

## 千葉セクション (更新世前期-中期境界の国際模式ポイント候補地): 現状と今後の課題

### The Chiba composite section (a candidate of the L-M Pleistocene GSSP): recent advances and future perspectives

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In the Chiba composite section, along the Yoro, Yanagawa, and Kogusabata rivers in the Bozo Peninsula, the Kokumoto Formation (Kazusa Group) represents an expanded and well-exposed sedimentary succession across the Lower-Middle Pleistocene boundary. The predominant silty beds of the Chiba composite section are intensely bioturbated and lack evidence of episodic deposition such as slumps or muddy turbidites, which interpreted to be hemipelagite formed by deposition of fine-grained suspended material under stable and calm bottom-water conditions. High-resolution oxygen isotope stratigraphic studies for the Kokumoto Formation reveal that a continuous sedimentary record from MIS 21 to MIS 18, with extremely high sedimentation rates up to 200 cm/kyr. The Matuyama?Brunhes boundary (MBB) is clearly observed at immediately above the widespread Byk-E tephra bed. A high-precision U-Pb zircon age of  $772.7 \pm 7.2$  ka for the tephra coupled with the oxygen isotope chronology provides a highly accurate MBB age of  $770.2 \pm 7.3$  ka. This MBB age is consistent with the latest MBB ages from high-resolution marine sediments and an Antarctic ice core. Because the MBB customarily serves as the primary guide for the Lower?Middle Pleistocene Subseries boundary, the Chiba composite section is considered an excellent candidate for its global boundary stratotype section and point (GSSP). For a better chronological constraint and global correlation of the section, more detailed magneto- and oxygen isotope stratigraphy will be obtained. And also, analyses of Mg/Ca in foraminifera and pollen assemblage will be carried out for a high-resolution paleoclimatic reconstruction during MIS 19.

## 更新統前期—中期境界を含む田淵セクションにおける上総層群国本層上部のシルト岩層の詳細層序と堆積環境 Litho-stratigraphy and sedimentary environment of upper part of Kokumoto Formation with the L-M Pleistocene boundary

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房総半島中部に広く分布する上総層群は、更新世前期～中期に、かつての太平洋の深海～浅海に連続的に堆積した。上総層群の模式ルートである養老川付近では、国本層は、厚さ約 350m あり、厚いシルト岩層と砂優勢の砂岩泥互層との交互層である。本層基底より約 60m 部分はシルト岩層（最下部）で厚さ数 cm のごく薄い砂岩層を挟み、Ku6 と Ku5 火山灰層を挟む。この上位の厚さ約 120m は、砂優勢の砂岩シルト岩互層（下部）である。大局的には、砂岩層の厚さは上方へ薄層化している。この上位は厚さ約 80m のシルト岩層（上部）で、厚さ数 cm 程度のごく薄い砂岩層を 1～3m 間隔に挟み、Byk zone, Tap, Tas, Ku2 の他、軽石層、スコリア層、白色ガラス質細粒火山灰層などが厚さ 5～10m 間隔に挟む。最上部の約 90m は、砂優勢の砂岩シルト岩互層（最上部）である。古地磁気層序の松山逆磁極期—ブリュンヌ正磁極期の境界（以後「M/B 境界」と略す）はこのシルト岩層の下部にあることが（中川ほか, 1969; 新妻, 1976）によって見出され、Suganuma et al (in review in press) によって Byk zone 中にあることが明らかにされた。更新世前期—中期境界は、M/B 境界付近にすることが ICS (2009) により定義されたことから、わかりやすい岩相境界である Byk-E の基底を提案している (Kazaoka et al, submitted)。

この境界付近の厚いシルト岩層の堆積の安定性を検討するため、Byk の下位約 10m より Ku2 において詳しい露頭観察を行い、Byk-E の下位約 10m から Byk-E の上位約 5m については連続的に厚さ 1cm, 幅 5cm, 長さ 25cm のスラブ試料を露頭から採取し、昼光色、軟 X 線、X 線 CT による画像を撮影し、シルト岩中の内部構造を検討した。また、0.5m おきにシルト岩の粒度分析を行い、代表的なシルト岩試料の剥片を作成し顕微鏡観察を行った。これらの結果明らかになってきたことを以下に示す。

