PALEOTEMPERATURE INTERPRETATION BASED ON CALCAREOUS NANNOPLANKTON OF KEDUNG SUMBER RIVER SECTION, SOKO, BOJONEGORO, EAST JAVA

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Abstract

Analysis of 64 samples taken from the Kedung Sumber River section represent of Kalibeng Formation, Atasangin Member, Klitik Member, Sonde Formation, and Pucangan Formation. The detail of nannoplankton analysis showing that temperature changes influenced to the growth of nannoplankton. Result of this study reveals that a number of 32 zones paleotemperature change. Age of the Kalibeng Formation is Late Miocene to Early Pliocene (NN10-NN13), divided into nine zones: 1/warm, 2/cold, 3/transitional, 4/warm, 5/cold, 6/warm, 7/cold, 8/cold, 9/warm zone. Atasangin Member are divided into 3 zones: 10/cold, 11/warm, 12/cold zone. Age of this member is Early Pliocene (NN13-NN14). Klitik Member is Early Pliocene to Late Pliocene (NN14-NN17), and divided to 7 zones: 13/transitional, 14/warm, 15/cold, 16/warm, 17/cold, 18/warm zone. Age of Sonde Formation is NN18-NN20 (Late Pliocene to Early Pleistocene), have into 7 zones: 19/cold, 20/warm, 21/transitional, 22/cold, 23/transitional, 24/cold, 25/transitional, 26/ cold, 27/transitional zone, 28/warm, 29/cold zone. Pucangan Formation are divided into 3 zones: 30/warm, 31/transitional, 32/cold zone. Age of this formation is Pleistocene (NN20-NN21).

Keywords: Palaeotemperature, nannoplankton, Kedung Sumber

INTRODUCTION

Researches of fossil are one of the most important tools for the study of sedimentary rocks and basins. First, the succession of evolutionary appearances and extinctions provides age control, which is critical for understanding of basins evolution and validation of geological concepts. Second, fossils are useful for interpretation of local paleoenvironment, paleoclimate, and also reconstructions of paleobiogeographic (van Gorsel., et al., 2014).

The Kedung Sumber River section, located in Soko, Bojonegoro, East Java, Indonesia (Figure 1). The section consists of Kalibeng Formation, Atasangin Member, Klitik Member, Sonde Formation, and Pucangan Formation.

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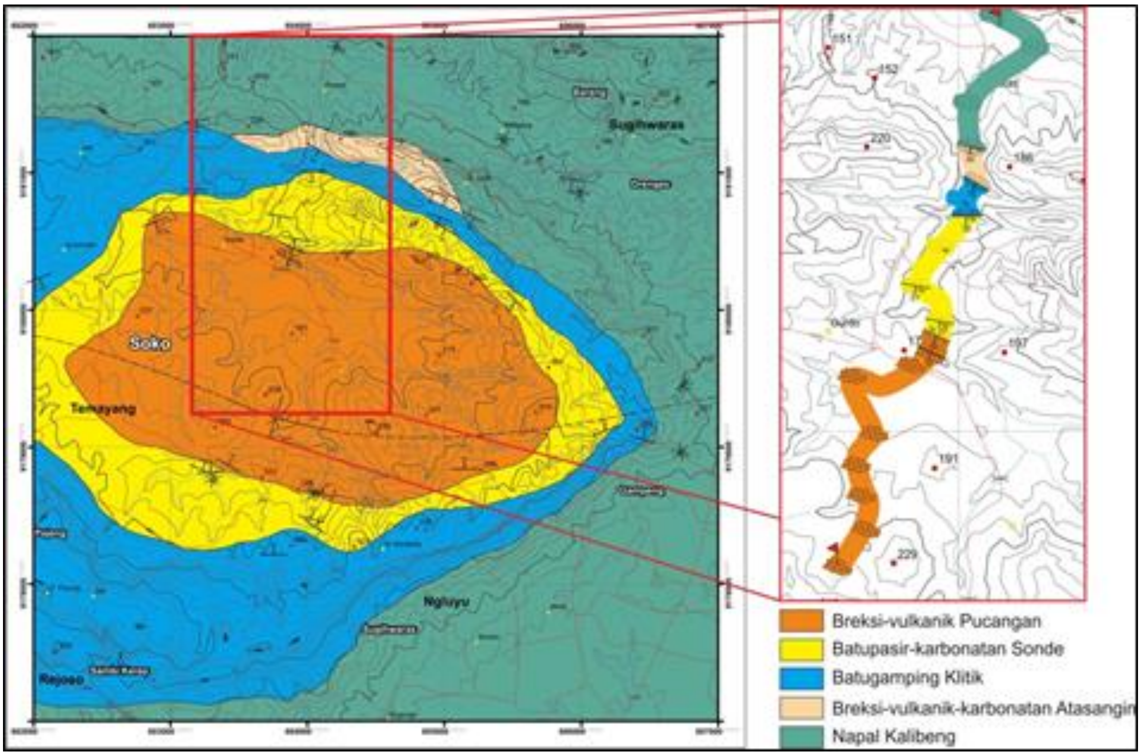

