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# CHIKYU 地球 HAKKEN 発見

## EARTH DISCOVERY

## The Future of the Earth, Opened through Deep Ocean Drilling

SPECIAL TOPIC 1:

### The World Joins Hands to Dig Deep Below the Sea Floor IODP: a Global Exploration Science Project

SPECIAL TOPIC 2:

### The *Chikyu*, *JOIDES Resolution*, and *Mission Specific Platform*: The Three Ships of IODP

May 2010
Volume
9

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*Chikyu*


*JOIDES Resolution*

INTEGRATED OCEAN DRILLING PROGRAM

IODP

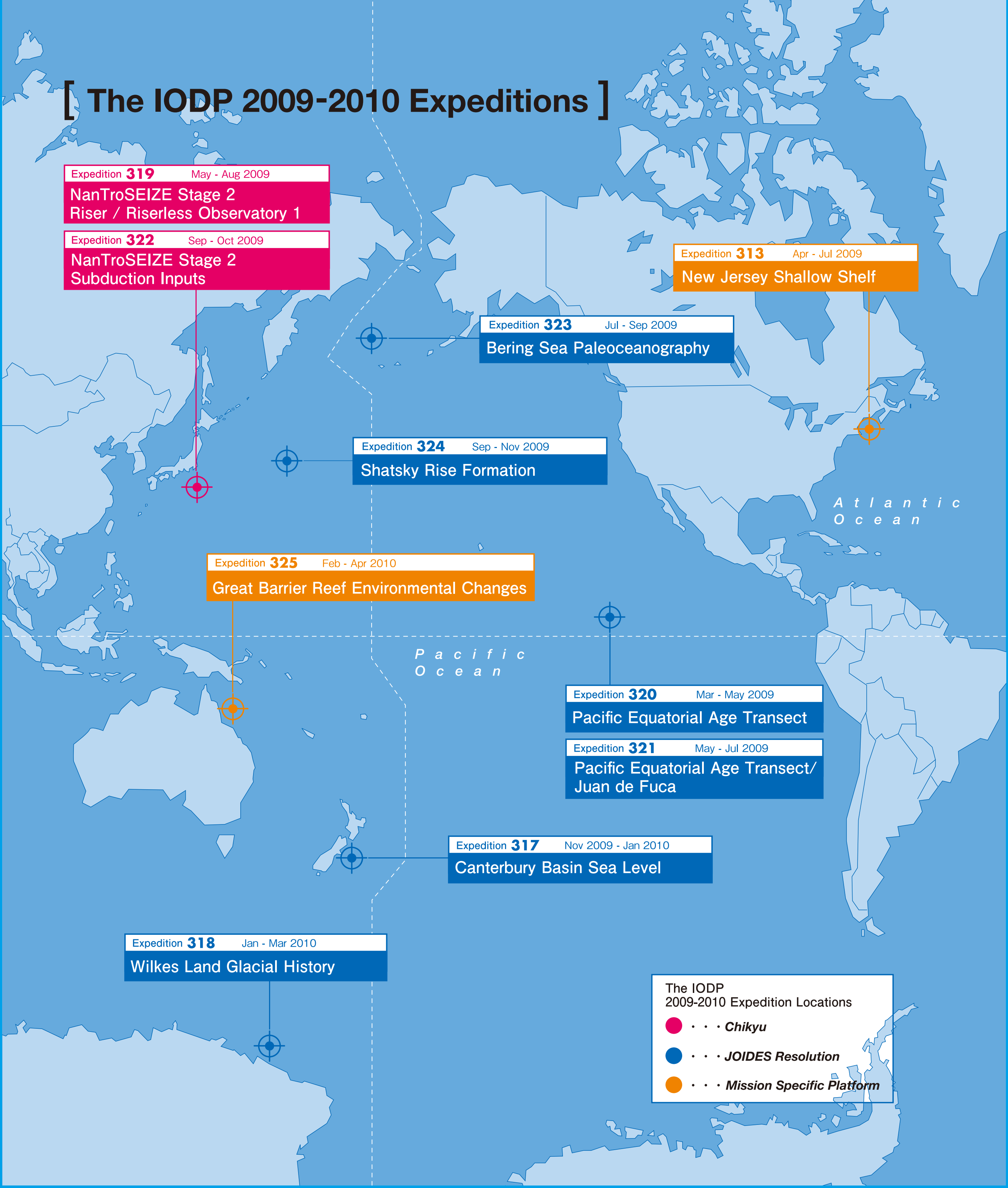
*Mission Specific Platform*


The international meeting
IODP New Ventures of Exploring Scientific Targets (INVEST) was held at the end of September 2009 at the University of Bremen.
A large number of scientists gathered there to discuss the scientific goals of the IODP for 2013 and beyond.
Above: The reception
Below: Dr. Gerold Wefer speaks at the opening ceremony

Cover: The three IODP ships (from above):
*Chikyu*, *JOIDES Resolution*,
and *Mission Specific Platform*



Photo credits: A Gerdes, MARUM William Crawford, IODP/TAMU © ECORD/IODP A.Stevenson © ECORD/IODP AERO ASAHI