①Byk-E から Ku2 の間に、Byk-D, Byk-C, Byk-B, Byk-A, Tap-B, Tap-A, Tas-C, Tas-B, Tas-A の 9 枚のテフラの連続性が養老川を中心に確認され、これらテフラ間の厚さが側方に大きな変化はない。すなわち安定的にシルトが堆積したと考えられる。

②スラブ堆積物が挟まれていない。また、厚い泥流堆積物や砂層は挟まれていない。

③スラブ試料の観察から、シルト岩中に多数の生痕化石を含んでおり、これにより火山灰層や薄い砂岩層が擾乱を受けている。すなわち流水が卓越するような環境ではなく、静かな環境下に堆積したといえる。

④シルト岩中に、厚さ 1～3cm の砂岩を数 m 間隔に挟む。また、シルト岩中に厚さ 1～5cm の砂混じり部分が 4～10 層 / m 挟まれている。これらは、静かな環境下であるものの、しばしば薄い砂が供給されることがあることを示している。

⑤粒度分析の結果、主体は細粒シルトであるが、極細粒砂を少し含む、2 峰性の粒度分布を示す。このことは、シルトが堆積するような水流がない環境下で通常は堆積しているものの、まれに砂が供給されるような流れがあることを示している。

以上のことから、通常時はシルトが堆積するような静穏な環境であるものの、しばしば極細粒砂が供給されるような流れがある環境であるといえる。また供給された薄い砂層は通常時の生物活動で擾乱されるような環境であるといえる。また、産出する底棲有孔虫化石が、bathyal と sub-littoral が混在している (Kamemaru, 1996) こと、生痕化石から深海を示す Zoophycos などがみられる (Nishida et al., submitted; Izumi et al, in press) こともあわせると、この厚いシルト岩層の堆積環境は slope を想定すると理解しやすい。

なお、軟 X 線撮影については産業技術総合研究所第 7 事業所内の宮地良典博士に、CT 画像については高知大学海洋コア総合研究センターの村山雅史教授・山本裕二博士・柳本志津氏にご協力いただいた。お礼申し上げます。

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## 上総層群国本層の生痕化石と生痕相：堆積環境と底生生態系への示唆 Ichnofossils and ichnofabrics of the Kokumoto Formation, Kazusa Group: Depositional environment and benthic paleoecology

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In the Tabuchi section, along the Yoro river in the Boso Peninsula, the Kokumoto Formation (Kazusa Group) represents an expanded well-exposed, continuous marine succession across the Lower-Middle Pleistocene boundary. Since the Tabuchi section contains the Matuyama-Brunhes boundary whose age was highly accurately constrained, it is considered as a candidate for the Global Boundary Stratotype Section and Point (GSSP). In addition, due to the high sedimentation rate and continuous deposition, the Kokumoto Formation is suitable for high-resolution paleoenvironmental studies. However, paleoecological studies of the formation are very few, responses of marine organisms to paleoenvironmental changes remain unclear. Therefore, this study systematically described the trace fossils and ichnofabrics of the Kokumoto Formation of the Tabuchi section. Twelve ichnogenera and another indeterminate U-shaped burrow were recognized from the silty beds of the formation, which are typical components of ichnofacies characterizing the bathyal zone (i.e. *Zoophycos* ichnofacies). In addition, no graphoglyptid trace fossils, which commonly occur in abyssal plain environments, were observed. Based on the trace-fossil assemblage combined with other sedimentological features, it is most likely that the silty beds of the Kokumoto Formation were deposited in a continental slope setting. Furthermore, two types of ichnofabrics were identified, which are *Phycosiphon*-dominated ichnofabric (*Phy* ichnofabric) and *Chondrites-Planolites-Thalassinoides* ichnofabric (*Ch-Pl-Th* ichnofabric). Observation of the thin-sliced slabs revealed the distinctive stratigraphic changes of these two ichnofabrics; namely, both the *Phy*-ichnofabric and *Ch-Pl-Th* ichnofabric occur in the lower and upper part of the Tabuchi section, whereas the *Ch-Pl-Th* ichnofabric is exclusively recognized in the middle part. The vertical change in ichnofabrics is not correlated with changes in sedimentation rate. Instead, the ichnofabrics are well correlated with changes in benthic-food contents, which are estimated by the results of high-resolution XRF analysis. In particular, the lower and upper parts of the Tabuchi section, which are characterized with the presence of *Phy*-ichnofabric, are synchronized with food-poor intervals. Since the *Phycosiphon*-producer is regarded as a grain-selective deposit feeder, which may have effectively ingested organic matter, it is reasonable that the *Phy*-ichnofabric occurs only in food-poor intervals.

