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MIS022-01 会場:201B 時間:5 月 23 日 08:30-08:45

ニュージーランド，カンタベリー沖の堆積シーケンスと IODP，Exp.317 採取コア試料の酸素・安定炭素同位体比との対比
Depositional sequences and isotope analyses of the samples from IODP Exp. 317, Canterbury Basin, New Zealand

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はじめに

統合国際海洋掘削計画（IODP）317 次航海は，縁辺海域における堆積サイクルを支配する汎世界的海水準変動と地域的なテクトニクスの相対的重要性の理解を目的として計画された．特に，地質時代の海水準変動の変動幅を直接知るため，私たちがまだ入手したことのない海水準低下期に海面上に露出する陸棚堆積物の連続コア試料を得ることが最大の目的である．この目的を達成するために，陸棚上で陸側から U1353（水深 85 m），U1354（水深 113 m）,U1351（水深 122 m）の 3 つのサイトを掘削した．これらのサイトでは，上部中新統から完新統までの堆積物を得ることができ，特に上部鮮新統以上（3.5 Ma 以降）に関しては，数万年周期の海水準変動の震幅を研究するに十分な回収率でコアを得た．このことから，酸素同位体変動曲線 (Lisiecki and Raymo, 2005) と汎世界的な海水準変動曲線 (Haq et al., 1987) との対比が試みられている．なお，沖側の水深 344 m の斜面上の掘削サイト（U1352）では，海底下 1927.5 m まで掘削して始新統に到達した．この斜面サイトで得られたコアは，陸棚サイトに対して年代を提供すると同時に，始新世以降の海洋循環に関する重要なデータも提供する．

シーケンス境界とその形成年代

カンタベリー堆積盆地の陸棚から斜面を形成する中部中新統から完新統中には 19 のシーケンス境界（U1 から U19）が地震波断面で確認されている（Lu and Fulthorpe, 2004）．実際に回収されたコアには，これらのサイスミックシーケンス境界と対比可能な不連続面が認められ，特に U10 から U19 のシーケンス境界に対比可能と思われる不連続面は全てのサイトで確認することが出来た（Expedition 317 Scientists, 2010）．これらのシーケンス境界の年代を斜面サイト（U1352）のコアから底棲有孔虫を抽出し，その酸素同位体比変動の時間的変化を描くことで，シーケンス境界の年代を高精度で求めた．現段階では船上で求められた石灰質ナンノ化石の年代（Expedition 317 Scientists, 2010）を参考に 1 から 2 Ma の間で約 1 万年の精度で酸素・炭素同位体比を測定，曲線を描き，それに基づきシーケンス境界の形成年代を推定した．なお，測定は高知コアセンターの質量分析計 (IsoPrime, Isoprime Ltd.) を用いた．その結果，Lisiecki and Raymo（2005）の MIS23 から 61 までのステージのほとんどを見出すことが出来た．

堆積物中の陸源有機物の寄与を考察するため，予察的に陸棚，斜面の 4 サイトのコアについて，有機物の安定炭素同位体比を測定した．測定は信州大学理学部の元素分析計 (FlashEA1122, ThermoQuest Ltd.) と質量分析計 (Delta V, ThermoQuest Ltd.) を使用した. 基本的にシーケンス境界形成時に陸源有機物の寄与が大きくなることが示されている．

REFERENCES

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キーワード: 海水準変動, カンタベリー堆積盆地, ニュージーランド沖, 酸素同位体比変動曲線
Keywords: sea level change, Canterbury Basin, offshore New Zealand, marine isotope stage

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IODP317 次航海ニュージーランド沖大陸棚堆積物における間隙水のマグネシウム同位体組成
Mg isotope geochemistry of pore-waters in shelf cores from IODP Expedition 317; Canterbury Basin, New Zealand

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Magnesium is a major element in the geosphere, biosphere, and hydrosphere. In seawater, Mg^{2+} is the fourth most abundant ion with a concentration of 55 mM. The dominant source of Mg to the ocean is chemical weathering of the continental crust, transported via riverine runoff. The Mg sinks are hydrothermal alteration of oceanic crust, limestone dolomitization, and ion-exchange reactions of clay minerals in marine sediments. Profiles of decreasing magnesium in porewaters have been observed in many anaerobic marine sediments such as in the near shore sediments. Cation exchange under reducing conditions results in magnesium removal from porewater, and this removal process account for 5-10 % of the Mg^{2+} brought to the sea by river (Bischoff et al., 1975). These diagenetic chemical reactions are thought to be reflected in the isotopic composition of the pore fluids. Recent developments in inorganic mass spectrometry allowed Mg stable isotope systems to be explored by cosmochemists and geochemists. By this time, little is known about the Mg isotope geochemistry in the interstitial waters of marine sediments. The effects of diagenesis on Mg isotopic composition are of interest in relation to the use of Mg isotope as a tracer of the oceanic mass balance of Mg. It has been demonstrated that modern seawater is isotopically homogeneous (de Villiers et al., 2005) but it should not been maintained following geochemical weathering, authigenic mineral precipitation and ionic exchange among various components. The elemental and isotopic compositions of sedimentary porewater have been extensively used to constrain diagenetic chemical reactions following burial.

