Dagh, and particulary of the Abtalkh Formation, have been performed using foraminifera (*e.g.* Afshar Harb, 1979). These micropalaeontologists did not identify any biozones but they assigned an age of Santonian-Maastrichtian to the Abtalkh Formation, based on various localities in the eastern Kopet-Dagh. The nannofossils of the Abtalkh Formation have been recently studied by Hadavi & Khodadadi (2002) beyond the type-locality in Baba Faragi village. They documented the calcareous nannofossil assemblages and determined the age of the formation.

2. Material and methods

The great thickness (up to 715m) of the formation in the type-area, and the lack of obvious bedding, caused problems in the following the stratigraphy through the middle part of the formation. Consequently, sampling was performed only on the lower and the upper portions of the formation, close to the obvious contacts with the underlying (Abderaz) and overlying (Nizar) formation.

A total of 27 samples were collected, representing the oldest and youngest strata of the 715m succession, 18 from the lower portion of the formation (the lowest from the last chalky limestone of the underlying Aderaz Formation), and nine from the upper portion, up to the contact with the Nizar Formation.

Samples examined for calcareous nannofossil content were subjected to smear-slide preparation. For this, the surface of each sample was scraped with a razor-blade until a fresh surface was obtained and then a small amount of sediment was scraped onto a glass coverslip and diluted with distilled water. The suspension was smeared with a flat-sided toothpick along the surface of the coverslip and then dried on a hot-plate. Between preparations, the razor used in the preparation was washed in distilled water. The coverslip was affixed to a glass slide using Norland Optical Adhesive #61. The counter and the hot-plate used in making the smear-slides were wiped with 10% HCl between sample preparations. This was done to reduce the chance of contamination.

All slides were examined with an Olympus BH-2 light-microscope at 1500x magnification. Five hundred specimens were counted to allow calculation of the relative species abundances. On Tables 1 and 2, abundances are as follows: (A) abundant = >65 specimens; (C) common = 25-65 specimens; (F) few = <25 specimens.

3. Results and conclusions

Tables 1 and 2 show the nannofossil relative abundance data for the studied samples for the upper and lower parts of the formation, respectively. The Abtalkh Formation nannofossils are moderately preserved, and high in species richness and abundance. *Micula decussata* and *Watznaueria barnesiae* are the major components of the assemblages in the lower part of the formation, contributing 20.44% and 27.33%, respectively. *Prediscosphaera cretacea* and *Cribrosphaerella ehrenbergii* are also important components, contributing 8.38% and 10.38%, respectively. The predominant species in the upper part of the Abtalkh Formation are also *M. decussata* (8.78%) and *W. barnesiae* (20.38%). There is a marked decrease in the overall nannofossil abundance and species richness in the Lower Maastrichtian.

Nannofossils from the oldest sample (0m; the topmost chalky limestone of the Abderaz Formation) were previously determined as Early Campanian in age (Hadavi & Notghi Moghaddam, 2002). In the present study, this has been confirmed, the base of the section corresponding to UC14a (after the biozonation of Burnett, 1998), equivalent to CC18a (following the scheme of Sissingh, 1977, as modified by Perch-Nielsen, 1985). The top of the lower part of the formation (+70m) has been here identified as Late Campanian in age, corresponding to UC15d^{TP}-15e^{TP} (equivalent to CC22a-c). In the upper part of the formation, UC20b^{TP} (CC25c) was determined for the upper portion. Consequently, the age of the Abtalkh Formation is Early Campanian to Late Maastrichtian.

References

Afshar Harb, A. 1979. *The stratigraphy, tectonics and petroleum geology of the Kopet Dagh region, northern Iran*. Unpubl. PhD thesis, Univ. of London.

Burnett, J.A. 1998. Upper Cretaceous. *In*: P.R. Bown (Ed.). *Calcareous Nannofossil Biostratigraphy*. Chapman & Hall/Kluwer Academic Publishers: 132-199.