## 千葉セクションにおける下部—中部更新統境界と白尾火山灰層の分布状況(その2) Lower - Middle Pleistocene Boundary at Chiba Section and distribution situation of Byk zone, central Japan(part2)

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本調査地域に分布する上総層群は、更新統下部から中部の海成層で日本の模式層となっている。第四系更新統において、下部—中部境界について現在も議論が進行中である。ただし、1991年の国際第四紀研究連合(INQUA)および1992年の万国地質学会議(IGC)において、ブリュンヌ正磁極期と松山逆磁極期の境界(以下B/M境界)付近に下部—中部更新統境界(以下L/M境界)が設定することでは合意されている。そして、このB/M境界は上総層群国本層中に存在することは多くの研究から報告されている。千葉県市原市をほぼ縦断して北流する養老川の田淵露頭(千葉セクション)にスコリア火山灰と白色細粒火山灰から構成される火山灰束(名称:白尾火山灰層, 以下Byk zone)が確認されるが、このByk zone中にB/M境界が確認されている。本調査地域に分布する国本層はN67~69° E7~9° Nの地質構造で、傾斜方向と養老川の流下方向がほぼ一致する。全体に塊状泥層、砂層勝ち砂泥互層、等量砂泥互層、泥層勝ち砂泥互層、塊状砂層の堆積物層で構成される(石和田ほか, 1971; 三梨ほか, 1959, 1961; 徳橋・遠藤, 1983; 木村ほか, 2012, 2014)。本調査では基本的に塊状泥層は層厚2 m以上のものを塊状泥層とし、薄い砂層が挟まる場合は、基本的に砂:泥=1:10以上とし、砂層勝ち砂泥互層は砂:泥=6:4~10:1となるもの、等量砂泥互層は砂:泥=6:4~4:6の間のもの、泥層勝ち砂泥互層は砂:泥=4:6~1:10となるもの、塊状砂層は基本的に層厚2 m以上のものを塊状砂層とし、薄い泥層が挟まる場合は、基本的に泥:砂=1:10以上とした。上記基準を基に国本層は4部層(最上部層:砂層勝ち砂泥互層主体, 上部層:塊状泥層, 中部層:砂層勝ち砂泥互層主体, 下部層:塊状泥層)に区分される(木村ほか, 2014)。Byk zone(再定義:風岡ほか, 2014; 木村ほか, 2014)は国本層上部層下部に挟在し5層(A:灰白色細粒+スコリア, B・C・D:スコリア, E:白色細粒)からなる。Byk-Eは従来のTNTT(新妻, 1976)。Byk zone(Byk-A~E)は養老川の東方の田淵川, 西川, 古敷谷川(古敷谷川セクション)においても確認されている。Byk-A~E間は東方へ減じているため国本層上部は東方向で堆積速度が減じていると言える。

キーワード: 白尾火山灰層束, 下部—中部更新統境界, 国本層上部層, 養老川, 千葉セクション

Keywords: Byk zone, Lower-Middle Pleistocene Boundary, Kokumoto Formation upper part, Yoro River, Chiba Section



