

## インドモンスーン復元のためのベンガル湾掘削 (IODP Exp. 353)

Drilling in the Bay of Bengal for reconstruction of the Indian summer monsoon variability

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インド夏期モンスーンはインド亜大陸に降雨をもたらす、降水は河川を經由してベンガル湾に流れ込む。したがって、ベンガル湾の古塩分や懸濁物の河川流出物量等を復元することにより過去のインドモンスーン変動を理解することができる。IODP第353節掘削航海 (iMonsoon; 2014年11月末から2015年1月末) では過去のインドモンスーン変動を復元することを主目的として、ベンガル湾およびアンダマン海の6地点において堆積物採取のための掘削が実施された。

サイトU1443 (Ninetyeast Ridge) では白亜紀に遡る遠洋性堆積物が得られた。サイトU1444 (ベンガル湾中央部) では中新世に至るタービダイト層を主体とする堆積物が得られた。サイトU1445およびU1446 (ベンガル湾インド沖) では、それぞれ中新世および中期更新世に至る半遠洋性堆積物が得られた。サイトU1447およびU1448 (アンダマン海) では、中新世に至る遠洋性堆積物が得られた。

キーワード：ベンガル湾、IODP第353節航海、インドモンスーン

Keywords: Bay of Bengal, IODP Exp. 353, Indian monsoon

## IODP Exp. 354, ベンガルファンの堆積物記録と重鉱物組成

Sedimentary records and heavy minerals assemblages of the Bengal Fan deposits recovered during IODP Exp. 354

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The deep-sea Bengal Fan is the largest submarine fan in the world. The formation of this fan is a direct result of the erosion of the Himalayan orogen (Curry and Moore, 1971). Thus the change of the mineral and geochemical characteristics of this fan sediments records uplift, erosion, weathering history of the Himalayan orogenic system during Paleogene-Neogene period.

IODP Exp. 354 drilled seven sites in an E-W transect, with three deep and four shallow holes, at 8° N, in the mid fan region of Bengal Fan. The deepest site, U1451, ~1500 meters below seafloor recovered a complete sequence of the fan deposits which overlie on lower Oligocene pre-fan deposits (France-Lanord et al., 2015). The fan sediments drilled in the mid fan region mainly consist of mica- and quartz-rich sand, silt, and clay with several hemipelagic deposits. The hemipelagic deposits, which associated distinct seismic reflectors, consists of calcareous clay and nannofossil ooze. At the bottom of the hole, Eocene and Paleocene limestones were recovered. Above mentioned results are evidential for the record of early fan deposition by 10 My into the late Oligocene. These sediments were documented mineralogical signatures relevant for reconstructing time series of development of Himalaya. Previously, several researches on heavy minerals of Bengal Fan sediments were carried out using the fan sediments on DSDP Leg 22, Site 218 (Thompson, 1974) and ODP Leg 116, Sites 717-719 (Yokoyama et al., 1990; Amano and Taira, 1992). In this study, we show the result of the modal proportions of heavy mineral in the sediments recovered from site U1451, by smear slides and thin sections, and discuss the historical change of the mineral assemblages.

The heavy mineral assemblage of the Late Oligocene sands, which is oldest sediments from the Bengal Fan, mainly consists of ultra-durable ZTR component (zircon-tourmaline-rutile) with rare garnet, amphibole and pyroxene. The heavy mineral assemblage, in the Early Miocene sediments, mainly includes ZTR component with small amount of garnet, apatite and rare aluminosilicates (kyanite). - At the early part of Middle Miocene sequence, amphibole and garnets rapidly increase with frequent occurrence of aluminosilicate. In the Middle Miocene sediments, the assemblage of heavy minerals become diverse and metamorphic minerals such as staurolite, chloritoid, aluminosilicate, amphibole and garnet, are frequently included in the sediments.

These results of preliminary measurement of heavy minerals show rapid uplift and sediment production from metamorphic terrane in the Himalayas during early part of the Middle Miocene period, though the erosional history in Early Miocene and Oligocene periods is still obscure.

