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KEMENRISTEKDIKTI RI

## SAINS & TEKNOLOGI

PENGEMBANGAN RISTEK DAN PENGABDIAN  
MENUJU HILIRISASI INDUSTRI



LEMBAGA PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT  
UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN"  
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DAFTAR ISI  
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	Halaman
Halaman Judul	i
Daftar Reviewer	iii
Sambutan Rektor	iv
Kata Pengantar Kepala LP2M	v
Daftar Isi	vii
<b>Karakteristik Mikroskopis Batubara Dan Potensi Sumberdaya Gas Metana Batubara, Seam-A Daerah Keban, Kab. Lahat, Sumatera Selatan</b> .....	1
Basuki Rahmad, Sugeng Raharjo, Ediyanto, Indra, Fadhil, Heru Asbi Rahmanda	
<b>Pengaruh Dosis Pupuk Npk Dan Pemberian Kitosan Terhadap Pertumbuhan Tanaman Kemiri Sunan Di Lahan Marjinal</b> .....	10
Ellen Rosyelina Sasmita, Ami Suryawati Dan Endah Budi Irawati	
<b>Hidrolisis Minyak Kelapa Sawit Fasa Homogen</b> .....	18
Mahreni, Angelina Natalia Sekardewi S Dan Gusti Kurnia Dwiputra	
<b>Pengaruh Ekstrak Daun Jambu Biji Terhadap Ketertarikan <i>Menochilus Sexmaculatus</i></b> .....	24
Mofit Eko Poerwanto & Cimatatus Solichah	
<b>Perbanyak Pisang Abaka Secara <i>In Vitro</i> Dengan Menggunakan Macam Arang Aktif Dan Thiamin</b> .....	31
Rina Srilestari, Ari Wijayani Dan Bambang Supriyanta	
<b>Potensi Sistem Perminyakan Pada Endapan Subvolcanic Area Pegunungan Selatan Jawa Bagian Timur</b> .....	36
Carolus Prasetyadi, Achmad Subandrio, Mahap Maha, Muhammad Gazali Rachman	
<b>Potensi Geowisata Gunung Sabulan Desa Mojosari, Kecamatan Asembagus, Kabupaten Situbondo, Provinsi Jawa Timur</b> .....	46
Df. Yudiantoro, B. Agus Irawan, I. Paramita Haty, S. Bawaningrum, P. Ismaya.	
<b>Aplikasi Biosurfaktan Dalam Upaya Peningkatan Perolehan Minyak Tahap Lanjut: Uji Laboratorium Pada Sampel Sumur Kw-58</b> .....	55
Harry Budiharjo S., Joko Pamungkas, Sri Rahayu G., Triyana Wahyuningsih	
<b>Type Deposit Dan Mineralisasi Emas Daerah Arinem Dan Sekitarnya Kabupaten Garut Jawa Barat</b> .....	61
Heru Sigit Purwanto, Agus Harjanto, Yody Rizkianto, Dedi Fatchurohman	
<b>Evaluasi Kestabilan Lereng Lokasi Ekowisata Kaliadem, Desa Kepuharjo, Kecamatan Cangkringan, Kabupaten Sleman, Diy</b> .....	67
Purwanto, Sutanto, Siti Hamidah	