Figure 1. Geological map of the study area

The study area is a part of Kendeng Zone, East Java Basin. This section of the study area was selected because this section has a sedimentation sequence consisting mostly of fine-grained marine sedimentary rocks that contain abundant microfossils with age from Early Miocene to Pleistocene.

Calcareous nannoplankton included of planktonic organisms, who are sensitive to environmental changes, such as fluctuations of light, salinity, temperature, sea-level change, ocean productivity, nutrients and water pollution. The role of the calcareous nannoplankton in reconstructing paleoecological changes, for identifying global and regional environmental development, and to predict of climatic change.

The calcareous nannoplankton, included of the planktonic organisms, reflects with high fidelity environmental changes, such as fluctuations of seawater, salinity, temperature, sea-level changes, ocean productivity, nutrients and water pollution. The key role of the calcareous nannoplankton in reconstructing palaeoecological changes, in identifying global and regional environmental modifications and in advancing climatic predictions is argued (Melinte and Dobrinescu, 2004).

Paleotemperature interpretation in Kendeng Zone has been done by Choiriah (1999) using calcareous nannoplankton and Van Gorsel & Troelstra (1981) using plankton foraminifera. The results of his study showed different results. This is because it has a different lithostratigraphic

METHODS

The samples for calcareous nannoplankton studies are collected from sediment outcrops with a certain interval. Very small samples are needed. The preparation technique of smear-slides for calcareous nannoplankton analysis is simple and the cheaper. The Nannoplankton zones of Martini (1971) were applied. Specimens were randomly counted using a grid pattern.

Several parameters are used to interpret the paleotemperature for each sample, which must be calculated and ratio, i.e. the total amount:

1) Species (diversity)
2) Individual (abundance)
3) Species of Discoaster
4) Individual of Discoaster
5) *Discoaster pentaradiatus*
6) Form of Coccolith
7) Species of cold temperatures
8) Species of environmental characteristics with cold temperature
9) Species of environmental characteristics with transition temperatures
10) Species of environmental characteristics with warm temperature
11) Species that characterize the environment with warm temperatures
12) Individuals who characterize a warm temperature environment
13) Species ratio as indicator of cold environment
14) Species ratio as indicators of transition environment
15) Species ratio as indicators of warm environment

RESULT AND ANALYSIS

The lithostratigraphic nomenclature used in this study follows regional stratigraphy (Pringgoprawiro, 1983) (Figure 2).

Stratigraphy of Kedung Sumber section in this study area is composed Calcareous sandstone of Kalibeng Formation, Volcanic breccia unit of Atasangin Member, Limestone Unit of Klitik Formation, Calcareous sandstone of SOnde Formation, and Volcanic breccia Unit of Pucangan Formation (Figure 3).

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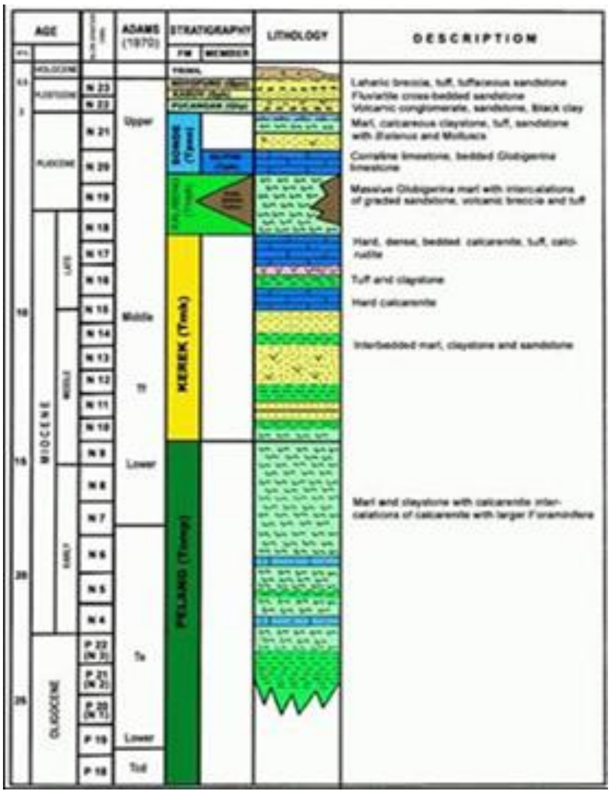