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キーワード：ベンガルファン、ヒマラヤ、重鉱物

Keywords: Bengal Fan, Himalaya, Heavy Minerals

## 新生代アラビアモンスーン-IODP Exp.355航海速報

## Initial results of IODP Expedition 355, Cenozoic Arabian Sea Monsoon

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During International Ocean Discovery Program (IODP) Expedition 355, two sites (U1456 and U1457) were drilled in Laxmi Basin in the eastern Arabian Sea. Scientific objectives are (1) to document the coevolution of mountain building, weathering, erosion, and climate over a range of timescales, and (2) to recover basement from the eastern Arabian Sea for constraining on the early rifting history of the western continental margin of India.

Penetration depth at Sites U1456 and U 1457 were 1109.4 and 1108.6 m below seafloor (mbsf), respectively. Drilling reached sediments at Site U1456 were dated to 13.5–17.7 Ma, although with a large hiatus between the lowermost sediment and overlying deposits dated to <10.9 Ma as a result of a large mass wasting deposit, the Nataraja Slide emplaced before 10.9 Ma. At Site U1457, igneous basement, comprising massive basalt was cored. The calcareous sediment on top of the volcanics were biostratigraphically dated to ~62 Ma[DP1] .

In spite of hiatuses spanning ~8.2–8.7 and ~4.1–5.6 Ma, continuous sedimentary sections spanning the 8 Ma climatic transition were recovered. Sediments from a large mass transport deposit were also recovered, with measuring ~330 and ~190 m thick at Sites U1456 and U1457, respectively. Siliceous microfossils are found only in the mudline and the uppermost cores from both sites, whereas calcareous microfossils occur in varying numbers throughout the succession. Diatoms in the mudline samples are well preserved and consist mainly of coastal species, whereas these taxa are absent in the cored sediments. Diatoms are restricted in the uppermost 10 and ~0.5 mbsf at Sites U1456 and U1457, respectively. The assemblage includes benthic and freshwater taxa that indicate the lateral transport to those sites.

[DP1]We have not yet dated. Therefore I feel we should put late Cretaceous, instead of 62 Ma.

キーワード：アラビア海、モンスーン、国際深海科学掘削計画

Keywords: Arabian Sea, monsoon, IODP

Preliminary report of International Ocean Discovery Program Expedition 356 -What can we learn from the (sub) tropical carbonates off northwest Australia? -

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International Ocean Discovery Program (IODP) Expedition 356 cored the upper 400 to 1000 m of Cenozoic strata off northwestern Australia from 1st August to 30th September 2015. The main goals were: 1) to reveal a detailed history of variation in the Indonesian Throughflow (ITF), determine timing of onset of the Leeuwin Current, and explore their relationships to regional and global climates; 2) to obtain a 5 Myr orbital-scale record of tropical to subtropical paleoceanographic and paleoclimatic changes in the Australian monsoon area; and 3) to describe the spatio-temporal patterns of subsidence along the Northwest Shelf of Australia. Expedition 356 recovered cores from seven sites (U1458, U1459, U1460, U1461, U1462, U1463, and U1464) along a latitudinal transect from 28° 40' S to 18° 31' S. Biostratigraphic ages were determined to be early Eocene to Pleistocene at Site U1459, Pliocene to Pleistocene at Site U1460, and Miocene to Pleistocene at Sites U1461, U1462, U1463, and U1464. The lithology at all sites is composed mainly of unlithified to lithified carbonates (mudstone to packstone), intercalated with dolomitized layers at two sites. Thick evaporite (anhydrite and gypsum) in the Miocene strata at Site U1464 implies a sabkha environment (drier conditions). The very good preservation of calcareous microfossils in the latest Miocene to Pleistocene at Site U1463 will allow us to investigate orbital-scale secular changes in paleoceanographic and palaeoclimatic environments during the last 5 Myr.