Davoudzadeh, M. & Schmidt, K. 1984. Review of the Mesozoic paleogeography and paleotectonic evolution of Iran. *N. Jb. Geol. Paläont. Abh.*, **2**: 182-207.

Hadavi, F. & Karami, Z. 2000. Biostratigraphy of the Abderaz Formation in Taher Abad. *Proceedings of the 4th Symposium of the Geological Society of Iran, Tabriz*: 150-154.

Hadavi, F. & Khodadadi, L. 2002. Calcareous nannoplankton of the Campanian-Maastrichtian of NE Iran. *J. Nannoplankton Res.*, **24**: 109.

Hadavi, F. & Notghi Moghaddam, M. 2002. Calcareous nannofossils from the Chalky Limestone in the Kopet-Dagh range, NE Iran. *J. Nannoplankton Res.*, **24**: 110.

Hadavi, F. & Sanati, F. 2000. Biostratigraphical studies of the Abderaz Formation at the type section. *Isfahan University Research Bulletin*, **13**: 197-229.

Hadavi, F. & Shokri, M.H. 2000. Biostratigraphy of the Sarchashmeh Formation in the type section, in the Kopet-Dagh range. *Proceedings of the 18th Symposium on Geoscience, Tehran*: 127-131.

Perch-Nielsen, K. 1985. Mesozoic calcareous nannofossils. *In*: H.M. Bolli, J.B. Saunders & K. Perch-Nielsen (Eds). *Plankton Stratigraphy*. Cambridge University Press: 329-426.

Sissingh, W. 1977. Biostratigraphy of Cretaceous calcareous nannoplankton. *Geol. Mijnbouw*, **56**: 37-65.

Stocklin, J. 1968. Structural history and tectonics of Iran: a review. *Bull. Am. Assoc. Petrol. Geol.*, **52**: 58-129.

STAGE	FORMATION	SAMPLE HEIGHT IN SECTION (m)	*Braarudosphaera bigelowii*	*Calculites obscurus*	*Ceratolithoides aculeus*	*Cribrosphaerella ehrenbergii*	*Eiffellithus turriseiffelii*	*Lithraphidites carniolensis*	*Lucianorhabdus cayeuxii*	*Microrhabdulus decoratus*	*Micula concava*	*Micula decussata*	***Micula murus***	*Prediscosphaera cretacea*	*Quadrum gartneri*	*Reinhardtites anthophorus* (reworked)	*Retecapsa angustiforata*	*Retecapsa crenulata*	*Tranolithus orionatus* (reworked)	*Uniplanarius sissinghii*	*Uniplanarius trifidus* (reworked)	*Watznaueria barnesiae*	*Watznaueria biporta*	*Zeugrhabdotus bicrescenticus*	*Zeugrhabdotus diplogrammus*	*Zeugrhabdotus* spp.	NANNOFOSSIL EVENT	NANNOFOSSIL ZONE after Sissingh (1977)	NANNOFOSSIL ZONE after Burnett (1998)
MAASTRICHTIAN *pars.*	Niz.	717				F			F			A		C				F		F	F	A					Cret. taxa present	CC25c	UC20b[TP]
	Abtalkh	715					F			F	F	A		C		F						A							
		705								F		A	**F**	C		F		F				A		F	F	F			
		700		F	F	C			F		F	A		C		F						A			F				
		695	F			C	F	F	F			A	**F**	C	F		F					A	F	F		F			
		692	F	F		C	F			F		A	**F**	C			F	F		F	F	A		F	F	F			
		689		F	F	C	F	F		F	F	A	**F**	C	F	F		F	F	F	F	A	F		F	F	FO *M. murus*		
		684			F	C	F		F	F		A		C	F	F	F	F	F	F	F	A	F	F	F	F		CC25b?	UC20aTP?