## 房総半島のブルン-松山地球磁場逆転境界における初生残留磁化極性の識別 Discrimination of primary remanent magnetization during Matuyama-Brunhes polarity transition

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We report preliminary results of magnetostratigraphy from an outcrop in Boso Peninsula, which is considered to record Matuyama-Brunhes polarity transition. The outcrop is 74m height, facing west and situated along a roadside in Terasaki, Chiba Prefecture, Japan. The sediment mainly consists of massive silt of Kokumoto Formation, Kazusa Group. The outcrop shows several tephra layers including TNTT (Byk-E) residing close to Matuyama-Brunhes polarity transition (Okada and Niitsuma, 1989).

In order to identify the polarity of primary remanent magnetization recorded, we have taken 55 paleomagnetic drill cores at intervals of 10 cm. Progressive alternating field demagnetization (PAFD) was conducted on all the sub-samples taken from the drill cores. The higher coercivity (>20 mT) magnetization component has mostly positive inclination (normal polarity) and shows a swing to negative inclination (reversed polarity) at 76-91 cm below TNTT. Preliminary results of progressive thermal demagnetization shows sharp drop in remanent magnetization by heating up to 175 °C. By heating above 175 °C, magnetization decreases gradually up to 300-350 °C and becomes unstable above 300-350 °C.

In order to understand the origin of instability during heating to 30-350 °C, we have conducted progressive thermal demagnetization in combination with isothermal remanent magnetization acquisition. The results suggest the presence of (titano-)magnetite and greigite, and the production of magnetic mineral during heating above 200-350 °C in the laboratory.

Combination of thermal remanent magnetization up to 200 °C and further AF demagnetization was conducted in order to extract primary remanent magnetization hidden by the strong secondary magnetization and thermal instability, however, the extraction of primary remanent magnetization was not successful. Further improvements in demagnetization might be pursued to clarify the magnetization at the time of deposition free from later diagenesis.

キーワード: ブルン-松山地球磁場逆転境界, 熱消磁, 交流消磁, 低温消磁, 初生残留磁化, グレイナイト

Keywords: Matuyama-Brunhes polarity transition, thermal demagnetization, alternating field demagnetization, low temperature demagnetization, primary remanent magnetization, greigite

## 市原市田淵における国本層の掘削コアのマツヤマーブリュンヌ地磁気極性トランジション

### Matuyama-Brunhes magnetic polarity transition from a sequence of the Kokumoto Formation drilled at Tabuchi, Ichihara

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A detailed Matuyama-Brunhes transition was revealed from a 54-m oriented core of the Kokumoto Formation drilled at Tabuchi, Ichihara, Chiba Prefecture, central Japan. The core mainly consists of silts except the lowermost part intercalated with thin sand layers. For magnetic analyses, we prepared one meter long u-channel samples from 3 to 52 m depth, and discrete samples of 10 cc cube at 10 cm to 1 m intervals. Magnetizations were measured every 1 cm using a 2G cryogenic magnetometer for u-channel samples and subjected to alternating field demagnetizations (AFD), while both AFD and thermal demagnetizations were used for discrete samples. Preliminary oxygen isotope data on planktonic foraminifera (*Globorotalia inflata*) suggest that the main MB polarity boundary, just underlain by the Byakubi-E tephra layer, lies between the sea-level highstand of marine isotope stage (MIS) 19.3 and the MIS 19.2 lowstand. Characteristic remanent magnetizations of u-channel samples calculated by principal component analysis reveal a rapid reversal interval (RRI), a very important feature characteristic of the final stage of the MB transition, which lies between depths correlated with the MIS 19.3 highstand and MIS 19.2 lowstand. The RRI spans about 1.7 m in depth, during which the virtual geomagnetic pole crossed the geographic equator 11 times. A preliminary astronomical age model suggests that the RRI was ca. 2 kyr in duration, predating 776 ka and postdating 779 ka. The RRI can be correlated with similar intervals observed in the Osaka Group, Chinese loess-paleosols, and deep-sea sediments. The RRI incorporates both the MB boundary and the Byakubi-E tephra in the Chiba section. This has important implications for the definition of the Early-Middle Pleistocene boundary. Other MB transition features, including paleointensity variation, will be discussed together with the results from discrete samples.