Keywords: IDOP Expedition 356, Australia

Exp.346 U1430地点における中期中新世サイクル層序の確立とXRFスキャナーを用いた古海洋変動復元  
Cyclo-stratigraphy of the Middle Miocene interval at Site U1430 and its paleoceanographic reconstruction using XRF core scanner

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中期中新世は東南極氷床が拡大した時期にあたり、氷床量変動が当時の気候に影響を及ぼしていた事が示唆されている[Zachos et al., 2001, Holbourn et al., 2005]。近年、海洋堆積物コアから得られた酸素同位体比やXRFコアスキャナーデータにサイクル層序を適用した数万年の解像度での中期中新世古気候・古海洋変動復元が行われており、地球軌道要素変化と古気候・古海洋変動との対応関係が明らかにされつつある[e.g; Holbourn et al., 2013, Westerhold et al., 2005]。一方で、北太平洋域においては、遠洋堆積物中に石灰質微化石をほとんど産しないため、サイクル層序を適用した高時間解像度の年代モデルすら確立していない。中期中新世の日本海は半閉鎖的な環境であったとされ[Iijima et al., 1988]、海水準変動及び酸素極小帯位置の変化が日本海内の水塊構造に影響を与え、その結果生じた変動が日本海深海堆積物コアに見られる岩相変化を生み出したとされる[Tada, 1994]。従って、東南極氷床の拡大・縮小に伴う海水準変動や太平洋域での海洋循環パターンの変化を復元する上で、日本海深海堆積物コアを使った詳細な年代モデルの確立及び岩相変化パターンの復元は重要である。

そこで筆者らは、2013年夏に行われた統合国際深海掘削計画(IODP)第346次航海で得られたU1430地点の日本海深海堆積物コアを用いて、中期中新世の高時間解像度サイクル層序確立を試みた。まず、船上データやコア写真を用いて、完全連続な堆積記録の復元を行ない、それを基に船上で計測されたGRA,NGR等の連続データを編集した。そして放散虫及び珪藻による微化石層序を基にした仮の年代モデルを作成し、それに基づいて時系列化したGRA,NGRの連続データから40万年、10万年、4万年周期を抽出し、これらと地球軌道要素の離心率、地軸傾度の時系列変化を対比して、サイクル層序に基づく高解像度年代モデルを確立した。こうして確立した高解像度年代モデルを使って、XRFスキャナーによる元素組成データを時系列化し、中期中新世日本海における古海洋変動復元を試みた。

今回の発表では、サイクル層序の確立及びXRFスキャナーに基づく日本海堆積物の元素組成変動とその要因について議論する。

キーワード：中期中新世、サイクル層序、XRFコアスキャナー、IODP Exp.346

Keywords: Middle Miocene, Cyclo-stratigraphy, XRF core scanner, IODP Exp.346

## Glacial-interglacial biotic changes on the Great Barrier Reef from onshore and offshore boreholes

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Understand how ecosystems respond to global environmental changes is important to predict their fate and decide on adequate measures of protection. The fossil record offers a unique opportunity to study the influence of natural perturbations on ecosystems. Here we examine the response of the Great Barrier Reef (GBR) coral communities to glacial-interglacial cycles based on a combination of offshore and onshore boreholes drilled by IODP Exp. 325 in 2010 and by the International Consortium for the GBR Drilling in 1995, respectively. Thirty four offshore boreholes were drilled during IODP Exp. 325 along four transects at three localities along the shelf edge of the GBR (Hydrographers Passage, Noggin Pass, and Ribbon Reef). These boreholes record the evolution of the GBR during glacial-deglacial conditions when the continental shelf was exposed and reef growth was restricted to the shelf edge. The onshore core material consists of two deep boreholes drilled in Ribbon Reef 5 (RR5) and Boulder Reef (BR) in the northern GBR. The RR5 and BR boreholes record a succession of highstand reef sequences formed during late deglacial-interglacial conditions when the shelf was submerged. These two data sets combined provide the first record of biotic changes in the GBR during a complete cycle of glacio-eustatic sea level change, from the glacial maximum to full interglacial conditions. Our statistical analysis reveals a marked difference in coral composition between glacial-early deglacial fringing reefs and late deglacial-interglacial barrier reefs, and enables us to clarify the relationships between reef architecture, shelf morphology and coral composition.