In this study we analyzed Mg isotope values of porewater from Integrated Ocean Drilling Program (IODP) Expedition 317 Canterbury Basin Sea Level: Global and local controls on continental margin stratigraphy. This expedition was devoted to understanding the relative importance of global sea level change versus local tectonic and sedimentary processes in controlling continental margin sedimentary cycles. Therefore, the recovered sediments provide geochemically unexplored deep-penetrated cores at shallow shelf sites. Cores were drilled in the eastern margin of the South Island of New Zealand. Upper Miocene to recent sedimentary sequences were cored in a transect of three sites on the continental shelf (Sites U1351, U1353 and U1354) and one on the continental slope (Site U1352). Continental slope Site U1352 represents a complete section from modern slope terrigenous sediment to hard Eocene limestone.

We use Mg isotope ratios of sedimentary porewaters to evaluate the role of Mg-carbonate precipitation/dissolution, Mg-adsorption/desorption between sediments/rocks and porefluid on the Mg isotope composition with the help of other tracers, providing a geochemical framework for an evaluation on the Mg isotope variability. Our aim are to assess the effect of diagenetic processes on the Mg budgets of porewater and bulk sediments using Mg isotope ratios, and to constrain the effect of chemical reactions in the sediments to global Mg isotope cycles.

キーワード: IODP, 間隙水, マグネシウム同位体, MC-ICP-MS
Keywords: IODP, pore-water, Mg isotope, MC-ICP-MS

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MIS022-03 会場:201B 時間:5 月 23 日 09:00-09:15

ベーリング海における高周波の古海洋変動：統合深海掘削計画第 323 次ベーリング海掘削
High-frequency paleoceanographic fluctuation of the Bering Sea: scientific results of the IODP Expedition 323.

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The IODP Expedition 323 in the Bering Sea was the first expedition to recover continuous marine sediment sections to investigate high-resolution paleoceanography at the most northern region of the North Pacific during 5 Ma. Drill sites explored in the Bowers Ridge region (Sites U1340 and U1341) provide complete sequences for the last 5 myrs, including Northern Hemisphere Glaciation (NHG), and drill sites at the continental slope of the Aleutian Basin (Sites U1343 and U1344) provide complete sequences for the last 2 myrs, including the Mid Pleistocene Transition (MPT) with drastic changes in the character of glacial-interglacial cycles.

Post cruise age models of the drilled sequences are constructed using oxygen isotope stratigraphy, tephrachronology, and optically stimulated luminescence (OSL) dating, along with onboard bio- and magneto-stratigraphy. Astronomical calibration of high-resolution non-destructive core measurement data provides additional age control, and shows that sedimentation rates during interglacials are two to three times higher than that of glacials.

Marine primary productivity changes dramatically during the Plio-Pleistocene. Si /Al ratio measured using non-destructive XRF scanning by TATSCAN-F2 is consistent with discrete biogenic silica content, and exhibits large glacial-interglacial cycles. The productivity is relatively high, similar to that of the present Green-belt, during the interglacial periods with increasing glacial-interglacial variability after NHG, and even larger amplitude variations during last 500 kyrs. Significant large peaks of biogenic carbonate detected by TATSCAN-F2 occur during every deglaciation period (in the early stage of warming) during the Pleistocene. The increase in biogenic carbonate is related to enhanced terrigenous nutrient supply mainly from the continental shelf exposed during the glacial periods. During the middle and later part of the interglacial, carbonate content becomes significant low due to restoration of ocean circulation to a state similar to the present.

Sea-ice history was reconstructed by the ice-rafted debris (IRD). IRD is defined by counts of coarse (>1mm) grains using transparent X-ray images (TATSCAN-X1), and by counts of coarse fraction (0.160?0.900 mm) using grain-size analysis; IRD has a positive correlation with the abundance of diatom ice-algae. Time series data of the IRD abundance shows significant changes, relating to sea-ice expansion, Alaskan glacier discharge, and sea level changes in the last glacial cycle.

Marine primary productivity, ocean circulation, sea-ice expansion of the Bering Sea may play an important role during the MPT and NHG, especially through its impact on surface and bottom water circulation in the Arctic and the Pacific oceans.

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MIS022-04 会場:201B 時間:5 月 23 日 09:15-09:30

グレートバリアリーフサンゴ礁掘削による海水準および古環境復元ー IODP325 速報
Climate and Sea-level changes since the last glacial maximum: Preliminary results from IODP Expedition 325 the Great Bar

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Sea-level was lower by as much as 120 m and climate was colder globally during the last glacial maximum (LGM) at around 20 ka. Because the environmental changes since the LGM comprise the largest magnitude changes during the Earth's recent history, data of this period recorded in geological archives are important for understanding climate dynamics and ecological responses. The history of environmental changes are best recorded in fossil coral reefs from the LGM, and hence Integrated Ocean Drilling Program (IODP) Exp. 325 was designed to recover samples of these fossil reefs on the shelf edge of the Great Barrier Reef (GBR). Three major objectives of Expedition 325 are to 1) establish the course of sea level change, 2) define sea-surface temperature variations, and 3) analyze the impact of these environmental changes on reef growth and geometry for the region over the period of 20 ? 10 ka. This expedition compliments Exp. 310 "Tahiti Sea Level" that in 2005 recovered Postglacial coral reef cores around Tahiti between 41.6-117.5 meters below sea level that span ~ 16 to ca. 8 ka.

