

松山-ブリュンヌ古地磁気極性境界直下に位置する白尾E テフラ層 (Byk-E) の堆積相
Sedimentary facies of the Byakubi-E tephra bed (Byk-E) just below the Matuyama-Brunhes
Polarity Chronozone boundary in Boso Peninsula, central Japan

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白尾Eテフラ層 (Byk-E) は、上総層群国本層中部の暗灰色シルト層に挟まれる厚さ1.0~7.0cmほどの白色ガラ
ス質細粒火山灰層である。房総半島中央部の千葉セクション (田淵・柳川・小草畑川セクション) において
Byk-Eは、松山-ブリュンヌ古地磁気極性境界 (MBB) の約80cm下位に位置する (Suganuma et al.,
2015; Kazaoka et al., 2015)。MBBを含む国本層中部が連続的に露出する千葉複合セクションは、前期-中期
更新世境界の国際境界模式層断面とポイント (GSSP) 候補地の1つである (Head et al., 2008; Head and
Gibbard, 2015)。松山-ブリュンヌ古地磁気極性境界直下の明瞭な岩相境界であるByk-E基底面は、前期-中期
更新世境界のGSSPにおいて適切な基準面の役割を果たすことが期待される (Kazaoka et al., 2015)。
房総半島におけるByk-Eの分布 (Kazaoka et al., 2015) やその給源火山 (Takeshita et al., 2015) につい
ては明らかにされているが、Byk-Eの詳細な堆積相については報告がない。そこで、Byk-Eが下位のシルト層を侵
食することなく堆積しているか否かを確認することを目的として、房総半島中央部の養老川セクション、柳川
セクション、大福山林道沿いの露頭および房総半島南部の館山の露頭においてByk-Eの堆積構造を詳しく観察し
た。

観察の結果、いずれの露頭においても次の3点を確認することができた。1. Byk-Eには明瞭なラミナが認められ
ない。2. Byk-E中にはシルトの偽隙を含まない。3. Byk-Eの基底面は、下位のシルト層中の生痕化石を切断し
ない。また、生物擾乱が著しい養老川セクションを除く3つの露頭では、Byk-Eの基底部に細粒火山灰からなる
薄層が確認された。以上の観察結果は、Byk-Eは下位のシルト層を侵食することなく堆積したことを示してい
る。

キーワード：Byk-E、前期-中期更新世境界、GSSP、堆積相、千葉セクション

Keywords: Byk-E, Lower-Middle Pleistocene boundary, GSSP, Sedimentary facies, Chiba composite
section

房総半島の第四紀テフラのジルコンLA-ICP-MS U-Pb年代

Zircon LA-ICP-MS U-Pb dating on some Quaternary tephras in Boso Peninsula

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房総半島に分布するいくつかの第四紀テフラを対象にLA-ICP-MSによるジルコンのU-Pb年代測定を行った。これらのテフラは第四紀更新世前期・中期境界の国際模式地の候補地とも関連があるため、正確な年代測定を行う意義は大きい。最近、房総半島に分布する松山-Brunhes (MB) 境界直下のテフラを対象にSHRIMPによるジルコンのU-Pb年代として 0.773 ± 0.007 Maという高精度な年代が報告された (Suganuma et al., 2015)。今回、MB境界より上位にある二つのテフラ (Ks11, Ch2) から高精度なジルコンU-Pb年代として、Ks11から 0.52 ± 0.04 Ma, Ch2から 0.61 ± 0.02 Maが得られた。これらは層序から推定される年代とも一致していることから、信頼性の高い年代であると考えられるとともに、日本や世界の更新世の年代層序の確立にも貢献することが期待される。

キーワード：U-Pb年代測定、ジルコン、テフラ、松山-ブリュンヌ境界

Keywords: U-Pb dating, zircon, tephra, Matuyama-Brunhes boundary

千葉セクション、大阪湾、北大西洋に共通する軌道スケール、千年スケールの古海洋変動
Orbital and suborbital scale paleoceanographic features for marine isotope stage 19 from
the Chiba section well correlated with those from Osaka Bay and North Atlantic