Figure 2. Regional Stratigrafi of Kendeng Zone (Pringgoprawiro, 1983)

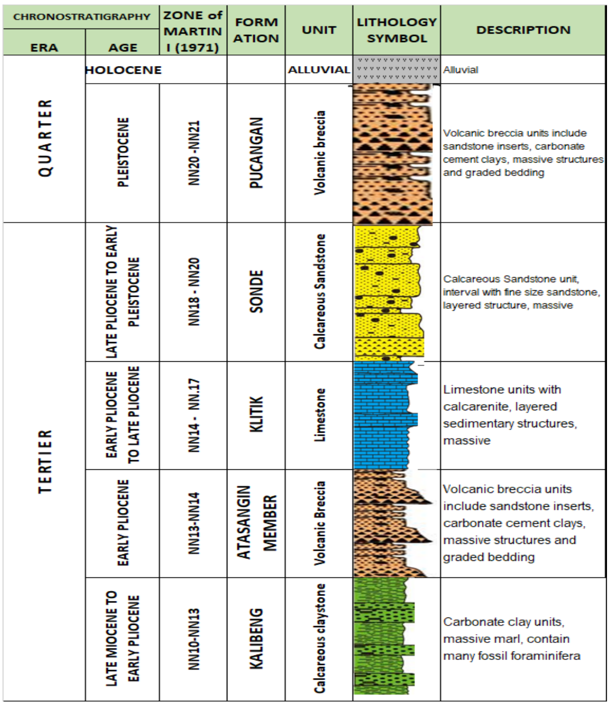

Figure 3. Stratigrafi of Kedung Sumber, Soka (Tim Research, 2016-2019)

Analysis of nannofossil found in the study area from a total of 64 samples of rock results in 11 genus and 32 species of nannofossil (Table 1)

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PALEOTEMPERATURE INTERPRETATION

Interpretation of paleotemperature based on calcareous nannoplankton analysis divided into several parameters, such as: (Figure 4)

1. Total of diversity, shows 21 zones of paleotemperature change zone, that is 8 cold zones, 8 transitional zones, and 5 warm zones.
2. Total of abundance indicated that 16 paleotemperature zones, that is 7 cold zones, 7 transitional zones, and 2 warm zones.
3. Amounts of species *discoaster*, shows there are 23 paleotemperature zones. This zone indicated 8 cold zones, 6 transitional zones, and 9 warm zones.
4. Total of individual *discoaster*, there are 22 paleotemperature zones, this zone are 9 cold zones, 5 transitional zones, and 8 warm zones.
5. Amounts of *Discoaster pentaradiatus*, shows there are 10 paleotemperature zones. This zone are 5 cold zones, 2 transitional zones, and 3 warm zones.
6. Amounts of individual coccolith forms (*Calcidiscus leptoporus, Coccolithus pelagicus, Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Helicosphaera carteri, Helicosphaera kamptneri,* and *Helicosphaera sellii*), indicated of 32 paleotemperature zones: 10 cold zones, 9 transitional zones, and 13 warm zones.
7. Amounts of species cold (*Coccolithus pelagicus, Discoaster intercalaris, Discoaster tamalis, Gephyrocapsa caribbeanica, Thoracosphaera saxea*), shows there are 29 paleotemperature zones, that is 6 cold zones, 11 transitional zones, and 12 warm zones.
8. Total of individual cold, indicated of 20 zones of paleotemperature: 6 cold zones, 6 transitional zones, 8 warm zones.
9. Amounts of species transitional (*Calcidiscus leptoporus*), because there is only one species is found, on this parameter divided into 3 transitional zones.
10. Total of individual transitional, because there is only one species and one individual is found, on this parameters divided into 3 transitional zones.
11. Total of species warm: *Ceratolithus rugosus, Discoaster asymmetricus, Discoaster blackstockae, Discoaster pentaradiatus, Gephyrocapsa oceanica, Rhabdosphaera clavigera*, indicated of 33 paleotemperature zones: 15 cold zones, 14 transitional zones, and 4 warm zones.
12. Total of individual warm, indicated of 32 paleotemperature zones, that is 14 cold zones, 8 transitional zones, and 10 warm zones.
13. Cold species Ratio indicated that 29 paleotemperature zones: 8 cold zones, 9 transitional zones, and 12 warm zones.
14. Transitional species Ratio indicates the existence of 3 paleotemperature zones (2 transitional zones and 1 warm zone).
15. Warm species Ratio indicated of 33 paleotemperature zones, that is 14 cold zones, 10 transitional zones, and 9 warm zones.