キーワード: マツヤマーブリュンヌ極性トランジション, 国本層, 更新世前期-中期境界, チバセクション, GSSP

Keywords: Matuyama-Brunhes polarity transition, Kokumoto Formation, Early-Middle Pleistocene boundary, Chiba Section, GSSP

## 千葉複合セクションにおける松山ーブルネ極性反転記録 Revised Matuyama-Brunhes polarity transition record from a marine succession at the Chiba composite section

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We report revised paleomagnetic records of the Matuyama-Brunhes (M-B) polarity transition from a continuous marine succession at the Chiba section of the Kokumoto Formation, Kazusa Group. The Chiba section is the one of the candidate sites for the Lower-Middle Pleistocene Boundary GSSP. An age model for the section, provided by newly obtained oxygen isotopes of benthic foraminifera from a 100 meters succession across the M-B boundary, indicates that the boundary is situated in the interglacial period of MIS19. We have taken 130 oriented mini-cores from a 13 meters succession across the Byk-E tephra bed at the Chiba section and the Yanagawa section. Thermal magnetic experiments suggest that the samples include iron sulfides, magnetites but no hematite. Measurements of magnetic hysteresis indicate that the magnetic domain state is PSD. Progressive alternating field (AF) demagnetization indicate a reversed to normal polarity transition boundary is at around 1.5 meter below the Byk-E bed as well as previous studies, however the transition boundary is observed at around 1 meter above the Byk-E bed in thermal demagnetization results. Therefore, the reversed to normal polarity transition boundary seen below the Byk-E bed is thought to be overprint. This overprints, which might be carried by iron sulfide, are particularly observed in a transitional interval. The virtual geomagnetic pole (VGP) latitudes and preliminary derived paleointensities using thermal demagnetizations from the Chiba section quite match well with the U1308 records. We will show globally comparable VGP and paleointensity records during the M-B polarity transition at the Chiba section.

キーワード: 千葉セクション, 中部一下部更新統境界 GSSP, 古地磁気学, 松山ーブルネ境界

Keywords: Chiba section, M-L Pleistocene boundary GSSP, Paleomagnetism, Matuyama-Brunhes boundary



千葉複合セクションのMg/Ca古水温記録に基づく更新世前期-中期における北西太平洋中緯度域の水温変動  
Mg/Ca-based temperature variations across the L-M Pleistocene Boundary in the Chiba composite section, central Japan

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The Kuroshio Current, a western boundary current in the North Pacific, transport warm saline waters from low- to high-latitude and thus plays a crucial role in heat transport in the mid-latitude. Around 0.8 Ma, near the L-M Pleistocene boundary corresponding to the Matuyama-Brunhes boundary (MBB), is the one of the key time period to understand initiation of 100-kyr glacial-interglacial climate cycle. The Chiba composite section, including the Tabuchi section as a L-M Pleistocene boundary GSSP candidate, is a continuous marine sedimentary succession exposed in the Boso peninsula, central Japan. The MBB is well defined based on virtual geomagnetic pole (VGP) latitudes in this section and an age model is determined based on benthic foraminiferal oxygen isotope record. The site of this section (35°N) is located in the mixing zone (35°N - 40°N at present) of warm Kuroshio and cold Oyashio waters. Thus, temperature changes in the site can be interpreted as reflecting the latitudinal shift of the Kuroshio-Oyashio boundary, which could be related to the Kuroshio variations and also impact on the heat transport in the mid-latitude. Here, we present Mg/Ca records of planktic foraminifera *Globigerina bulloides* and *Globorotalia inflata* in the Chiba section and reconstruct surface and subsurface water temperatures across the Matuyama-Brunhes Boundary. Preliminary results suggest that the average surface temperature was 18-19 °C during the time interval from 780-740 Ka. The higher time resolution (~0.5-1 ky) surface and subsurface water temperatures will be presented and discussed by comparison with the oxygen isotope data.