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Chemical and magnetic data of a 54-m long core drilled near the Chiba section, Tabuchi provide excellent proxies of sea-level variations. The Ca/Ti ratio, magnetic susceptibility, ARM, and ARM/magnetic susceptibility values measured every 1 cm interval show variations well correlated with those from the oxygen isotope data from planktonic foraminifera fossils. The existence of such correlations reflects combined effects of changes in biogenic calcium carbonate production, accumulation rate (a.r.) and grain size of clastics due to sea-level variations. The Ca/Ti curve, a best sea-level proxy, shows precession-related signals correlated with highstands 19.3 and 19.1, and lowstand 19.2. The orbitally tuned Ca/Ti curve represents a number of centennial scale features well correlated with those of sea-level proxies from Osaka Bay and North Atlantic. In consideration of a.r. variability, the age model for the Chiba section was refined with more control points between the orbital scale control points, adjusting to the astronomical time scale for the Osaka Bay core that has a uniform a.r. In the early MIS 19, the highest sea-level peak is preceded by a sea-level fall event, as in Osaka Bay. After MIS 19.2, there are many millennial scale fluctuation features, most of which are observed in the records from Osaka Bay and North Atlantic (IODP site U1313). These features are possibly global, and some of them are affected by eustatic sea-level changes. The MBB is dated at 777 ka in Osaka Bay, and 778 ka in the Chiba section and the North Atlantic.

キーワード：千葉セクション、マツヤマーブリュンヌ境界、大阪湾、北大西洋、海水準変動

Keywords: Chiba section, Matuyama-Brunhes boundary, Osaka Bay, North Atlantic, sea-level variation

上総層群国本層の浮遊性有孔虫生層序と古海洋の復元

Planktonic foraminiferal biostratigraphy and paleoceanographic reconstruction of the Pleistocene Kokumoto Formation, Kazusa Group in the Boso Peninsula, Japan

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The Plio-Pleistocene Kazusa Group is widely distributed in the Boso Peninsula. The Matuyama-Brunhes reverse boundary (MBB) has been recognized in the Kokumoto Formation of the upper part of the Kazusa Group. To reconstruct a detailed paleoceanographic record of environmental change across the early-middle Pleistocene boundary, we carried out a faunal analysis of planktonic foraminifera from a sediment core (TB2) obtained from the Kokumoto Formation at Tabuchi, Ichihara City, Chiba Prefecture, central Honshu, Japan. We also reexamined a planktonic foraminiferal biostratigraphy extending from the Kokumoto Formation to the lower Kakinokidai Formation along the Yoro River section, in order to identify important planktonic foraminifera biohorizons.

The 54-m core mainly consists of massive siltstone with a key tuff bed (Byakubi-E) and covers marine oxygen isotope stages (MIS) 20.2 to 19.2 with a high sedimentation rate of 1-2 m/ka. Total 41 species belonging to 15 genera of planktonic foraminifera were detected from 59 samples of the TB2 core. We reconstructed sea surface temperature and salinity based on the planktonic foraminiferal assemblages by using the Modern Analog Technique and the Transfer Function method. The results clearly demonstrates the migration process of the Kuroshio front from stages 20 to 19. The biostratigraphic result of the Yoro River section indicates that the top occurrence datum of *Neogloboquadrina inglei* Kucera and Kennett is placed near the boundary between Kokumoto and Kakinokidai formations. This biohorizon has been dated as 0.73 +/- 0.05 Ma at Ocean Drilling Program Site 1150 off the Sanriku region, Northwest Pacific (Domitsu and Oda, 2008, The Open Paleontology Journal, 1, 1-6). Combining with previous studies, we refined the planktonic foraminiferal biostratigraphy of the Kazusa Group.

キーワード：国本層、浮遊性有孔虫、生層序、古海洋

Keywords: Kokumoto Formation, planktonic foraminifera, biostratigraphy, paleoceanography

房総半島マツヤマーブリュンヌ地磁気逆転境界における高解像度珪藻化石群集解析

Detailed variations in diatom assemblages across the Matuyama-Brunhes magnetic polarity boundary from a core collected adjacent to the Chiba section, central Japan

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We conducted diatom analysis of a core named TB2 of the Kokumoto Formation of the Kazusa Group drilled near the Chiba section, a candidate for the Early to Middle Pleistocene boundary. 71 taxa of diatoms were identified. The number of total valves is controlled by coastal species such as *Paralia sulcata*, *Cyclotella striata* + *C. stylorum*, and *Actinoptychus senarius*. The coastal species show variations well correlated with the ratio of Ca/Ti, a biological production proxy, and planktonic $\delta^{18}O$, representing the highest peak at 44.5-33.9m and the second one at 19.9-14.8m. The former is correlated with highstand MIS 19.3 and the latter with highstand MIS 19.1. This result suggests not only the biogenic production rate but the production of coastal diatom species increases as the sea-level rise. Cold diatom species of the Oyashio Current are dominant below a depth of 25 m, and warm species of the Kuroshio Current become dominant above it. This suggests occurrence of a large current system change during MIS 19.