<b>Pemodelan Geomekanik Berdasarkan Analisis <i>Fracturing Brown Shale</i> Kelompok Pematang Untuk Menentukan Gaya Utama Dalam Pengembangan <i>Shale Hydrocarbon</i> Di Dalam Bengkalis Cekungan Sumatra Tengah (Studi Kasus: Singkapan Analog <i>Brown Shale</i> Formasi Sangkarewang Cekungan Ombilin, Sumatera Barat) .....</b>	458
Aris Buntoro, Basuki Rahmad, Ahmad Khafid	
<b>Produksi Bahan Bakar Cair Dari Limbah Plastik Melalui Proses Pirolysis Dengan Limbah Biomassa Sebagai Sumber Energi .....</b>	468
Bambang Sugiarto, Andri Perdana, Aditya Kurniawan	
<b>Konsep Penerapan Teknik Pertambangan Yang Baik Dan Benar Didukung Oleh Peduli Lingkungan Dan Keselamatan Kesehatan Kerja .....</b>	474
Eddy Winarno, Gunawan Nusanto	
<b>Gasifikasi Limbah Batubara Hasil Pencucian Dengan Reaktor Unggun Terfluidisasi ....</b>	481
Edy Nursanto, Adi Ilcham , Gogot Haryono	
<b>The Pendawa Hill, Jering, Sleman Is On Of Geosite In Yogyakarta Geoheritage Very Interesting To Be Developed In To Geological Torism Object .....</b>	488
Jatmika Setiawan, Alim Sugiantoro , M. Nurjati Setiawan	
<b>Aplikasi Alat Bantu Foto Udara (Drone) Dan Pengeditan Foto Untuk Mendukung Pengambilan Data Geologi Pada Tebing Curam, Studi Kasus : Tebing Breksi, Yogyakarta .....</b>	495
Muchamad Ocky Bayu Nugroho, Muhamad Syaifudin, Bambang Yuwono, Gigih Sinangaseta	
<b>Pengembangan Pangan Sehat Berbasis Sorgum Di Masyarakat .....</b>	501
Mohammad Nurcholis, Dwi Aulia Puspitaningrum, Henri Krismawan	
<b>Implikasi Struktur Geologi Terhadap Kedalaman Muka Airtanah Dan Kualitas Airtanah Di Desa Gilangharjo, Kecamatan Pandak, Kabupaten Bantul, Daerah Istimewa Yogyakarta .....</b>	508
Puji Pratiknyo, Wrego Seno Giamboro	
<b>Paleotemperature Interpretation Based On Calcareous Nannoplankton Of Kedung Sumber River Section, Soko, Bojonegoro, East Java .....</b>	521
Siti Umiyatun Choiriah, Carolus Prasetyadi, Rubiyanto Kapid, Dwi Fitri Yudiantoro, Muhammad Syaifudin	
<b>Reduksi Chromium Dalam Limbah Batik Menggunakan Adsorben Dari Limbah Padat Industri Tepung Onggok .....</b>	528
Sri Wahyuni Santi Rahadiningrum, Purwo Subagyo, Valeria Dianitya Hernawati	
<b>Interpretasi Fasies Lapisan Batubara A, B, C, And D, Formasi Tanjung , Daerah Arang Alus , Provinsi Kalimantan Selatan .....</b>	532
Sugeng, Sari Bahagiarti Kusumayudha, Heru Sigit Purwanto, Basuki Rahmad	

## 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.

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.

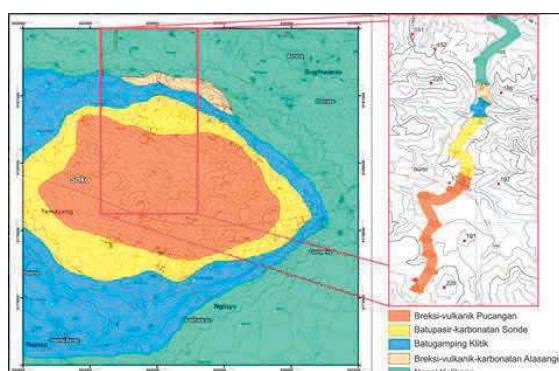


Figure 1. Geological map of the study area

Calcareous nanoplankton 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 nanoplankton in reconstructing paleoecological changes, for identifying global and regional environmental development, and to predict of climatic change.

The calcareous nanoplankton, 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 nanoplankton 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 nanoplankton 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 nanoplankton studies are collected from sediment outcrops with a certain interval. Very small samples are needed. The preparation technique of smear-slides for calcareous nanoplankton 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).