The offshore phase of Exp. 325 was conducted from February to April 2010 to core a series of fossil reef preserved along the shelf edge of the Great Barrier Reef at three geographic locations (Hydrographers Passage, Noggin Pass and Ribbon Reef). A total of 34 boreholes across 17 sites were drilled in four depth transects ranging from 42.2 to 167.2 meters below sea level. Wireline logging operations at four boreholes provided continuous geophysical information about the drilled strata. According to the Onshore Science Party at the IODP Bremen Core Repository (Germany) in July 2010, high-quality fossil coralgal frameworks are found in a number of horizons of different cores thus recording high energy reef settings, which crucial for precise reconstructions of sea level and sea-surface environmental change. Ages obtained so far range from > 30 to 9 ka, indicating successful capture of the period of interest. This includes the time into and out of the LGM, the 19ka-Mwp, Mwp-1a, t
he Younger Dryas, the Bolling-Allerod, and Heinrich Events 1 and 2. The fact that there are very limited number of fossil coral records spanning these intervals, and even fewer from tectonically stable, passive margin settings far from the confounding influence of ice sheets, only highlights further the importance of the new Exp. 325 cores.

We will summarize Exp. 325's preliminary results and their broader

implications for understanding global sea level and paleoclimate changes, as well as how coral reefs respond to environmental stress.

キーワード: グレートバリアリーフ, サンゴ礁, 海水準, 古気候, 古海洋, IODP
Keywords: Great Barrier Reef, Coral reef, sea level, paleoclimatology, paleoceanography, IODP

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タヒチ島における最終後氷期の海水準変動，気候変動，サンゴ礁形成
Sea-level change, climate variability and reef development during the last deglaciation

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Integrated Ocean Drilling Program (IODP) Expedition 310 ”Tahiti Sea Level” was conducted from October to November 2005 (Offshore Party) and from February to March 2006 (Onshore Party) (Camoin, Iryu et al., 2007, Sci. Drill., 5, 4-12). The objectives of this expedition were : 1) to establish the course of postglacial sea-level rise in Tahiti, 2) to define variations in sea surface temperature for the region during the 10-20 ka time window, and 3) to analyze the impact of sea-level and environmental changes on reef growth and geometry. In this presentation, we show summaries of scientific results of the objectives (2) and (3).

The response of coral reefs to sea-level and environmental changes during the last deglacial sea-level rise at Tahiti has been reconstructed from chronological, sedimentological and paleontological analyses of drill cores obtained by drilling the relict reefs occurring beneath the modern fore-reef slopes. Changes in the composition of coralgal assemblages coincide with variations in reef growth rates and therefore characterize the response of the upward-growing reef pile to a non-monotonous sea-level rise and coeval environmental changes. Reefs accreted continuously, mostly through aggradational processes, at mean growth rates of 10mm/year during the 16-10ka period, indicating the lack of any catastrophic impact on reef development such as the temporary break or cessation of reef growth. An incipient drowning and a general backstepping of the reef complex have been evidenced during the 14.6-13.9ka time window, coeval with the MWP-1A, implying that reef growth gradually lagged behind sea-level rise (Camoin et al., in review, Geology) . Paleontological analysis of cored material allowed to identify twenty-six coral species, twelve coral genera and twenty-eight coralline algal species. Based on these data, and in comparison with modern and fossil analogs, seven coral and four algal assemblages have been identified in the deglacial reef sequences, each representing a specific environment (Abbey et al., 2011, Glob. Planet. Change, doi:10.1016/j.gloplacha.2010.11.005). Reef initiation pattern and timing varied at sites based on the available substrate, and early colonizers suggest water conditions at all sites were unfavorable to sensitive corals, such as Acropora, prior to ca. 12.5 ka. Mainly shallow water (i.e. less than 10?15 m water depth) corals and coralline algal assemblages developed continuously at all sites from 16 ka to ˜8 ka, suggesting that changes in coralgal assemblages were more influenced by factors such as turbidity and water chemistry than sea-level rise alone.

Sr/Ca ratios and oxygen isotopes of fossil Tahiti corals suggest that a shift toward lower temperature by ˜1.5 degrees Celsius and higher oxygen isotope composition by ˜0.2 per mill at the sea surface from 14.2 to 12.4 ka (Asami et al., 2009, EPSL, 288, 96-107). Along with previously published deglacial coral records, our results provide new evidence for a significant cooling of the western to central tropical South Pacific Ocean during the Northern Hemisphere Younger Dryas episode, which are not consistent with foraminiferal Mg/Ca-derived sea surface temperature records from the equatorial Pacific Ocean. Higher Ba/Ca ratios and Cd content together with lower reconstructed SSTs using U/Ca ratios in the coral specimens between 12.7 and 9.8 cal ka compared to around 15 cal ka suggest that upwelling and/or entrainment of subsurface water into mixed layer was enhanced around Tahiti during this period. This finding is consistent with previous reports and supports the idea that the South Pacific was characterized by La Nina-like conditions at least from 12.7 to 9.8 cal ka.