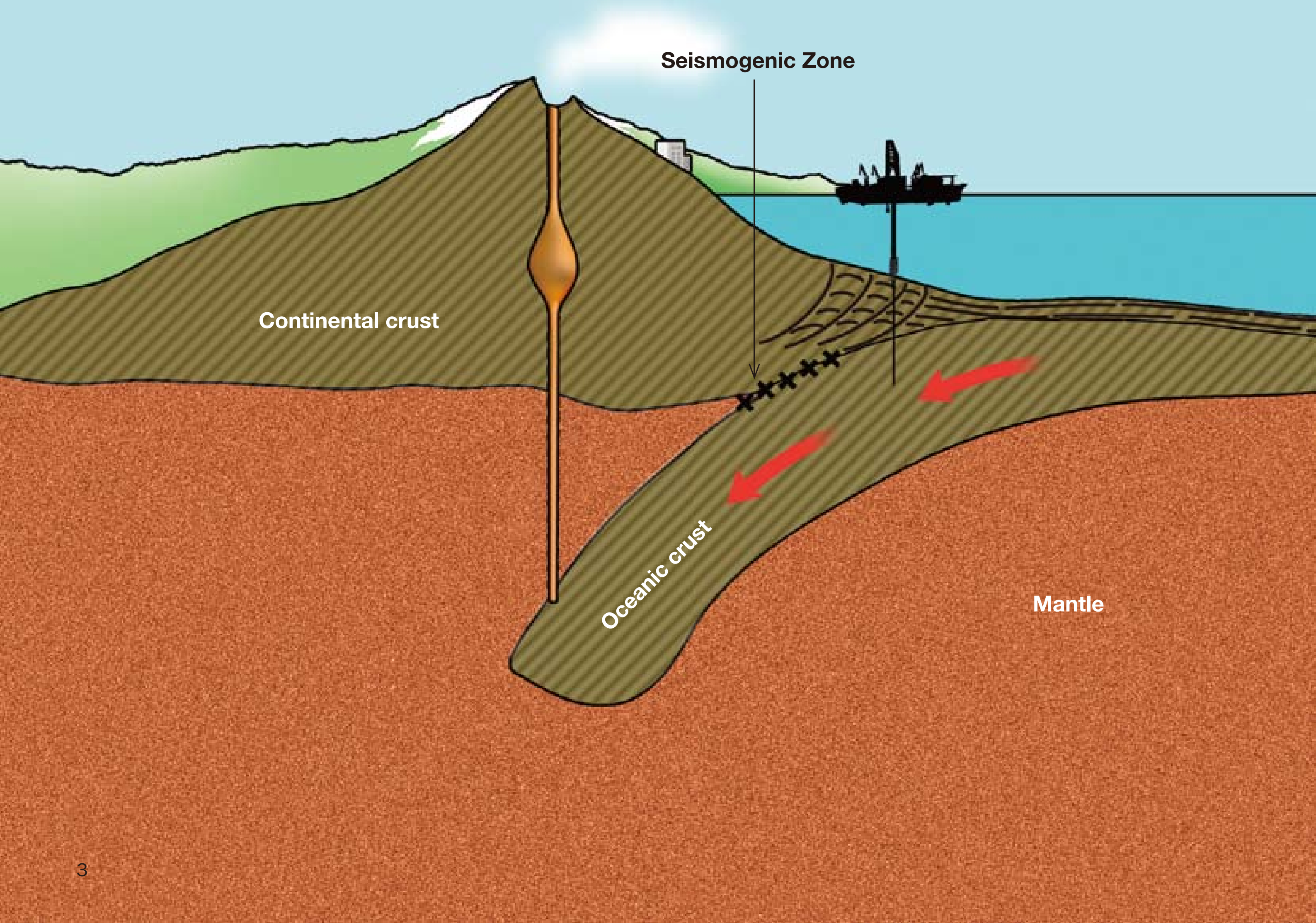

# The Future of the Earth, Opened through Deep Ocean Drilling

**The Integrated Ocean Drilling Program (IODP) is an international joint research program comprising 24 participant countries that aims to create new information on geoscience through deep ocean drilling. The three ships of IODP—The *Chikyu* of Japan, *JOIDES Resolution* of the United States, and *Mission Specific Platform* of Europe each did excellent work in making 2009 a landmark year.**

# The World Joins Hands to Dig Deep Below the Sea Floor IODP: a Global Exploration Science Project

**To dig to the earth's mantle: This is the dream that the 24 participant countries of the Integrated Ocean Drilling Program (IODP) are working to realize. What kind of program is the IODP? See the big picture here.**

Prof. Kiyoshi Suyehiro, IODP-MI President &CEO. Having served as a professor in the Ocean Research Institute of the University of Tokyo and an executive director of Japan Agency for Marine-Earth Science and Technology [JAMSTEC], he has been in his current position since May 2009. He is a Doctor of Science specializing in marine seismology and long-term borehole observation.



Students wishing to study the ocean flock to the Tokyo University of Marine Science and Technology's Ecchujima Campus, which also hosts the offices of IODP-MI. "IODP" stands for Integrated Ocean Drilling Program, and "MI" stands for Management International, Inc.

"The IODP-MI is an organization that functions as a kind of coordinator in running the IODP project. With staff numbering between 10 and 20, our offices were divided between Sapporo and Washington, DC until last year, but we were just recently combined into one office in Tokyo," explains Prof. Kiyoshi Suyehiro, who himself just became IODP-MI President in May 2009.

He adds that IODP is a marine scientific drilling project in which 24 countries currently participate, and which is drilling in seas around the world on a schedule that extends until 2013. But when and how did the concept of drilling in the ocean for research begin? Prof. Suyehiro begins his answer while showing us an article from an old magazine.