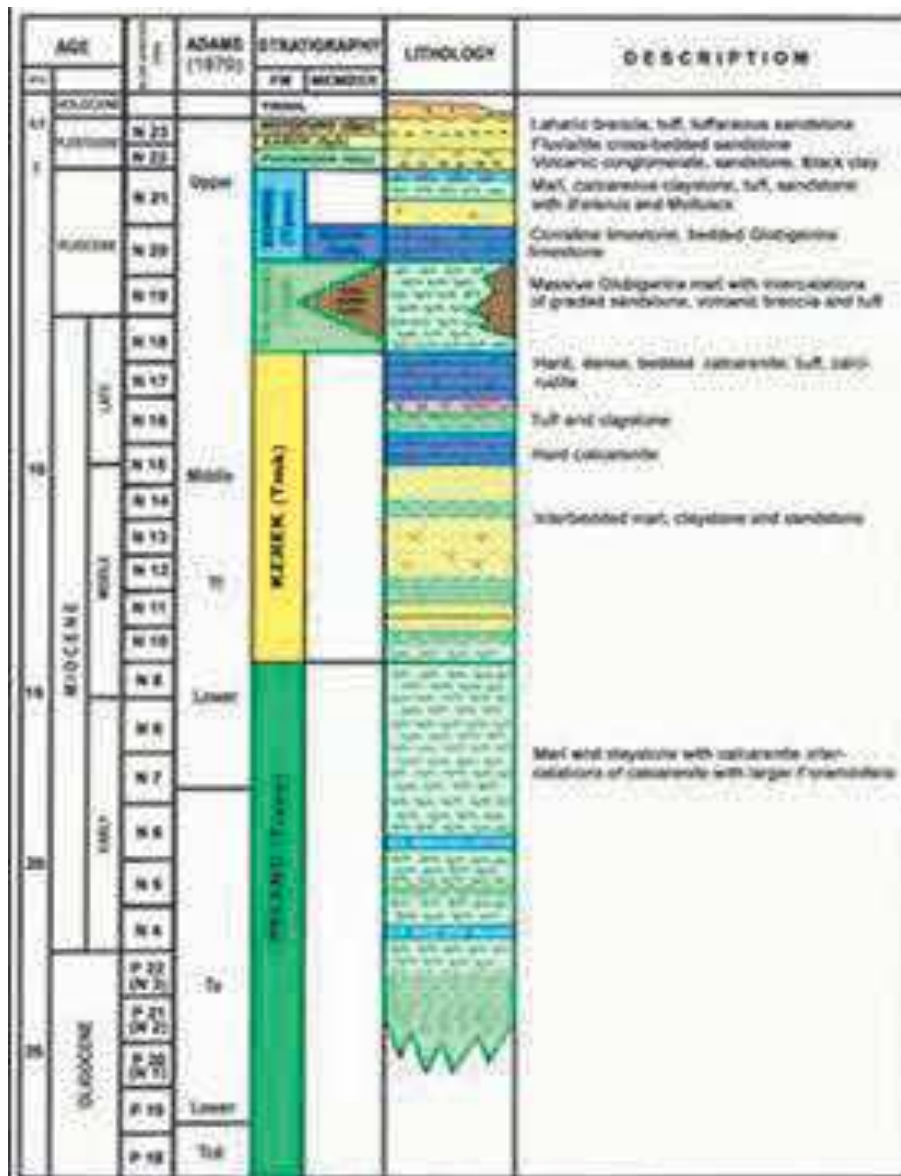


Figure 2. Regional Stratigraphi of Kendeng Zone (Pringgoprawiro, 1983)



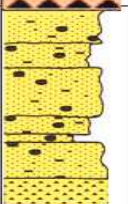

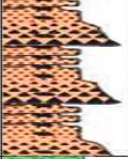
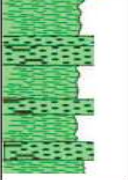
CHRONOSTRATIGRAPHY		ZONE of MARTIN I (1971)	FORM ATION	UNIT	LITHOLOGY SYMBOL	DESCRIPTION	
ERA	AGE						
QUARTER	HOLOCENE			ALLUVIAL		Alluvial	
		PLEISTOCENE	NN20 -NN21	PUCANGAN	Volcanic breccia		Volcanic breccia units include sandstone inserts, carbonate cement clays, massive structures and graded bedding
TERTIER	LATE PLOCIENE TO EARLY PLEISTOCENE		NN18 - NN20	SONDE	Calcareous Sandstone		Calcareous Sandstone unit, interval with fine size sandstone, layered structure, massive
	EARLY PLOCIENE TO LATE PLOCIENE		NN14 - NN.17	KLITIK	Limestone		Limestone units with calcarenite, layered sedimentary structures, massive
	EARLY PLOCIENE		NN13-NN14	ATASANGIN MEMBER	Volcanic Breccia		Volcanic breccia units include sandstone inserts, carbonate cement clays, massive structures and graded bedding
	LATE MIOCENE TO EARLY PLOCIENE		NN10-NN13	KALIBENG	Calcareous claystone		Carbonate clay units, massive marl, contain many fossil foraminifera

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)

#### PALEOTEMPERATURE INTERPRETATION

Interpretation of paleotemperature based on calcareous nanoplankton 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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