キーワード: 統合国際深海掘削計画, 海水準変動, 古気候, サンゴ礁, 最終後氷期, タヒチ島
Keywords: Integrated Ocean Drilling Program, Sea-level change, Paleoclimate, Coral reef, Last deglaciation, Tahiti

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モルディブ・北マーレ環礁縁の掘削：堆積構造と完新世の礁形成過程
Drilling atoll-rim in the North Male Atoll, Maldives: sedimentary structure and Holocene reef development

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環礁における現成サンゴ礁の堆積構造と形成過程が示される例は少ない。我々はマーレ島で外洋側礁縁部付近に達した南東部の埋め立て地で，旧礁嶺部にあたる地点をボーリング地点として選定し，掘削深度 53.5m に達するコアを得た。本研究では，このボーリングコアを基に，環礁外縁部の堆積構造と完新世の礁形成過程を提示する。また，マーレ島北東部の礁湖側斜面では 2002 年に発生した地盤崩壊によって，礁面 (水深 3m)〜水深 25m までの礁湖側斜面の内部構造が確認できる。本研究ではこの崩壊地の壁面にて観察した堆積構造および採取した試料を用いて，礁湖側端部の形成を論じる。

岩相記載および X 線回折による鉱物の同定より，環礁外縁部（MMC: Maldive Male Core-site）における更新統／完新統境界は，現平均海面下 9.5m 付近に認められる。一方，礁湖側崩壊地では観察できた水深 25m までは全て完新統であった。マーレ環礁南縁の完新世サンゴ礁の基盤地形は，環礁縁で高く礁湖側で低い。

環礁外縁部のコア (MMC) では 40m を超える更新統を観察することができた。岩相より 4 つのリーフユニットが判別できた。各リーフユニットでは coral framestone を挟む礁性砂礫上に，サンゴ・石灰藻（サンゴモ）より成る coral-algal bindstone が載る。

完新統の堆積構造では，環礁外縁部のコア (MMC) 上部の，礁原面以下 3.3m で固結した coral-algal bindstone がみられ，以下は礁性砂礫が主となる。環礁外縁部以外の堆積構造は礁性砂礫が主であり，固結した堆積構造は認められない。マーレ島北東部の崩壊地での観察より，礁湖側斜面の表面から約 2m の厚さで固結した礁構造が認められるのみである。本研究で得られた試料の AMS 年代測定より，マーレ島が載る北マーレ環礁南縁における約 8ka 以降の礁形成過程が明らかになった。

キーワード: 環礁, 掘削コア, サンゴ礁形成, 堆積構造, 完新世, モルディブ
Keywords: atoll, drilling core, coral reef development, sedimentary structure, Holocene, Maldives

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海底熱水鉱床を掘削する　－ IODP Exp.331 速報－
Unique hydrogeological mode of a submarine hydrothermal system within volcaniclastic sediment

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島弧・縁海系では海底熱水循環系が火山性砕屑層内に発達することが多いが、地殻の間隙率が圧倒的に高い点などで、若い海洋地殻内を熱水が循環する中央海嶺とは異なった特徴が見られることが期待できる。中部沖縄トラフ伊平屋北海丘で実施された IODP（統合国際深海掘削計画）Exp.331 は、火山性砕屑層内に発達する熱水活動域の海底下に直接アクセスし、そこに発達している海底下生物圏と熱水鉱床を研究する絶好の機会を提供した。海丘の海底面は材木状軽石を主体とする火山性砕屑物で覆われていることが確認され、また熱水マウンドの近傍では軽石堆積物がごく浅い深度から普遍的に熱水変質を被っていることがコア観察から明らかになった。このような熱水変質帯の分布と観測された高い温度勾配は、熱水流体が堆積層に沿って横方向に浸入移動していることを示している。硫化鉱物の鉱化作用も同様に堆積層に沿って特徴的に分布しており、このことは東北日本に見られる黒鉱鉱床との類似性を改めて強く認識させる。高い間隙率を持つ火山性砕屑層内を熱水が横方向に広がる熱水循環の様式は、経済的に重要な価値を持つ大型の海底熱水鉱床を形成するのに有利な地質学的環境を提供すると考えられる。

キーワード: 火山性硫化物鉱床, 海底資源, 珪質マグマ, 熱水変質作用, 火山性砕屑物, 海底熱水循環
Keywords: Volcanic massive sulfide deposit, submarine mineral resources, felsic magma, hydrothermal alteration, volcaniclastic sediment, submarine hydrothermal fluid circulation

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MIS022-08 会場:201B 時間:5 月 23 日 10:15-10:30