千葉県銚子市で掘削された銚子コアの花粉記録を用いた下部—中部更新統境界付近における植生変動の復元（予報）  
A vegetation change reconstruction at around the L-M Pleistocene boundary from a pollen record of the CHOSHI core

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千葉県市原市田淵（田淵セクション）に露出する上総層群国本層の露頭は、下部-中部更新統境界（L-M境界）GSSP 模式地となっているため、本地層における詳細な花粉記録の復元は重要である。しかし田淵セクションの堆積物は、遠洋性の堆積物であることから花粉密度が薄く、針葉樹花粉が過剰に優占するというように花粉組成が大きく歪んでいることが報告されている（大西, 1969）。そこで本研究では、Okuda et al. (2006) によって L-M 境界上位層準における良質な花粉記録が報告されている銚子コアを用いて、L-M 境界付近における詳細な花粉記録の復元を行うことを目的とする。千葉県銚子市森戸町で掘削された銚子コアは、香取層および犬吠層群の豊里層、倉橋層、横根層、小浜層で構成されている。これらの地層は酸素同位体ステージ (MIS) 25-11 を被覆し、下部-中部更新統境界をは横根層中部に相当する (Kameo et al., 2006)。犬吠層群は田淵セクションの近傍であるため、層序対比が比較的容易であり、L-M 境界の位置を精度良く決定できる。今回は L-M 境界を含む MIS20-18 の区間に相当するコア深度 150-170m の試料について花粉分析を行い、L-M 境界付近の植生変動を議論する。

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キーワード: 中部—下部更新統境界, 花粉分析

Keywords: Lower-Middle Pleistocene boundary, pollen analysis

## 下部-中部更新統境界 GSSP 候補地へのご案内 Invitation to the Tabuchi section, central Japan: A candidate GSSP for the Lower-Middle Pleistocene Subseries/Subepoch

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The Tabuchi section is a continuous marine sedimentary succession exposed in the Boso peninsula and is a Lower - Middle Pleistocene boundary GSSP candidate.

From the geological advantages and the easy access to the outcrops, the Tabuchi section seems to be the most suitable for the Lower - Middle Pleistocene boundary GSSP.

### Geological characteristics

- \*Tabuchi section is only candidate representing the Pacific realm.
- \*Thick L - M Pleistocene sedimentary succession (>3000 m) (2.4 ? 0.5 Ma) .
- \*Well exposed along the Yoro River with high sed. rates (ca. 2 m/kyr) & no visible breaks.
- \*Well preserved calcareous nannofossils, planktonic foraminifera, diatoms.
- \*Standard section for Japanese Pleistocene tephrostratigraphy (>50 ash beds).
- \*Well established d18O isotope stratigraphy: Kokumoto Fm. corresponds to MIS 20?18.
- \*M?B boundary is located ca. 1 m above a distinctive, widespread tephra bed (Byk-E).
- \*High-precision U-Pb zircon age of the Byk-E.  
Consistent with the latest astrochronology of marine sediments and Antarctic ice core.
- \*A basis for immediate comparisons between, magnetostratigraphy, biostratigraphy, O isotope stratigraphy, absolute ages (40Ar/39Ar & U-Pb), and astrochronology.
- \*Taking the M?B boundary as the primary guide to the L?M Pleistocene boundary, the Byk-E bed would serve as an appropriate level for the GSSP.

### Access

There are well developed public transportations. You can reach to Tabuchi section within 2 hours from Tokyo and 3 hours from both international airports. There are big car parks. There are lodge and toilet.

The access to the Tabuchi section is very easy and convenient by car, bus and train with very small walk.