キーワード：パラリア・サルカータ、MIS 19、国本層、マツヤマーブリュンヌ地磁気逆転境界

Keywords: *Paralia sulcata*, MIS 19, Kokumoto Formation, Matuyama-Brunhes magnetic polarity boundary

千葉セクションにおける定方位試料から得られたマツヤマ・ブリュンヌトランジションの高解像度記録

High resolution magnetostratigraphy of the Matuyama-Brunhes transition from oriented samples from the Chiba Section, central Japan

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Pleistocene sediments of the Kokumoto Formation in the upper part of the Kazusa Group, central Japan have been studied by many research groups. However, very few studies have focused on the marine isotope stage 19 interglacial including the Matuyama-Brunhes magnetic polarity boundary (MBB). In order to establish detailed magnetostratigraphy across the MBB, we collected oriented samples for magnetic analyses by drilling from 140 horizons of the Chiba Section, a candidate for the Global Boundary Stratotype Section and Point (GSSP) of the Early to Middle Pleistocene Boundary. We also collected block samples to pick up foraminifera fossils from 35 horizons for construction of oxygen isotope stratigraphy. Here, we first report preliminary results of paleomagnetic analyses. Progressive thermal demagnetizations reveal natural remanent magnetizations (NRMs) consist of two components demagnetized at or below 350 degrees Celsius and between 500 degrees Celsius and 680 degrees Celsius. The values of magnetic susceptibility measured at each step of thermal demagnetizations begin to increase from 400 degrees Celsius and decrease above 500 degrees Celsius. These results indicate that the samples include a ferromagnetic iron sulfide mineral such as greigite, which is decomposed below about 350 degrees Celsius, followed by oxidation to form magnetite and further to hematite, causing an increase and a decrease of magnetic susceptibility, respectively. Characteristic remanent magnetizations isolated above 350 degrees Celsius show that reverse and normal polarity continue from 1440 cm below to 60 cm above and from 290 cm to 430 cm above the Byakubi tephra (Byk-E), respectively. Therefore, the Matuyama-Brunhes transition would lie between 60 cm and 290 cm above the Byk-E, which would require reviewing the previous MBB position in detail. The result of oxygen isotope analysis using fossils of *Bolivinita quadrilatera* will also be reported.

キーワード：下部-中部更新統境界GSSP、千葉セクション、マツヤマ・ブリュンヌ境界、*Bolivinita quadrilatera*、MIS19、Byakubi-E

Keywords: Early to Middle Pleistocene GSSP, Chiba Section, Matuyama-Brunhes boundary, *Bolivinita quadrilatera*, MIS19, Byakubi-E

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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The Kanto fore-arc basin in the Kato plain is an extremely deep submarine basin that was formed during the early Pleistocene. The sediments in the basin change from deep-sea sediments to lacustrine-alluvial sediments, the Mandano formation which is up to 95 m in thickness and overlays the Tokyo Bay unconformity that is widely distributed under Tokyo bay area. The formation consists of three parts. The lithofacies in the lower part on the unconformity gradually change, with decreasing depth, from sand to gravel. The lithofacies of the middle part are muddy. The upper part changes with increasing depth from gravel to sandy silt by transgression. The lower part and lower half of the middle part comprise sediments characteristic of a topset fan delta (Nirei H., 1997) in the regression stage. The upper half of the middle part and upper parts are composed of transgression sediments. The lower half of the middle part contains sediments from the ice age regression stage, evidence of which is provided by the cold-index plant remains, *Picea maximowiczii*, *Tsuga diversifolia*, *Fagus crenata*, *Cryptomeria japonica*, etc., present in the uppermost part of the lower half. Geological analysis reveals the Kanto continental shelf to extend widely under the Kanto Plain; it is also underlaid by a range of bottom set sediments in distinct formations and forest sediments, also in distinct formations, in ascending order under the conformity.

キーワード：東京湾不整合、万田野寒冷期

Keywords: Tokyo bay unconformity, Mandano ice-age

千葉セクションにおける松山-ブルン極性反転境界記録

Revised Matuyama-Brunhes polarity transition record from a marine succession at the Chiba section, a Lower-Middle Pleistocene GSSP candidate