IODP 第 329 次研究航海の概要及び調査速報
Primary report on IODP 329 Expedition on South Pacific Gyre Microbiology

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本研究航海は、地球上で最も海水中の有機物生産量が低く、海水の透明度が最も高いことで知られる南太平洋環流域を掘削し、低栄養・高酸素濃度の堆積物や玄武岩帯水層に生息する地殻内生命の実態を解明し、地球規模での地殻内生命圏の規模や分布、代謝活性等を理解することを目的とした。本発表では航海の概要と船上での研究活動について紹介する。

キーワード: 地下生命圏, 南太平洋環流, 海底下生命圏
Keywords: Deep biosphere, South Pacific gyre, subseafloor life

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MIS022-09 会場:201B 時間:5 月 23 日 10:45-11:00

IODP 第 327 次航海：ファン・デ・フーカ海嶺東翼部の玄武岩質海洋地殻の水理地質学的構造
IODP Expedition 327: Juan de Fuca Ridge-Flank Hydrogeology

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Integrated Ocean Drilling Program (IODP) Expedition 327 focus on understanding fluid?rock interactions in young, upper ocean crust on the eastern flank of the Juan de Fuca Ridge, delineating the magnitude and distribution of hydrologic properties; the extent to which crustal compartments are connected or isolated; the rates and spatial extent of ridge-flank fluid circulation; and links between ridge-flank circulation, crustal alteration, and geomicrobial processes. Expedition 327 installed subseafloor borehole observatories (CORKs) in basement holes to allow borehole conditions to recover to a more natural state after the dissipation of disturbances caused by drilling, casing, and other operations; provide a long-term monitoring and sampling presence for determining fluid pressure, temperature, composition, and microbiology; and facilitate the completion of active experiments to resolve crustal hydrogeologic conditions and processes.

During Expedition 327, two basement holes were cored and drilled at Site U1362. Hole U1362A was cored and drilled to 528 meters below seafloor (mbsf) (292 meters subbasement [msb]), subjected to geophysical logging and hydrologic testing, and instrumented with a multilevel CORK observatory. Hole U1362B was drilled to 359 mbsf (117 msb), subjected to a 24 h pumping and tracer injection experiment, and instrumented with a single-level CORK observatory. Both CORK observatories include monitoring of pressure and temperature and downhole fluid and microbiology sampling. In addition, part of an instrument string deployed in Hole U1301B during Expedition 301 was recovered, and a replacement string of thermal sensors was installed. Finally, a program of shallow sediment coring was completed adjacent to Grizzly Bare outcrop, a suspected site of regional hydrothermal recharge. Thermal measurements and analyses of pore fluid and microbiological samples from a series of holes aligned radially from the outcrop edge will elucidate rates of fluid transport and evolution during the initial stages of ridge-flank hydrothermal circulation.

キーワード: IODP, Hydrogeology, Anisotropy, Crustal-scale properties, Microbiology
Keywords: IODP, Hydrogeology, Anisotropy, Crustal-scale properties, Microbiology

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MIS022-10 会場:201B 時間:5 月 23 日 11:00-11:15

IODP Expedition 330 ルイビル海山列掘削航海概要
Preliminary results of IODP Expedition 330: Louisville Seamount Trail

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The Louisville Seamount Trail is a 4,300 km long volcanic chain that is inferred to have been built in the past 80 Myr as the Pacific plate moved over a hotspot. It is the South Pacific counterpart of the much better studied Hawaiian-Emperor Seamount Trail. Paleomagnetic studies on drill cores of ODP Leg 197 from the Emperor seamounts revealed a ~15 degree southward motion of the Hawaiian hotspot prior to 50 Ma, calling into question whether the primary Pacific hotspots constitute a fixed frame of reference. Two end-member geodynamical models have been considered; (1) the Hawaiian and Louisville hotspots have moved in concert, (2) they have moved independently (mantle flow model, which predicts little latitudinal motion of Louisville hotspot). IODP Expedition 330 seeks to test these models using modern paleomagnetic and geochronological techniques. Another primary objective of the expedition is to determine the magmatic evolution and melting processes of Louisville volcanoes. Prior to Expedition 330, the only dredged samples recovered have been alkali basalts, which suggest that shield-building stage in the Louisville volcanoes is mostly alkalic, in sharp contrast to the massive tholeiitic shield-building stage of Hawaiian volcanoes. Geochemical and isotopic studies of the rocks recovered during Expedition 330 will allow us to map the fundamental differences between Louisville and Hawaiian hotspot volcanism.