Table 1: Distribution of nannofossils in samples from the upper contact of the Abtalkh Formation

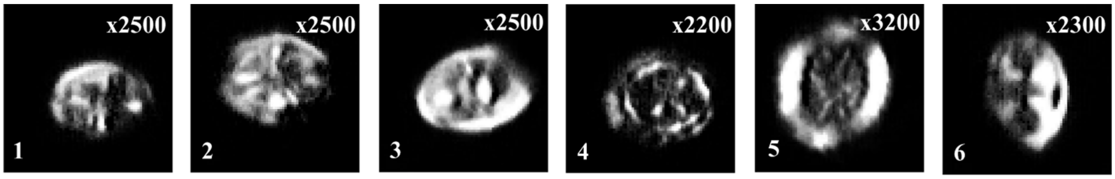
STAGE	FORMATION	SAMPLE HEIGHT IN SECTION (m)	*Ahmuellerella octoradiata*	*Arkhangelskiella specillata*	***Aspidolithus parcus constrictus***	***Aspidolithus parcus parcus***	*Biscutum* spp.	*Braarudosphaera bigelowii*	*Calculites obscurus*	*Calculites ovalis*	***Ceratolithoides aculeus***	*Ceratolithoides sesquipedalis*	*Corollithion exiguum*	*Cribrosphaerella ehrenbergii*	*Cylindralithus serratus*	*Eiffellithus eximius*	*Eiffellithus gorkae*	*Eiffellithus turriseiffelii*	*Lapideacassis* sp.	*Lithraphidites carniolensis*	*Lucianorhabdus cayeuxii*	*Lucianorhabdus maleformis*	***Marthasterites furcatus***	*Microrhabdulus belgicus*	*Microrhabdulus decoratus*	*Microrhabdulus helicoideus*	*Microrhabdulus undosus*	*Micula concava*
CAMPANIAN *pars*	Abtalkh	70.00									**F**			A			F			F	F			F	F		F	F
		69.00							F		**F**			C		F	F	F			F			F	F			F
		67.00	F				F		F	F	**F**			A	F		F								F		F	
		65.00					F		F		**F**	F		C	F		F				F			F	F		F	
		59.20		F					F		**F**		F	A	F	F	F	F			F			F	F		F	F
		55.00		F					F			F	F	A	F	F	F	F	F			F			F		F	
		51.00		F			F		F	F	**F**			C			F	F		F	F				F		F	F
		46.50		F			F		F	F	**F**	F	F	A		F	F	F	F		F	F			F	F	F	F
		42.00		F						F	**F**			C		F	F			F	F	F		F	F			F
		36.80	F	F	**F**	**F**	F		F		**F**	F		C	F	F	F			F	F			F	C	F		F
		32.20	F	F	**F**		F		F					C		F	F	F	F		F			F	F			F
		26.50	F		**F**		F	F	F				F	C		F	F	F		F	F				F	F	F	F
		22.00	F		**F**			F	F	F			F	C		F	F	F	F		F				F	F	F	
		17.00			**F**	**F**		F	F	F				C			F		F	F				F	F	F		F
		12.50	F		**F**		F		F	F				C	F		F							F	F	F		
		9.40	F		**F**	**F**			F					C		F	F				F	F			F		F	
		4.25	F			**F**		F	F					C		F	F	F			F		**F**		F			
	Abd.	0.00	F			**F**			F					C	F		F			F	F		**F**		F	F		

Table 2: Distribution of nannofossils in samples from the lower contact of the Abtalkh Formation