キーワード: 田淵セクション, 下部・中部更新統

Keywords: Tabuchi section, Lower and Middle Pleistocene

## 中下部更新統, 中上部上総層群の詳細テフラカタログ Detailed Tephra Catalog of Lower to Middle Part of the Kazusa Group, Lower to Middle Pleistocene, Central Japan

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房総半島に分布する上総層群は, 日本を代表する中下部更新統の一つである. 上総層群は深海から浅海までの堆積環境で形成された連続的な堆積物で構成されており, 天然ガスとヨウ素に富む鹹水のリザーバとしても知られている. 上総層群では古くから数多くのテフラ層の認定に基づき層序区分が行われてきた. 著者らは, 中上部上総層群が分布する茂原地域における地質図幅調査の一環として, 従来のテフラ層序を再確認し, テフラカタログを作成した. 上総層群大田代層中部の O7 から笠森層の Ks4 までの間で確認されたテフラは 139 層である. これらの中には中下部更新統境界を指示する Byk-E テフラも含まれる. テフラの同定には, 火山ガラス, 斜方輝石及び角閃石の屈折率とともに, 一部のテフラについては火山ガラスの主成分化学組成を用いた. 房総半島北西部の銚子地域では同時代の地層について酸素同位体比曲線が求められており, テフラの対比により各テフラの MIS 年代を求めることができる.

キーワード: 中?下部更新統, 中?上部上総層群, テフラカタログ, 茂原地域, 房総半島, 千葉県

Keywords: Lower to Middle Pleistocene, Upper to Middle Part of the Kazusa Group, Tephra Catalog, Mobara District, Boso Peninsular, Chiba Prefecture

## 房総半島国本層における珪藻化石層序 Detailed stratigraphy of diatom assemblages from a core of the Kokumoto Formation collected in the Boso Peninsula, Japan

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Diatom analyses were conducted on a core of the Kazusa Group in the Boso Peninsula, central Japan, to reveal stratigraphic variations of diatom assemblages across the Matsuyama-Brunhes magnetic polarity boundary (MBB). The core is 54 m long collected near the Chiba section along the Yoro River, a candidate for the GSSP of the Early-Middle Pleistocene boundary. Stratigraphic variations of diatom assemblages in response to the glacial eustatic sea-level changes shown by the planktonic marine oxygen isotope record from *Globorotalia inflata*. Diatom assemblages in the lowermost part of the core are dominated by extinct species of *Actinocyclus ingens*, often observed in reworked deposits in the Kazusa Group. This part is correlated with the earliest stage of marine isotope stage (MIS) 19, and is dominated by reworked deposits that were accumulated during a low sea-level period. The extinct species suddenly decrease at a horizon of about 5 m below the Byakubi tephra (ByK) layer, during a gradual sea-level rise. Turbidity currents may have still affected the sedimentation at the site, although the lithology shows no turbidite layer above a horizon of about 8.5 m below the ByK. Above a level of 5 m below the ByK, marine littoral diatoms such as *Paralia sulcata* and *Cyclotella striata* become dominant, and have a peak at about 3 m below the ByK, coinciding with the lightest oxygen isotope value correlated with MIS 19.3. Above the peak abundance, the proportion of *P. sulcata* gradually decreases, and *A. ingens* re-increases at about 3m above the ByK, with a maximum at about 7m above the ByK, where marine isotope data show a maximum value. The re-increase of extinct diatom species suggests a sea-level drop. Thus the maximum of *A. ingens* at about 7 m above the ByK may be correlated with the MIS 19.2 sea-level lowstand. Therefore, the MBB that lies at 1 m above the ByK occurs between MIS 19.3 and 19.2. *A. ingens* can be used as a proxy of reworked deposits in the Kazusa Group.