Expedition 330, from 13 December 2010 to 12 February 2011, planned to drill ~350 m into the igneous basement of four seamounts of different ages, from 50 to 80 Ma, along the Louisville Seamount Trail. It was expected that by drilling to such depths we would be able to sample a sufficient number of lava flows required to average out the secular variations of the geomagnetic field, and as a result be able to obtain a reliable estimate of the paleolatitude of the hotspot at the time each of the seamounts was formed. So far we have occupied five sites on four seamounts, and drilling is still ongoing while this abstract is being written. At Site U1374 on Rigil Guyot with an estimated age of ~73 Ma, we reached 522 mbsf with an extraordinarily high average core recovery of 88%. The rock samples obtained during this expedition will enable us to fulfill the scientific objectives after onboard and post-cruise research.
Keywords: IODP, Louisville Seamount, hotspot, mantle dynamics, paleomagnetism

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MIS022-11 会場:201B 時間:5 月 23 日 11:15-11:30

IODP Expedition 330 (Louisville Seamount Trail) の船上古地磁気測定結果の概要
Shipboard paleomagnetic results from IODP Expedition 330 (Louisville Seamount Trail): an overview

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One of the primary objectives of the IODP Expedition 330 was to retrieve cores of a sufficient number of volcanic rock units (lavas and volcaniclastics) at each target seamount of the Louisville Seamount Trail to precisely determine the late Cretaceous to early Paleogene (about 80 to 50 Ma) paleolatitude of the Louisville hotspot. Cores composed mainly of various lithologies of volcanic edifices and shallow marine sediments were retrieved from 6 sites (U1372 to U1377) at 5 seamounts of the trail. Detailed paleomagnetic and rock magnetic investigations for discrete samples currently being undertaken at onshore laboratories will provide data that constrain the hotspot paleolatitude. Onboard the JOIDES Resolution, we carried out magnetic measurements for archive half-cores and discrete samples (8 cc cubes) to obtain preliminary results. The remanent magnetization of archive halves was measured at 2 cm intervals using the automated pass-through DC-SQUID cryogenic rock magnetometer. An integrated in-line AF demagnetizer was used to progressively demagnetize the core. Remanent magnetization directions for each 2 cm measurement were calculated using principal component analysis (PCA) with an automated procedure. Remanent magnetization in discrete samples was measured with a spinner magnetometer. Discrete samples were subjected to stepwise alternating-field or thermal demagnetization. In general, relatively well-defined PCA directions were obtained from archive half-core measurements (for core pieces >9 cm in length), and they are consistent with characteristic remanent magnetization directions of discrete samples. Also, the anisotropy of magnetic susceptibility (AMS) was determined for all discrete samples. The shipboard results will be used to calculate preliminary paleolatitude estimates for individual seamounts drilled.

キーワード: IODP, Expedition 330, Louisville Seamount Trail, Louisville hotspot, paleolatitude, paleomagnetism
Keywords: IODP, Expedition 330, Louisville Seamount Trail, Louisville hotspot, paleolatitude, paleomagnetism

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MIS022-12 会場:201B 時間:5 月 23 日 11:30-11:45

IODP　Exp332 での長期孔内観測所の設置
Long-term borehole observatory installation during Exp 332.

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Tonankai earthquakes are magnitude 8 class earthquakes known to occur every 100-150 years in the Nankai Trough, south of Japan. In order to monitor and watch detailed seismic process in the vicinity of its epicenter, we plan to establish a network of long-term borehole observatory in NantroSEIZE program in the IODP in three locations with different seismic characteristics; C0009 above the seismically coupled plate interface to cause Tonankai earthquake, C0002 near the edge of the seismically coupled zone, and C0010 above the aseismic part of plate interface of incoming Philippine sea plate and penetrating one of splay faults from the plate boundary. The C0010 and the C0009 Site were drilled during the Exp 319 in 2009. A pressure and temperature monitoring package called ”Smart-Plug” was installed in the C0010A hole in 2009 for monitoring the pore-fluid pressure in the splay fault and seafloor.

During IODP Exp 332 in December 2010, we have successfully recovered the Smart-Plug from C0010A and replaced with further improved observatory package called ”Genius plug”, adding water-sampler (osmo-sampler) and in-situ microbial package.

In the IODP Exp 332, we also installed the first planned permanent seafloor borehole observatories in the NantroSEIZE program in IODP Hole C0002G. Strainmeter, tiltmeter and seismic sensors were cemented near the bottom of 980 m seafloor borehole to ensure stable environment required for these geodetic measurement, where distance to the Tonankai seismogenic fault is approximately 6 km. In the same borehole, we can also measure pore-fluid pressure in three depths and temperature in 5 depths. The borehole observatory in C0002G is currently measuring pore-fluid pressure in the accrecionary prism, sediment basin, and seafloor. In March, 2011, we plan to start long-term seismic and geodetic observation in the C0002G borehole observatory. We expect the strainmeter, tiltmeter, pore-fluid pressure, and broadband seismometer data from quiet and stable environment in Hole C0002G and C0010A will produce a key observation defining slip behavior of the subducting plate in zone between seismically coupled and decoupled plate interface.