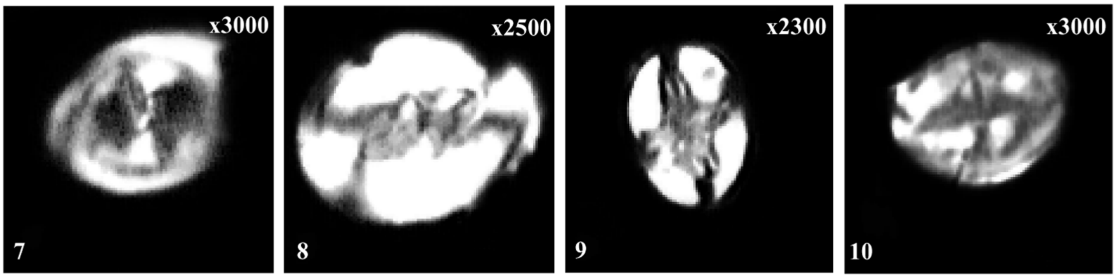
Micula cf. *M. cubiformis*	*Micula decussata*	*Quadrum campanensis*	*Prediscosphaera cretacea*	*Prediscosphaera spinosa*	*Quadrum gartneri*	*Quadrum intermedium*	***Reinhardtites anthophorus***	*Retecapsa crenulata*	*Tranolithus orionatus*	*Uniplanarius gothicus*	***Uniplanarius sissinghii***	***Uniplanarius trifidus***	*Watznaueria barnesiae*	*Watznaueria biporta*	*Zeugrhabdotus diplogrammus*	*Zeugrhabdotus* spp.	NANNOFOSSIL EVENT	NANNOFOSSIL ZONE after Sissingh (1977) & Perch-Nielsen (1985)	NANNOFOSSIL ZONE after Burnett (1998)
	A		A				**F**	F			**F**	**F**	A	F		F	*R. anthophorus* present	CC22a-c	UC15d^{TP}-15e^{TP}
	A	F	A				**F**	F	F	F	**F**	**F**	A			F			
	A		A	F			**F**	F	F		**F**	**F**	A	F	F	F	FO *U. trifidus*		
	A		C				**F**	F		F	**F**		A	F	F	F		CC21a-c	UC15c^{TP}
	A		A			F	**F**	F	F	F	**F**		A	F		F			
F	A	F	A		F	F		F	F		**F**		A				FO *U. sissinghii*		
	A	F	A	F	F		**F**	F					A					CC20	UC15b^{TP}
F	A	F	A	F	F	F	**F**	F	F	F			A	F	F	F			
	A		A		F		**F**	F					A	F	F	F			
F	A	F	A		F		**F**	F	F				A	F		F	FO *C. aculeus*		
F	A	F	A	F			**F**	F	F	F			A		F	F		CC18b-19b	UC14b^{TP}-15a^{TP}
	A	F	C					F	F	F			A	F	F	F			
	A	F	A				**F**	F					A	F		F			
F	A	F	A	F	F		**F**	F		F			A		F	F			
	A	F	A	F	F		**F**	F					A		F	F			
F	A	F	C		F		**F**		F				A		F	F	FO *A. parcus constrictus*		
	A	F	C		F			F	F				A	F		F	LO *M. furcatus*	CC18a	UC14a
	A	F	A					F					A	F	F	F	*A. parcus parcus* present		

Plate 1

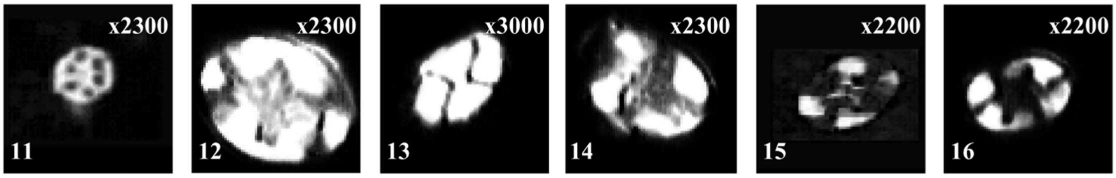
All images are stored on CD in the Geology Dept., Faculty of Science, Ferdowsi University of Mashhad