Keywords: Corals, Glacial-interglacial cycles, Great Barrier Reef, Quaternary, Boreholes

IODP第317次航海ニュージーランド沖掘削のコア解析に基づくシーケンス境界の形成年代とその震探断面再解釈に基づく陸棚-斜面の対比

Ages of sequence boundaries based on the core analysis of IODP Expedition 317 and their correlation between shelf and slope on the basis of reinterpretation of the seismic profiles, offshore New Zealand

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カンタベリー堆積盆地は、ニュージーランド南島東縁位置し、現在のカンタベリー平野とその沖の陸棚に広がっている。本地域では、商用もしくは科学目的で地震探査や掘削が実施されており、それらの結果を用いて Lu and Fulthorpe(2004)はこの地域に中新世から完新世にかけて19のシーケンス境界があることを明らかにし、その年代を定めた。2009年から2010年にかけて行われたIODP 317次航海は、陸棚3サイト (U1351,U1353, U1354), 上部陸棚斜面1サイト (U1352) を掘削した。Hoyanagi et al.(2014)は底棲有孔虫化石の酸素同位体比と海洋酸素同位体ステージを示すLR04 stack (Lisiecki and Raymo, 2005) との対比から、更新世以降の年代モデルを示した。しかし、この年代モデルにしたがった陸棚斜面のシーケンス境界の年代と Lu and Fulthorpe(2004)の示した年代に矛盾が生じている。そこで、本研究では震探断面中のシーケンス境界反射面を再解釈して、IODP第317次航海のコアに認められた不連続面と対比した。その結果、震探断面中に認められた7つのシーケンス境界反射面と深度が一致する不連続面を上位からシーケンス境界SB1からSB7とした。修正されたU1352の年代モデルに基づく、シーケンス境界SB1から6はそれぞれMIS6, 8, 16, 18, 22, 54の低海水準期に形成されたものである。一方、最下位のSB7は4サイトで認められた1.8から2.7Maのハイエイタスを示す不連続面と一致する。さらに、震探断面上で認められたシーケンス境界SB3が下位にある2つのシーケンス境界を陸棚上で削っていることから、MIS16に対応するSB3の形成時期は他の氷期よりも海水準低下が大きかったと考えられる。

キーワード：IODP第317次航海、地震探査断面、更新世、海水準変動、ニュージーランド

Keywords: IODP Expedition 317, Seismic profiles, Pleistocene, Sea-level change, New Zealand



ベーリング海大陸斜面堆積物中における低温でのスメクタイト-イライト反応 (IODP Expedition 323)

Evidence for low temperature smectite to illite transformation in the Bering Sea slope sediments (IODP Expedition 323)

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The smectite to illite (S-I) transformation is a kinetically or thermodynamically controlled diagenetic process with dehydration in sediments at a relatively high temperature range of 60°C to 150°C. The S-I transformation also significantly impacts on *in-situ* physical and geochemical characteristics, such as pore water pressure, faulting, and migration of hydrocarbon gasses. Recent experimental studies showed that anaerobic iron-reducing microbial activity of possibly promoted the S-I transformation at low temperatures (Kim et al., 2004). However, the low temperature S-I transformation has not been observed in natural sedimentary environments. In this study, we demonstrate here the transformation of S-I at <40°C in the Bering Sea Slope sediments based on the pore water chemistry, clay mineral composition, and microstructures. The sediment samples were obtained by drilling down to ~800 m below seafloor (mbsf) at Sites U1341 (Bowers Ridge), U1343 (Bering Sea Slope) and U1344 (Bering Sea Slope) during the Integrated Ocean Drilling Program (IODP) Expedition 323.