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掘削同時検層による長期孔内観測機器設置事前準備について
Long Term Borehole Measurement System installation using LWD in Exp332

木戸 ゆかり [1*], 荒木 英一郎 [1], ショーン・トスコ [1], 松田 繁美 [1], Kyaw Thu MOE[1], 真田 佳典 [1], 東 垣 [1]
Yukari Kido[1*], Eiichiro Araki[1], Sean Toczko[1], Shigemi Matsuda[1], MOE Kyaw Thu[1], Yoshinori Sanada[1], Wataru Azuma[1]

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地球深部探査船「ちきゅう」による南海地震発生帯掘削のステージ 3 段階目を迎えた地球深部探査センター（CDEX）では、ステージ 1 の 2007 年 9 月からの掘削し、データ取得をしたサイトの情報を元に、長期孔内計測器を設置するべく、2010 年 11 月に掘削同時検層（LWD）を行った。水深 1937m の南海トラフ斜面に近い熊野海盆の縁部の C0002G サイトを掘削作業と同時に検層を行い、比抵抗値とガンマ値を測定しながら海底下 980m を掘り進んだ。2007 年 10 月の第 314 次航海では、水平距離 50m 程東に離れた C0002A サイトにて、物性値や地層境界データが得られている。3 次元地震探査データや既存の検層データと今回取得したデータとを比較しながら、機器設置に最適な層序および深度を決め、孔内清掃の後、ケーシングパイプを設置、長期孔内観測装置を深さ 980m までの間に設置することができた。リアルタイムで検層データを見ながら、期間をおかずに孔壁の保護、機器の設置を行った例は、科学掘削史上初めてである。リアルタイムでモニターあるいは取得後すぐにラッシュプリント出力された検層データや掘削のパラメタを乗船研究者が確認した。さらにツール引き揚げ後、内部メモリを回収し、より高密度のデータとして品質の確認や環境補正を行い、データ解析を行うべく研究者へ提供される。今回は、機器設置準備のため、回収後のメモリデータを待たずに、リアルタイムデータを用いた。孔径測定は行なわず、比抵抗とガンマ線測定という必要最小限の項目であったが、掘削速度を 10-15m/h というゆっくりしたスピードで掘進したため、孔内状況を判断するに十分な良質データが得られた。

キーワード: 掘削同時検層, 地球深部探査センター, 地球深部探査船「ちきゅう」, 統合国際深海掘削計画, 南海トラフ地震発生帯, 長期孔内計測システム
Keywords: Logging while drilling, CDEX, D/V Chikyu, IODP, NanTroSEIZE, LTBMS

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MIS022-14 会場:201B 時間:5 月 23 日 12:00-12:15

IODP Expedition 333：インプットサイト掘削, 熱流量測定および海底地すべり掘削の概要
Summary of IODP Expedition 333: Drilling of Subduction input sediments, and mass transport deposits

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2010 年 12 月 12 日より 2011 年 1 月 10 日まで，IODP Expedition 333「南海トラフ地震発生帯掘削計画ステージ 2 インプットサイト掘削-2 および熱流量の測定」が， NanTroSEIZE の一環として，また NanTroSLIDE(APL) の実施のため行われた．

地震発生と海底地すべりとの関係を理解するために NanTroSLIDE project として，Site C0018 において 314.2mbsf まで掘削をおこない複数の海底地すべり層を掘削した．127-189mbsf に最も厚い海底地すべり層があり，直上の広域テフラの噴出年代から，この地すべりはおよそ 100 万年前に起こったと推定される．この厚い地すべり層の上位では，比較的規模が小さな海底地すべり層と均質な粘土層が交互に堆積している．海底地すべり層で採取されたコアは著しく変形しており，海底地すべり滑動時の様々な変形構造が記録されていた．一連の地すべり層の下位では，タービダイト層が繰り返し堆積しており，海底地すべり発生時に堆積物の供給に劇的な変化が起こったことを示唆している．今後，採取されたコアの詳細な構造解析，地盤力学的研究などにより，どのように海底地すべりが起こったのか，どの程度の規模の地すべりだったかを明らかにし，海底地すべり発生と堆積物供給の変化の関連，地すべりが津波を起こすポテンシャルや巨大地震との関連を研究する．

また，巨大地震発生帯を構成する物質の初期状態を知るために，第 322 次航海に引き続き，四国海盆の Site C0011 および Site C0012 の 2 点において，表層堆積物およびその下位の玄武岩をそれぞれ海底下 380m および 630.5m までライザーレス掘削した（NanTroSEIZE）．C0011 地点において海底下 380m まで，C0012 地点においては海底下 180m までの堆積層の掘削を行った．船上コア解析の結果，変質の進行および堆積物の物性変化がある特定の層で起っていることが確認された．また C0012 地点では海底地すべりが大規模に起っていることが確認された． C0012 地点の深部の掘削により，堆積物と玄武岩の境界を Exp.322 同様に採取することができ，さらに玄武岩層の変質度を知るため，海底下 630.5m まで掘削した．

C0011 および C0012 地点では，堆積層掘削と同時に地層の高密度温度測定を行い，C0012 では C0011 より高いヒートフローが得られた．インプットサイトの流体循環を考える上で，重要なデータを取得できた．C0011 および C0012 で採取された堆積物・玄武岩の組成変化の研究，地盤力学的研究，および流体循環モデルなどを通じて，海洋プレートから運び込まれる堆積層，玄武岩層の性質がどのように変化し，地震発生帯物質として準備されていくのか，第 322 次研究航海の成果と併せて検証してゆく．