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We report revised paleomagnetic records of the Matuyama-Brunhes boundary (MBB) 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. In the section, a wide spread tephra bed named as Byk-E is intercalated just 80 cm below the MBB. In order to provide globally comparable VGP (virtual geomagnetic pole) and paleointensity (past geomagnetic field intensities) records from the Chiba section, we have taken oriented mini-cores from a 13 meters succession with 10-cm intervals across the Byk-E tephra bed. 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 demagnetization (AFD) 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 0.8 meter above the Byk-E bed in thermal demagnetization (ThD) results. Therefore, the reversed to normal polarity transition boundary seen below the Byk-E bed is thought to be overprint. This overprint, which might be carried by iron sulfide, is particularly observed in a transitional interval. Since iron sulfides generally decompose and oxidized into magnetites due to heating during ThD, the yielded magnetites have no magnetic signal but provide an over estimate of magnetic grain amount which prevents to estimate paleointensities. To provide a reliable paleointensity record, we applied to use a composite demagnetization technique consisting of a 300°C ThD and a regular progressive AFD sequence. After the 300°C ThD, most of the overprint has been removed but the magnetic susceptibility has not changed even in the air condition, indicating that iron sulfides just lose magnetic signals due to the ThD but not to change the amount of magnetic grains. The VGP latitudes and preliminary derived paleointensities using the composite demagnetization technique from the Chiba section quite match well with the U1308 records. To use the both independent techniques of oxygen isotope and paleointensity will provide a further reliable stratigraphic correlation across the Lower-Middle Pleistocene Boundary.

キーワード：古地磁気学、古地磁気強度、国際標準模式層断面および地点

Keywords: Paleomagnetism, Paleointensity, GSSP

千葉県銚子より掘削された陸上ボーリングコアを用いたMIS 19における高解像度酸素・炭素同位体記録（予察）

A preliminary report for high-resolution foraminiferal oxygen and carbon stable isotope records in MIS 19 from an on land core drilled at the Choshi city, central Japan.

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The Plio-Pleistocene Inubo Group, distributed in the Choshi city, Chiba prefecture, central Japan, is thought to be a suitable marine succession to investigate paleoceanographic and paleoclimatic changes around the northwestern Pacific Ocean, because a lot of wide spread key tephra beds are intercalated, and microfossils and pollens are abundant. In 1998, a continuous, well recovered on land core drilled through the Obama, Yokone, Kurahashi and Toyosato Formations in the Inubo Group was obtained (after Choshi core). Kameo et al. (2006) studied calcareous nannofossil, paleomagnetic and planktonic foraminiferal oxygen isotope stratigraphies of the Choshi core, and reported that the core corresponded to a period between MIS 11 and 24 based on a correlation with the LR04 stack curve (Lisiecki and Raymo, 2005). In this study, we show a new high-resolution stable isotope record using benthic foraminifers from a section across the Lower-Middle Pleistocene boundary of the Choshi core. This record corresponds to MIS 18-20 with a time resolution of ca. 500 years. The average oxygen isotopic value of the Choshi core is about 0.5 ‰ lighter than that of LR04 during the period of MIS 19, and the difference becomes larger as the age becomes younger, indicating that the accumulation depth of the Choshi core was getting shallower due to uplifting and/or burring up the basin. Further analysis on the core will show some paleoceanographic findings at around the north western Pacific margin during the MIS 19 period.

キーワード：MIS 19、有孔虫安定同位記録、銚子コア

Keywords: MIS 19, Foraminiferal stable isotope record, Choshi core

房総半島中部に分布する上総層群下部-中部更新統の石灰質ナノ化石層序と古海洋環境
Calcareous nannofossil biostratigraphy of the Lower-Middle Pleistocene in the Kazusa
Group, central part of the Boso Peninsula, and estimated sea surface environments

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本邦中部太平洋側に位置する房総半島には第四系の海成堆積物から構成される上総層群が分布する。露頭条件が良いことや化石を多く含むことから、岩相層序学的研究や古地磁気層序学、テフラ層序学、微化石層序学のような年代層序学的な研究が行われてきた（新妻, 1976; 佐藤ほか, 1988; 五十嵐, 1994など）。このうち下部-中部更新統に相当する国本層には、ブリュンヌ/松山境界（Matuyama/Brunhes Boundary: MBB）が記録されており、GSSP（Global Boundary Stratotype Section and Point）模式地の有力な候補のうちの一つとなっている（Kazaoka et al., 2015）。そのため、前期-中期更新世の正確な年代を決定するために、より詳細な年代層序の検討が必要であると言える。ところが、国本層に産出する石灰質ナノ化石は、必ずしも高い時間解像度で解析されているわけではない（佐藤ほか, 1988）。そのため、当層準における石灰質ナノ化石層序は十分に検討されておらず、化石基準面も明らかにされていない。よって本研究ではMBB相当層準の石灰質ナノ化石基準面を明らかにするとともに、群集変化に基づいて同層準堆積当時の北西太平洋の表層海洋環境を推定するために、国本層の石灰質ナノ化石の検討を行った。検討した66試料からは、10属19種の石灰質ナノ化石が産出した。検討層準を通じて種組成に変化はないが、そのうち、小型の*Gephyrocapsa*属が多産する層準がMBB直上に位置し、この多産イベントは顕著である。この層準のイベントはイタリア南部のMontalbano JonicoやValle di Mancheでも指摘されていることから（Girone et al., 2013）、グローバルに追跡可能なイベントである可能性がある。さらに、寒冷な環境指標種である*Coccolithus pelagicus*や温暖な環境指標種である*Umbilicosphaera sibogae*の産出には逆相関する関係が見られた。層位分布をみると*Umbilicosphaera sibogae*が全層準を通して増減を繰り返す傾向が見られることから、黒潮水域と混合水域の北上、南下が交互に起きていたと考えられる。