Characteristics of each parameter is interpreted paleotemperature changes with a different color (Figure 4). The color differences are green is cold zone, the temperature is <11°C, red color is transitional zone, the range of temperature is (11°C-18°C), and the yellow color is warm zone, and range of temperature is (19°C-30°C).

CONCLUSION

Each parameter of temperature change shows different interpretations of temperature changes. The results of all parameters are interpreted 32 temperature zones consisted of 13 cold zones, 8 transition zones, and 11 warm zones.

Kalibeng Formation is Late Miocene to Early Pliocene (NN10-NN13), composed of 9 zones. The zones are: 1/warm, 2/cold, 3/transitional, 4/warm, 5/cold, 6/warm, 7/cold, 8/cold, 9/warm zone.

Atasangin Member is Early Pliocene (NN13-NN14) and composed of 3 zones: 10/cold, 11/warm, 12/cold zone. Age of Atasangin Member

Klitik Member is Early Pliocene to Late Pliocene (NN14-NN17), and divided to 7 zones. These zones are: 13/transitional, 14/warm, 15/cold, 16/warm, 17/cold, 18/warm zone.

Age of Sonde Formation is NN18-NN20 (Late Pliocene to Early Pleistocene), and consists of seven zones. These zones are: 19/cold, 20/warm, 21/transitional, 22/cold, 23/transitional, 24/cold, 25/transitional, 26/ cold, 27/transitional zone, 28/warm, 29/cold zone.

Pucangan Formation composed of 3 zones: 30/warm, 31/transitional, 32/cold zone. Age of thid formation is Pleistocene (NN20-NN21).

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Table 1. Data from nannoplankton analysis of the study area

No	Nama Spesies		Nomor Contoh Batuan LOKASI SOKO, BOJONEGORO																																							
			~~8~~	9	10	11	20	21	22	23	24	25	26	27	28	29	30	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
			KALIBENG		ANGGOTA ATAS ANGIN																KLITIK						SONDE FM.KLITIK												PUCANGAN			
		NN	12	13	14																15	16			17	18	19										20		21			
1	*Calcidiscus leptoporus*	w			R																					R	R					R										
2	*Ceratolithus rugosus*	w	R																R												R											
3	*Coccolithus pelagicus*	w	~~F~~	R													R					F	F	F	F		F				R											
4	*Discoaster attus*	w							R								F			F	F		F	R																		
5	*Discoaster asymmetricus*	w			F																		F		R				F			R										
6	*Discoaster berggrenii* B	w			R																																					
7	*Discoaster blackstockae*	w			R																																					
8	*Discoaster brouweri*	w	~~F~~	F	F												R				R		R	R		R																
9	*Discoaster intercalaris*	w		R																																						
10	*Discoaster mendomobensis*	w																																								
11	*Discoaster neorectus*	w	~~F~~																																							
12	*Discoaster pentaradiatus*	w		R													F								F																	
13	*Discoaster quinqeramus*	w																							R				R													
14	*Discoaster tamalis*	w																													R											
15	*Gephyrocapsa caribbeanica*	w																																		R				C	F	
16	*Gephyrocapsa oceanica*	w																																		*				R		
17	*Helicosphaera carteri*	w	~~F~~	R	F																								F	F									F			
18	*Helicosphaera kamptneri*	w	~~F~~																																				R			
19	*Helicosphaera sellii*	w			F											F	R				R	R	F				R	R	F		R			R				R	R		F	
20	*Pseudoemiliania lacunosa*	w																			F	F			R			R	R		F	F		R				R				
21	*Reticulofenestra haqii*	w		F	F											F	F																									
22	*Reticulofenestra minuta*	w	~~A~~	A	A			C	A								A									A	A	A		F		C		C							C	
23	*Reticulofenestra minutula*	w	~~A~~	A	A			C	A		F			C		C	A		F	A	A	A	A	A	C	A	A	A	C	C	C	C		C		C	C	C	C	C	C	F
24	*Reticulofenestra pseudoumbilicus*	w	~~F~~	C	F											F				C						R			C	R	F			R							C	
25	*Rhabdosphaera clavigera*	w			R		R	R							R					R	R					R						R										
26	*Scyphosphaera globulata*	w			R																																					
27	*Sphenolithus abies*	w	~~A~~	A	A									C		C					A	C		F		C		A			C				F	F	C	F		C	C	
28	*Sphenolithus moriformis*	w																																								
29	*Sphenolithus neoabies*	w	~~A~~	A	A				C							C	F	F	F	C	A	C	C	F	C	C		A	C		C	C	F	C	F	C	F	C	C	F	C	
30	*Thoracosphaera albatrosiana*	w			R															R			R																			
31	*Thoracosphaera heimii*	w			R																																					
32	*Thoracosphaera saxea*	w			R															R	R	R		R	R				R													

■ : **Index of Nannofosil**

VA = Very Abundant (over 10 specimens per fielc

A = Abundant (1-10 specimens per field of view).