Geochemical analyses of pore water samples from Bering Sea Slope sediments showed that chloride concentrations slightly decreased from ~550 mM near the seafloor to ~500 mM at the core bottom. Dissolved potassium concentrations decreased from ~13 mM at 150 mbsf to 6 mM at the core bottom. Below 150 mbsf, oxygen and hydrogen isotopic compositions of pore water (H<sub>2</sub>O) increased from 0‰ to 1.5‰ and decreased from -2‰ to -10‰ with increasing depth, respectively. These trends would be attributed to the release of dehydrated water into the pore water and the potassium uptake by the authigenic S-I transformation. However, those trends were not observed in sediments from the Bowers Ridge. The Illite/smectite mixed layered clay minerals, which are the intermediate products of the S-I transformation, were identified only from the Bering Sea Slope sediments based on XRD analyses of the clay-sized fractions. Illite content of the Illite/smectite mixed layered clay minerals increased from 2% near the seafloor to ~8% at 200 mbsf. TEM lattice fringe image of the clay minerals in 210 m-deep sample at Site U1343 showed that the layers of 1.0-nm spacing, which were illite, partially distributed at the tip of hairy shaped authigenic smectite particles, clearly indicating the occurrence of S-I transformation *in situ*. Because the thermal gradients at Sites U1343 and U1344 were 49.0°C/km and 53.3°C/km, respectively, indicating that the temperature ranged in the cored sediments was generally lower than 40°C. Consequently, our geochemical, geophysical and mineralogical data indicate that the low temperature S-I transformation occurs below 150 mbsf in the Bering Sea slope sediments. A possible explanation for this phenomenon is the contribution of microbial activity such as iron reduction. Interestingly, the occurrence of authigenic siderite (FeCO<sub>3</sub>) concretion was observed only below 150 mbsf at the Bering Sea Slope sediment (Pierre et al. 2014), supporting the increase of alkalinity by microbial decomposition of organic matters and

reduction of Fe (III) to siderite that leads to the low temperature S-I transformation.

キーワード：スメクタイト-イライト反応、ベーリング海、粘土鉱物

Keywords: smectite-illite transformation, Bering Sea, Clay mineral

国際深海科学掘削計画第352次研究航海で掘削された前弧玄武岩とボニナイトの物性研究  
Physical properties of Fore-arc-basalt and Boninite in the drilled cores during the IODP Expedition 352

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日本の南東には、伊豆・小笠原・マリアナ弧(IBM弧)が形成されている。IBMプロジェクトは、島弧進化の総合的理解と大陸地殻成因の解明を目的としたプロジェクトである。その一環として、国際深海科学掘削計画第352次研究航海(IODP Exp.352)が2014年7月30日から9月29日に行われた。小笠原海溝前弧域で掘削を実施し、沈み込み開始初期に特徴的な岩石である前弧玄武岩とボニナイトの採取に成功した。海溝側の2サイト(U1440, U1441)では前弧玄武岩、島弧側の2サイト(U1439, U1442)ではボニナイトが掘削された。本研究の目的は、Exp.352で掘削されたボニナイトと前弧玄武岩の物性を明らかにすることである。ボニナイトと前弧玄武岩を用いて、薄片観察及び物性測定を行った。物性測定では、密度、空隙率、弾性波速度、そして帯磁率を測定した。弾性波速度は常圧で測定し、一部試料は封圧下で測定した。薄片観察の結果、前弧玄武岩は無斑晶質な組織がみられた。ボニナイトは、ハイアロクラスタイトや間粒状組織、無斑晶組織など多様な産状が観察された。物性測定の結果、密度は2~3 g/cm<sup>3</sup>、空隙率は5~40%、常圧下の弾性波速度は3~5.5 km/sであった。密度と弾性波速度の関係に正の相関が認められた。この正の相関は、帯磁率と関係があり、帯磁率の高いグループ(>5 ×10<sup>-3</sup>)には、密度が高い前弧玄武岩とボニナイトが存在し、帯磁率の低いグループ(<5 ×10<sup>-3</sup>)には、密度が低いボニナイトのみが存在することがわかった。薄片観察において、帯磁率の高いグループでは磁鉄鉱が認められた。強磁性鉱物である磁鉄鉱は高い帯磁率と比較的高い密度をもつため、磁性鉱物のもつ高い密度が岩石全体の密度を押し上げている可能性があると考えた。この傾向は船上分析の結果においても確認できた。

キーワード：国際深海科学掘削計画第352次研究航海、伊豆・小笠原前弧、火山岩、密度、P波速度、帯磁率

Keywords: IODP Exp.352, Izu-Bonin forearc, volcanic rocks, density, P-wave velocity, Magnetic Susceptibility

水分活性が海底下微生物活動に与える影響 - IODP exp. 337下北八戸沖堆積盆地掘削コア試料を用いた考察-

An impact of water activity on microbial activity - A case study of IODP Expedition 337