### The Beginning of the Dream

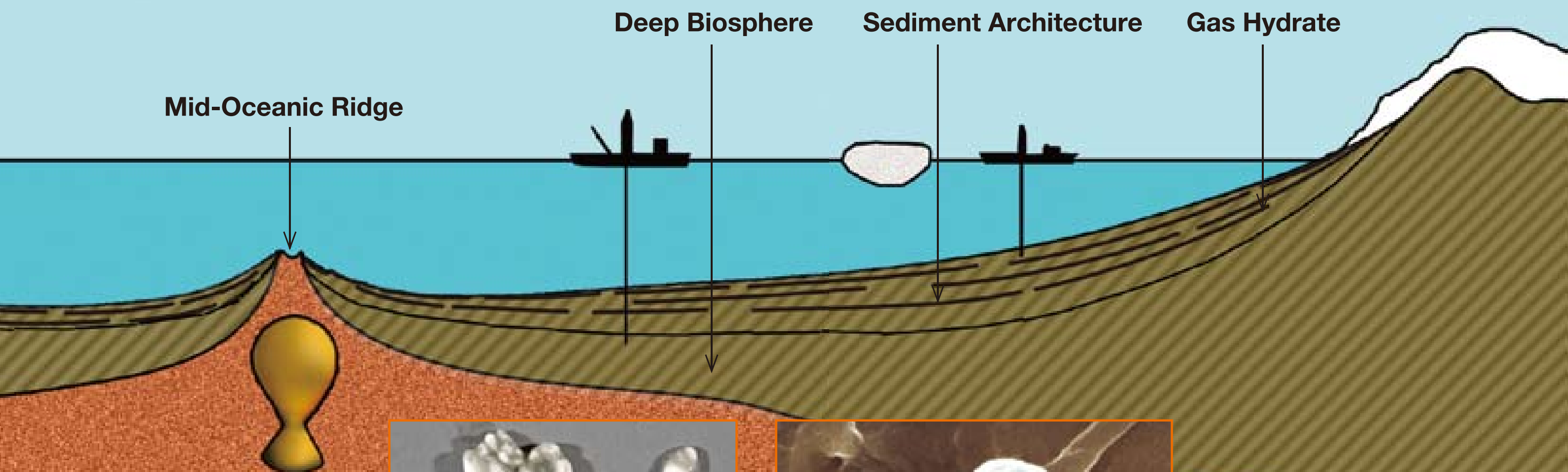
The dream began in the United States in 1958 with Project Mohole, a plan to drill down to the Mohorovičić Discontinuity (the border zone between the earth's crust and mantle). It was the height of the Cold War, and reaching the mantle first was an achievement then considered on par with being first to reach the moon. People therefore had a strong sense of competitive awareness.

To reach the mantle, scientists reasoned, it would be better to drill from the sea floor, where the earth's crust is thinner than on land. In 1961, Project Mohole successfully performed the first deep-sea drilling in waters 3,800-meters deep in the seas off California. The drilling garnered significant attention in the US: a Life magazine article written by John Steinbeck was acknowledged by President Kennedy who sent his congratulations.

However, the project suffered from insufficient funding and was suspended in 1966.

Attempts at deep-sea drilling continued in U.S.A., though. In the same year, 1966, the four US ocean-

**IODP scientific themes of deep-sea drilling are to shed light on: global environmental changes, the internal structure of the earth, and the deep biosphere inside the Earth's crust. From these, Japanese researchers have set Japan's goals and points of focus as follows: To study the mantle and crust, elucidate global changes due to cycling of lithosphere within subduction zones, and further, to successfully explore the deep biosphere and carry out long-term observations inside boreholes.**





**Gas hydrates**

Gaseous molecules such as methane that have become surrounded by water molecules and crystallized amid a high-pressure, low-temperature environment. Methane gas hydrates have the possibility of becoming a future energy source.

IODP/USIO

**Microorganisms in the deep earth**

A previously unimaginable biosphere exists deep beneath the surface of the earth. This photograph shows one species of ancient bacteria sampled from the sediments, which is collected during a *Chikyu* expedition. Deep-sea drilling may lead to better understanding of methane-producing bacteria, as well as key to the origin of life.

Fumio Inagaki

ographic institutions formed the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES). That organization began the Deep Sea Drilling Project (DSDP), which became an international endeavor as five other countries such as Japan joined starting in 1975. With the conclusion of the DSDP in 1983, 18 US oceanographic institutions joined as the Joint Oceanographic Institutions (JOI) to begin the new international Ocean Drilling Program (ODP). 21 countries, including Japan, participated in the ODP, which continued until 2003.

With contributions to create the theory of plate tectonics, the DSDP and ODP touched off nothing short of a revolution in earth science. However, the deepest either of the projects drilled was 2,111 meters below the sea floor. The dream of reaching the mantle remained far away.

### Birth of the IODP

A half-century after Project Mohole, IODP is getting ever closer to that dream. Two main factors resulted in formation of the new deep-sea drilling project, IODP. One was that in the 1990s, the United States was looking for a post-ODP framework. The other was that momentum was gaining for construction of a riser drilling vessel in Japan.

"Without these two factors, I think oceanographic drilling projects would have finished with the ODP," opines Prof. Suyehiro.