キーワード: 国本層, パラリア サルカータ, アクチノキクルス インゲンス, MIS19, 松山 - ブリュンヌ境界, GSSP  
Keywords: Kokumoto Formation, *Paralia sulcata*, *Actinocyclus ingens*, MIS19, Matsuyama-Brunhes boundary, GSSP



## 東京湾不整合と万田野寒冷期 The Tokyo Bay Unconformity and the Mandano Ice Age

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関東フォーク・ベースンの前期更新統は深海堆積相をしめすが、次第に浅海化する。東京湾不整合によって浸食される。この不整合下位に上総層群が分布する。

この不整合は、東京湾岸の地下で発見されており、International Stratigraphic Guide に沿って模式地も東京湾岸の地下にある。そして、一連の不整合現象は東京湾側で顕著であるが、北東方向の長南町周辺からは整合となる。

地上では、海退期のデルタ堆積相の万田野層直下に認められる。万田野層の中部泥層は、上下に2分され、下半部は淡水域の環境を示し、*Picea maximowiczii*, *Tsuga diversifolia*, *Fagus crenata*, などの植物遺体が発見されている。つまり、当時の植生は、寒冷系の植物からなる植物群で構成されていたことが示唆される。また、大阪層群で知られる満池谷寒冷期と同一寒冷期の可能性も高い。関東フォーク・ベースン=関東深海盆が、始めて陸化した現象でもある。

中部泥層の上半部は汽水域となり、さらに上位の砂礫相には海生貝化石が多産し笠森層の浅海層へとかわる。笠森層の堆積時には、関東平野は関東大陸棚と呼ぶにふさわしい堆積環境にあったようである。

キーワード: 東京湾不整合, 万田野寒冷期, 上総層群, 下総層群, 関東大陸棚

Keywords: Tokyo Bay Unconformity, Mandano Ice Age, Kazusa Group, Shimohusa Group, Kanto Continental Shelf

福島県南相馬市塚原海岸に分布する中期-後期更新世境界にあたる塚原層の古地磁気  
および古環境学的研究  
Paleomagnetic and paleoenvironmental studies for the U-M Pleistocene boundary Tuk-  
abara Formation

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The Tukabara formation distributed along the Tukabara coast, Minamisoma City, Fukushima Prefecture, which is considered to have been deposited at early part of the last interglacial period, since the sediments suggested a transgression that leads to the marine isotope stage 5e. The base of the Tukabara formation consists of a basal gravel layer and the Tagashira tephra bed which is detected at the MIS 5/6 boundary in the Images MD01-2421 core taken from off Kashima, Pacific side of the central Japan. The main part of the formation consists of a 7 meter thick varved siltstone including enough diatom and pollen fossils to reconstruct paleoenvironment. Previous paleomagnetic studies reported a reversed polarity from this siltstone layer which was correlated as the Blake excursion. Here we report results of reexamined paleomagnetic and rock-magnetic analyses.

The silt layer, consisting of the main part of the Tukabara formation, is divided into following three parts based on paleomagnetic characteristics; Upper Zone: unstable magnetization direction after both of alternating-field thermal demagnetizations, Middle Zone: stable magnetization direction after both of alternating-field and thermal demagnetizations, Lower Zone: stable magnetization direction after alternating-field demagnetization but after thermal demagnetization. Rock magnetic and paleomagnetic experiments exhibit that the Upper Zone of the siltstone has significantly low magnetization intensities which is supposed to be due to a weak geomagnetic field caused by the Blake excursion during the deposition.

We will also report preliminary results of paleoenvironmental reconstruction using microfossil analyses. Diatom fossils were produced from all of the silt stone layers. Based on diatom assemblages, the silt layer is divided into three parts as follows; Diatom Zone 1: a marine genera dominance zone at the bottom part, Diatom Zone 2: freshwater genera dominance zone at the middle part, Diatom Zone 3: marine genera dominance zone at the top part. In the Diatom Zone 2, a shallow water genus *Rhaphoneis* is not seen and a freshwater cosmopolitan species *Diploneis elliptica* is abundant. Furthermore, a lot of varves can be well observed this Zone. This indicates that the zone is supposed to be deposited under a stagnant condition caused by a closed estuarine like environment with a fresh water discharge.

キーワード: 中期-後期更新世境界, 古地磁気, 古環境復元, Blake イベント

Keywords: Upper-Middle Pleistocene boundary, Paleomagnetism, Paleoenvironmental reconstruction, Blake event