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更新統下部—中部境界を含む国本層上部の詳細層序と堆積環境：千葉セクション

Detailed litho-stratigraphy and sedimentary environment of upper part of Kokumoto Formation with the L-M Pleistocene boundary: the Chiba section, Central Japan

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The Lower -Middle Pleistocene Kazusa Group, deposited on mainly bathyal -shelf in the Pacific Ocean with many kind of fossils, distributes widely in Boso peninsula. The Kazusa Group exposes continuously along Yoro river, Chiba section, type section of the group. The Kazusa Group consists of Kurotaki Formation (mainly tuffaceous gravelly sandstone), Katsuura F. (mainly alternation of sandstone with slump bed), Namihana F. (mainly siltstone with slump bed), Ohara F. (muddy alternation of sandstone and siltstone), Kiwada F. (muddy alternation of sandstone and siltstone with slump bed), Otadai F. (alternation of sandy alternation and muddy alternation of sandstone and siltstone), Umegase F. (mainly sandy alternation of sandstone and siltstone), Kokumoto F. (alternation of thick siltstone and sandy alternation of sandstone and siltstone), Kakinokidai F. (sandysiltstone with sandstone) and Chonan F. (alternation of thin sandstone and thin siltstone) in ascending order (Mitsunashi et al., 1959). Total thickness of the Kazusa Group is over 2,000 meters with over 50 marker tephra beds. Trepid depositional rates of 2.0-2.5 m/ky are obtained for the Kazusa Group. Therefore the Chiba section have high potential for international stratotype section (Kazaoka et al., 2015).

Kokumoto Formation, about 350 meter thick, is composed of the lowermost part, the lower part, the upper part and the uppermost part in ascending order. The lowermost part, about 60 meter thick, consists of thick siltstone with thin sandstone bed and marker tephra, Ku6 and ku5. The lower part, about 120 meter thick, consists of sandy alternation of sandstone and siltstone with Ku3 tephra. The upper part, about 80 meter thick, consists of thick siltstone with thin sandstone and marker tephra (Byakubi zone (Byk-G, Byk-F, Byk-E, Byk-D, Byk-C, Byk-B and Byk-A), Koss2, Koss1-B, Koss1-A, Kosp-C, Kosp-B, Kosp-A, Tap-B, Tap-A, Tas-C, Tas-B, Tas-A, Ku2 and Ku1). Especially maker tephra are interbedded every 0.1-7.0 ky in the thick siltstone from Byk-E to Ku2 horizon. The Matuyama-Brunhes boundary is between Byk-C and Byk-B. Uppermost part, about 90 meter thick, consists of sandy alternation of sandstone and siltstone with Ku0.1 tephra.

The upper part, thick siltstone, is interbedded with thin, 1-3cm thick, sandstone every 0.3-3 m thick and thin, 1-5 cm thick, sandysiltstone every 0.1-0.25 m thick without slump bed and thick mudflow bed. The siltstone have bathyal and sublittoral benthic foraminifera and many trace fossils. Grain size distribution in the siltstone have bimodal grain group (Nishida et al., 2015). Main grain group is composed of fine silt and sub group consists of very fine sand. These

characteristics show hemipelagic sedimentary environment in deep sea and very fine sand flow often into, namely deep sea slope. The thickness from Byk-G to Byk-A change little laterally in the central part of Boso Peninsula. This show that the fracks deposited approximately uniformly. It is presumed that clastic sediments were supplied little around here from source mountain area, because this horizon is warm stage, MIS 19.

キーワード：更新統下部－上部境界、国本層、上総層群、火山灰鍵層、Byk-E、MIS 19

Keywords: L-M Pleistocene boundary, Kokumoto Formation, Kazusa Group, Maker Tephra, Byk-E, MIS 19