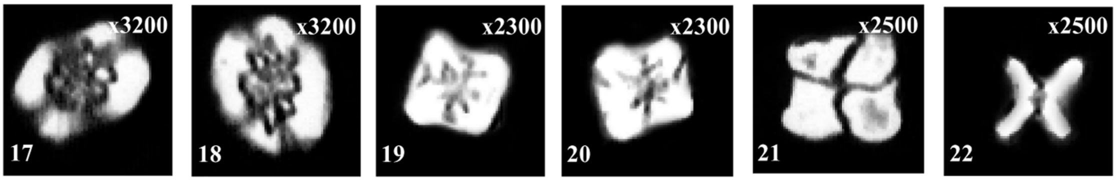
A. octoradiata Image #Abtalkh 14 | *A. octoradiata* Image # Abtalkh 13 | *Z. bicrescenticus* Image # Abtalkh 41 | *P. cretacea* Image # Abtalkh 31 | *R. crenulata* Image # Abtalkh 12 | *T. orionatus* Image # Abtalkh 42



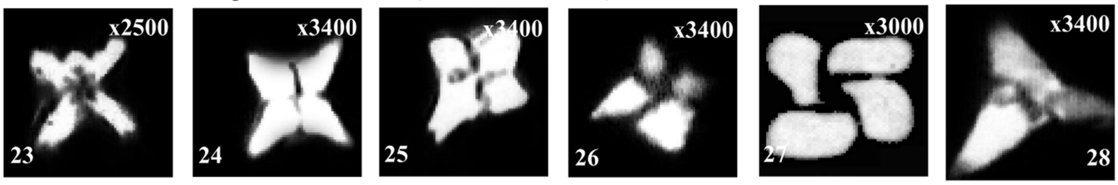
R. anthophorus Image # Abtalkh 21 | *A. parcus constrictus* Image # Abtalkh 25 | *E. eximius* Image # Abtalkh 24 | *G. segmentatum* Image # Abtalkh 6



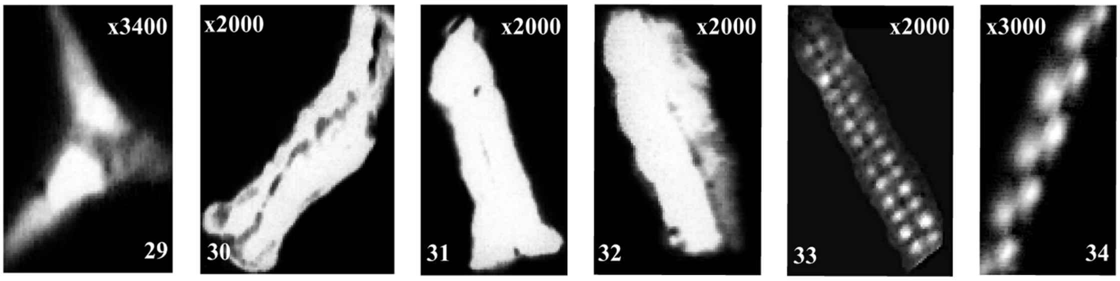
C. exiguum Image# Abtalkh 44 | *E. eximius* Image# Abtalkh 27 | *C. obscurus* Image # Abtalkh 29 | *E. eximius* Image # Abtalkh 28 | *E. turriseiffelii* Image # Abtalkh 35 | *E. turriseiffelii* Image # Abtalkh 36



R. angustiforata Image # Abtalkh 8 | *R. angustiforata* Image # Abtalkh 10 | *M.* cf. *M. cubiformis* Image # Abtalkh 9 | *M.* cf. *M. cubiformis* Image # Abtalkh 11 | *U.* cf. *U. gothicus* Image # Abtalkh 15 | *M. decussata* Image # Abtalkh 49



M. decussata Image # Abtalkh 53 | *U. sissinghii* Image # Abtalkh 19 | *U. sissinghii* Image # Abtalkh 17 | *U. sissinghii* Image # Abtalkh 18 | *M. murus* Image # Abtalkh 67 | *U. trifidus* Image # Abtalkh 47



U. trifidus Image # Abtalkh 40 | *L.* cf. *L. cayeuxii* Image # Abtalkh 60 | *L. maleformis* Image # Abtalkh 63 | *L. cayeuxii* Image # Abtalkh 61 | *M. decoratus* Image # Abtalkh 77 | *M. undosus* Image # Abtalkh 73