In 1994, the Japanese government revealed "OD21 (Ocean Drilling in the 21st century)," outlining that it would construct a riser drilling vessel capable of reaching the mantle and provide that vessel to an international drilling project. With that, the ODP created a special committee in conjunction with OD21. Following several international symposiums with researchers, the committee created a scientific plan containing specific goals and operational methods, etc. in 2001.

In April 2003, the US's National Science Foundation (NSF) and the Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) signed a memorandum of understanding. On October 1 of the same year, the IODP was launched.

### First Three-ship Fleet System

Let us take a look at the current organization of the IODP, which includes 24 participant countries.

Fundamentally, the system consists of the United States and Japan taking the main initiative as Europe handles certain important aspects of the project.

In addition, as seen with IODP-MI President Prof. Suyehiro's credentials as a seismologist and expert in down hole measurement, each organization is headed by a current or former scientist. The guiding principle is that researchers take the initiative.

However, the most prominent feature of the project is that it is the first scientific drilling project to employ multiple ships—actually a fleet of three—in its activities. Japan, the United States, and Europe each provide one vessel (see pages 7-8). With the three-ship fleet that includes the Japanese riser drilling vessel *Chikyu*, the drilling capability of the IODP is significantly larger than that of the ODP.

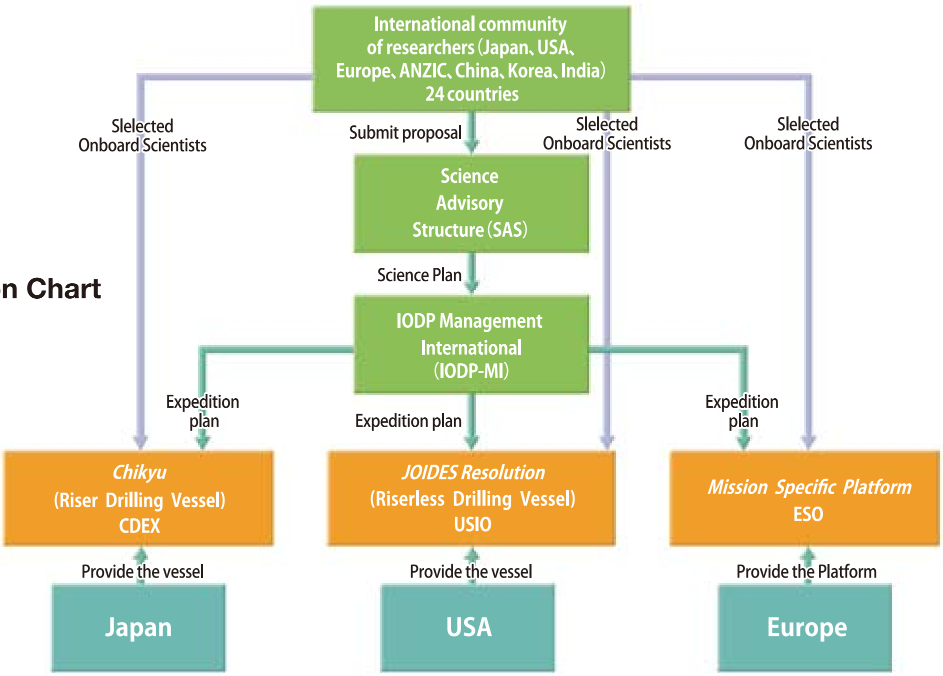
Prof. Toshitsugu Yamazaki, who studies paleomagnetism at AIST, serves as Chairman of the IODP Section at J-DESC

### A Research Clearinghouse

The scientific communities of each participating country send researchers on IODP drilling activities, which are called "expeditions." In the case of Japan, the Japan Drilling Earth Science Consortium (J-DESC) handles this function.

"J-DESC is an organization with 52 participating universities and research institutions, and its IODP subcommittee provides expedition support for researchers. The researchers themselves submit drilling proposals directly to the IODP Science Advisory Structure (SAS), but J-DESC supports workshops that help to clarify strategy as it strives to help Japanese researchers make the best drilling proposals they can. J-DESC also performs the function of recommending Japanese

## IODP Organization Chart



researchers, who wish to get aboard the expedition, to the Center for Deep Earth Exploration (CDEX) in Japan, US Implementing Organization (USIO), or ECORD Science Operator (ESO) in Europe, which are the respective IODP implementing organizations for those countries."