C = Common (one specimen per 2 to 10 fields of ·

F = Few (one specimen per 11 to 100 fields of vie

R= rare (1 to 2 specimens per slide)

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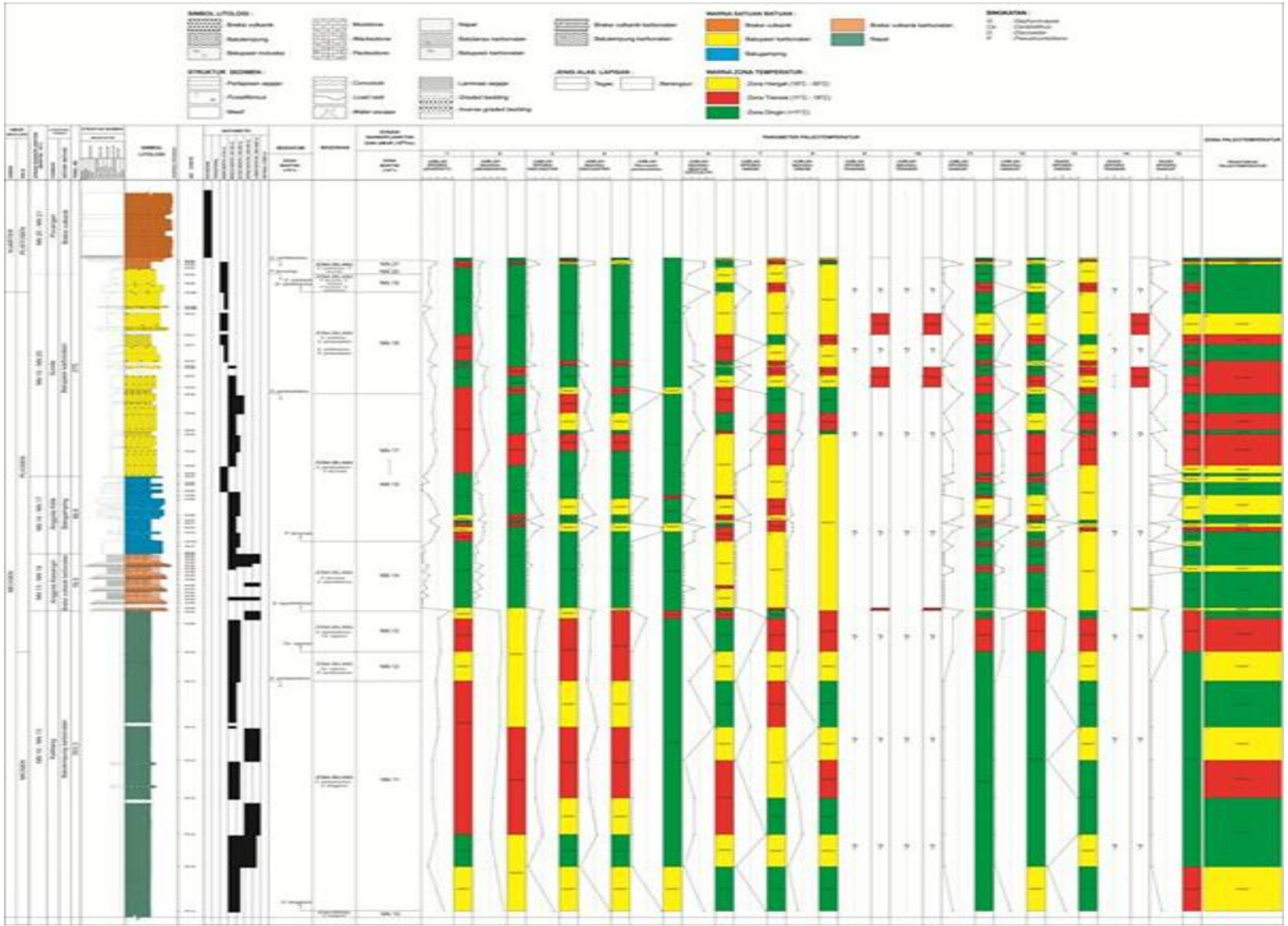

Figure 4. Paleotemperature Interpretation of Kedung Sumber, Soko, Bojonegoro