キーワード: ナントロシーズ, ナントロスライド, インプットサイト, 海底地すべり
Keywords: NanTroSEIZE, NanTroSLIDE, input site, submarine landslide

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MIS022-15 会場:201B 時間:5 月 23 日 12:15-12:30

IODP 第 322 次研究航海四国海盆掘削試料の堆積物組成分析と FT 年代測定結果から推定される西南日本の発達史と気候変動史
Sediment composition analysis and FT dating of the Shikoku Basin sediments drilled in the IODP Exp.322

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「南海トラフ地震発生帯掘削計画」で地球深部探査船「ちきゅう」を用いて行われた IODP 第 322 次研究航海の Site C0011 および C0012 において，紀伊半島沖四国海盆の 20-5Ma にわたる地層が掘削された．Site C0011 と C0012 の層序は次のような岩相 Unit に区分される．Unit I：後期中新世以降の多数の火山灰を挟む半遠洋性堆積物，Unit II：後期中新世の凝灰質砂岩を挟む岩相，Unit III：中期中新世-後期中新世の半遠洋性泥岩，Unit IV：中期中新世のタービダイト砂岩やタービダイト泥岩に富む岩相，Unit V：前期中新世-中期中新世の凝灰岩や火山砕屑性タービダイト砂岩に富む岩相，Unit VI:前期中新世の遠洋性泥岩，玄武岩基盤．このうち，Unit I から Unit V にかけての堆積物の砂粒鉱物組成分析，花粉化石分析，有機炭素分析，火山灰分析および FT 年代測定を行い，堆積物の後背地と推定される西南日本の発達史と気候変動史の解明を試みた．

Unit V の凝灰岩の FT 年代測定により，Site C0011 から 15.1±0.5 Ma, 16.1±1.2 Ma, 15.8±0.5 Ma, 14.7±0.9 Ma の四つの年代値を得た．また Site C0012 の Unit V 下部の火山砕屑性砂岩からは 13.2±0.7 Ma の年代値が得られている．また，Unit IV のタービダイト砂岩および Unit V の火山砕屑性タービダイト砂岩の鉱物組成分析の結果，黒雲母，柘榴石，ジルコン，アパタイトを含み，斜長石の屈折率分布が山下ほか,（2007）のタイプ I の特徴を持つことが示された．Unit IV および V の鉱物組成と年代から，これら Unit の砂岩の起源が熊野酸性岩に由来することが示唆され，15 Ma 頃の紀伊半島の隆起（Hasebe et al. 1993）を反映している可能性がある．

Unit II の上部の凝灰質砂岩の鉱物組成は，パミスを含み，火山ガラスが最大 30%を占めるほか，両輝石および角閃石を含む特徴的な鉱物組み合わせを示し，後期中新世の伊豆背弧での酸性火山活動との関連などいくつかの可能性が考えられる．

Site C0012 の Unit I から Unit V の主として半遠洋性泥岩の花粉化石分析の結果，下位から I-IV の四つの花粉化石帯に区分された．Unit V-III に相当する中期中新世から後期中新世初期の I-III 帯では暖温帯性の古植生が推定される． Unit I および II に相当する IV 帯ではツガ属の産出が増加し，後期中新世の気候の冷温化が推定される．花粉化石群集には全体に熱帯-亜熱帯性の分類群は含まれず，西南日本の主に低地-低山地起源と考えて矛盾はないが，日本の陸域や坑井の試料に較べて花粉化石量が一桁以上少ない特徴を持つ．これらの花粉化石群集の特徴は，堆積時の掘削地点の古地理や西南日本の古気候を考える上で重要な資料となりうる．
Keywords: IODP, Shikoku Basin, turibidites, composition, Fission-Track dating

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Improving techniques for the challenging scientific drilling targets: IODP science services perspective
Improving techniques for the challenging scientific drilling targets: IODP science services perspective

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Integrated Ocean Drilling Program (IODP) is an international marine research program that explores the Earth history and structure as recorded in seafloor sediments and rocks, and monitors subseafloor environments. First time in the scientific ocean drilling history, three drilling platform has been operating at global locations since 2009, and began planning for the new and ambitious program beyond the end of current IODP from October, 2013.

Since the initiation of IODP in 2003, various new techniques were initiated across three platforms, Chikyu, JOIDES Resolution and Mission Specific Platform (MSP), under the science services from Implementation Organizations. For the new challenges in the various IODP expeditions, those new techniques covering laboratory and downhole measurements, extended widely in measurement types and improved their capability and efficiency. Further addition of riser technology and very shallow locations for MSP brought wider choice of new logging and coring tools, rigfloor parameter, and very high-resolution slim-hole logging tools. All these large volume of data with wider choice of software further enhanced the integrated studies like cuttings/core-log-seismic integration for the very deep-riser holes.

In focus of improved techniques, science services across three platforms in IODP are thoroughly reviewed.

キーワード: IODP, Drilling, Logging, Science Service
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