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水分活性は土壌や食品中はもとより、海底堆積物中の微生物の生育限界と増殖速度を評価するうえで重要な指標である。しかし、海底下深部における堆積物の水分活性はこれまでほとんど測定されていないため、海底下深部の水分活性と微生物活動との関係性はわからなかった。そこで本研究では、国際深海科学掘削計画 (IODP) 第337次研究航海で採取した八戸下北沖堆積盆地のコア試料を用いて、水分活性を測定して微生物活動との関係を考察した。水分活性の測定は、Lab Touch aw (Novasina社製)とWP4-T (Decagon Devices社製)を用いて温度25℃条件下で測定した。

海底表層近傍から海底下2450m深度において、堆積物と堆積岩の水分活性は0.96から0.98の範囲を示し、微生物の生息可能な水分活性としては十分高い値である (一般細菌の生育最低水分活性は約0.90で、また生育限界値が約0.65とする微生物も確認されている[Stevenson et al., 2015])。水分活性は微生物量をはじめ、深度・岩石の種類・間隙率との関係は明瞭には認められなかった。一方、水分活性は堆積岩中の間隙水の塩分濃度と強い相関が認められ、塩分濃度が大きくなると水分活性が小さくなった。さらに、その相関はラウールの法則で説明できることがわかった。そこで水分活性と間隙水の化学組成の関係をj用いて国内外のIODP掘削サイト4地点における水分活性と微生物量の相関を調べたところ、水分活性の増加とともに細胞数が減少する傾向が認められた。一見奇異に見えるこの関係は、微生物に必要な間隙水中に溶存している栄養と水分活性が比例していると仮定すれば説明できる。さらに、微生物量は堆積岩の間隙率およびNMRロギングから推定された自由水の割合に対しても強い相関が認められた。そのため下北沖堆積盆地海底下の微生物量は、微生物生育に必要なエネルギーの存在量とそのエネルギーの移動しやすさが影響していると考えられる。

キーワード：水分活性、IODP expedition 337、microbial activity、間隙率

Keywords: water activity, IODP expedition 337, microbial activity, porosity

## 延岡衝上断層ボーリングコア中の断層帯の化学組成分布

Chemical composition distribution of the drilled core across the fault zone of the Nobeoka thrust

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Megasplay fault branching from a plate boundary at subduction zone is thought to be the source of earthquakes and tsunamis. Nobeoka thrust is the low-angle thrust which subdivides the Shimanto belt in Kyushu into the northern (Cretaceous and Tertiary) and the southern (Tertiary) subbelts, and is an exhumed analogue of an ancient megasplay fault. The hanging wall and the footwall of Nobeoka thrust show difference in lithology and metamorphic grade and their maximum burial temperature is estimated from vitrinite reflectance analysis to be 320~330°C and 250~270°C, respectively. Assuming these temperature gap is made by fault displacement, the total displacement is approximately 10 km (Kondo et al., 2005). As a unique analogue of modern megasplay fault, the Nobeoka thrust is the key for understanding current plate boundary process.

Fluid-rock interaction is one of a very important processes for faulting. We focus on the element composition distribution across the Nobeoka thrust, and thus analyzed chemical composition of the drilled core obtained by Nobeoka thrust drilling project (NOBELL). Major elements and trace elements are analyzed by XRF and ICP-MS, respectively

Results of XRF analysis showed no significant difference between the hanging wall and the footwall despite the difference in lithology and metamorphic grade. Na<sub>2</sub>O, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, K<sub>2</sub>O and CaO increase just above the fault core (Depth 41.3~41.8 m). This increase would be caused by the decrease in SiO<sub>2</sub>, because SiO<sub>2</sub> is the dominant component in the analyzed rocks (60~80 wt.%).

Results of ICP-MS analysis also did not show significant difference between the hanging wall and the footwall, except for Li and Cs which are relatively abundant in the footwall. High concentration of Li just above the fault core may suggest Li-rich fluid from external source. The provenance of Li can be attributed to the basalts where significant quantity of the oceanic crust is subducting. Some elements showed increase just above the fault core as observed in the major elements.

Summarizing the results, the divergence in chemical composition is limitedly observed in the vicinity of the upper interface of the fault core. The depletion in Si just above the fault core might be caused by the development of pressure solution resulting Si dissolution and flowing-out in this horizon. Chemical anomalies observed within and just above the fault core suggest high-temperature fluid-rock interaction associated with the faulting. Further characterization of stable isotope analysis (such as Sr, Nb) will provide insights into the provenance of the fluids.

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*Tectonics*, 24:TC6008

キーワード：流体 岩石 相互作用、NOBELL、衝上断層

Keywords: fluid-rock interaction, NOBELL, thrust

## 炭質物のビトリナイト反射率から推定した南海付加体の被熱構造

Thermal structure of the Nankai accretionary prism estimated by vitrinite reflectance of carbonaceous material

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Paleothermal structure of an accretionary prism is one of the basic information to understand the nature of plate subduction seismogenic zones. To evaluate the entire thermal structure of the Site C0002 located in the Kumano Basin off Kii Peninsula, we performed vitrinite reflectance analysis for cuttings samples collected every 100 m from 870.5 to 3058.5 m below sea floor (mbsf) during the Integrated Ocean Drilling Program (IODP) Expedition 348: Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE), which drilled down to 3058.5 mbsf.

$R_o$  values of vitrinite reflectance are  $\sim 0.15$  to  $\sim 0.20$  in Unit III (forearc basin),  $0.21$  to  $0.27$  in Unit IV (accretionary prism), and  $\sim 0.26$  to  $\sim 0.38$  in Unit V (hemipelagic sediment), respectively. In general,  $R_o$  values tend to increase with depth, but several reversals of  $R_o$  suggest the existence of faults which have large displacements enough to offset paleothermal structure.

We estimated paleotemperature based on reaction rate equation of EASY% $R_o$  (Sweeney and Burnham, 1990). Two heating duration time was assumed in the calculation: 1) depositional age of several formations by shipboard nannofossil ages, which is the maximum heating duration time, and 2) depositional age of lower forearc basin (1.67 Ma), which is minimum heating duration time.

Estimated maximum paleotemperatures are 1)  $\sim 58^\circ\text{C}$  in Unit IV and  $\sim 74^\circ\text{C}$  in Unit V, 2)  $\sim 67^\circ\text{C}$  in Unit IV and  $\sim 88^\circ\text{C}$  in Unit V, respectively. These temperatures are lower than estimated modern temperatures based on borehole temperature measurements and their downward extrapolations (Sugihara et al., 2014).

キーワード：付加体、南海トラフ、ビトリナイト反射率

Keywords: accretionary prism, Nankai Trough, vitrinite reflectance

大水深ライザー掘削でのカッティングスラグ深度の誤差推定：南海掘削Site C0002でのケーススタディ

Estimation of cuttings lag depth error in deep water riser drilling hole: A case study of NanTroSEIZE Site C0002.

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Drilling cutting is a unique tool to directly evaluate geological information in drilling hole, and precision and accuracy of cuttings lag depth are important for the geological evaluation to . During an actual operation, it is considered that mud water lag depth is the same as cuttings lag depth. However, since the cuttings lag depth obviously depends on size of cuttings, error of the cuttings lag depth should be independently evaluated as compared with the mud water lag depth. In this presentation, basic concept of the cuttings lag calculation is reviewed, and error of the cuttings lag depth is conceptually defined. As the result, potential of the cuttings evaluation is discussed showing quantitative result of the cuttings lag depth error.

キーワード：大水深掘削、カッティングス、泥水検層、ラグ深度

Keywords: Deep water drilling, Cuttings, Mud logging, Lag depth



## 掘削情報科学

Borehole informatics: scientific drilling as an information science

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掘削とは、地下を探るための手法の一つで、具体的かつ直接的に何がどのような状態で存在しているのか確認するための唯一の方法である。掘削を行うことで、ある場所の狙った深度から希望する物質・情報を得てきたが、実は掘削によって得ることができるデータは非常に多種多様かつ大量で、ほとんどのデータはこれまでは取得すらなされていない。掘削によって取得するデータ量の拡大と情報抽出、さらにはその高度化と統合によって地下への科学的な理解を別次元のものへと進化させるサイエンス、それが掘削情報科学である。

本発表では、より多くのデータを掘削作業や地下試料から取得する試みとそれによって何が見えてくるのかを紹介する。

キーワード：掘削科学、情報科学

Keywords: scientific drilling, information science