As Prof. Toshitsugu Yamazaki, chairman of the J-DESC IODP subcommittee and a scientist from the National Institute of Advanced Industrial Science and Technology (AIST) explains above, research deemed meaningful and in line with the IODP scientific plan by the SAS leads to actual drilling. In addition, any researcher belonging to a research institution in a participating country is eligible to join in expeditions. Indeed, the door is wide open.

## Groundbreaking Discoveries

In the six years since its launch, IODP has carried out 25 expeditions (as of March, 31 2010). Last year marked the first time when all three ships from Japan, the United States, and Europe operated simultaneously. However, the high price of oil prevented all of the vessels from operating to full potential.

"The IODP has used large budgets during its existence. We aim to make further groundbreaking discoveries as a way of gaining the understanding of citizens in each participating country," comments Prof. Suyehiro.

The project is making good on that goal. In 2004, the Arctic coring expedition led to the discovery of a warm climatic era in the Arctic some 56 million years ago, and drilling in the Nankai Trough (NanTroSEIZE) has revealed gravity faults that cause tsunamis. However, Prof. Suyehiro remains dedicated to the dream of reaching the mantle from the *Chikyu*.

"The *Chikyu* is currently putting all its effort into drilling in seismogenic zones. Last year we began discussing the next 10 years for the IODP, and I want the main goal to be reaching the mantle. It will be the greatest scientific achievement, and is certain to be the groundbreaking event that will yield further discoveries."

The dream goes on. ■

**The *Chikyu*, *JOIDES Resolution*, and *Mission Specific Platform* Researchers on the three ships of the IODP take on the challenge of finding new earth science discoveries**

***Chikyu***

Left: Dr. Yuzuru Yamamoto and Dr. Huaichun Wu observe a core
Right: Dr. Sasha Labanieh, dressed in a jumpsuit
(Both on Expedition 322)

***JOIDES Resolution***

Carlos Alvarez Zarikian, IODP/TAMU

John Beck, IODP/TAMU

Left: Dr. Christina Ravelo (Left: Co-Chief Scientist) and Dr. Alan Mix holding a core on Expedition 323
Right: Removing pore water from core samples on Expedition 321

***Mission Specific Platform***

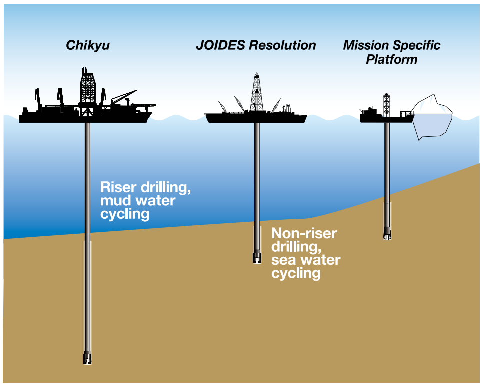
@ECORD-IODP

Hisao Ando

Left: Researchers are suspended from a crane as they are brought on board Kayd from a support ship during drilling off the coast of New Jersey (Expedition313)
Right: Discussion during the onshore party held at the University of Bremen. At center is Dr. Ando, who participated in Expedition 313 (see page 8).

# The *Chikyu*, *JOIDES Resolution*, and *Mission Specific Platform*: The Three Ships of IODP

**Ocean drilling ships for scientific purposes began with *CUSS-1* of Project Mohole, continued with *Glomar Challenger* of the DSDP and *JOIDES Resolution* of the ODP. Two new platforms — one each from Japan and Europe — now join that illustrious history with the launch of the Integrated Ocean Drilling Program (IODP).**




Using each ship's strengths, depending on drilling purpose

## The *Chikyu* takes on the "mantle" of expectations

The *Chikyu* was completed in 2005, having been constructed to achieve the scientific dream of drilling to the earth's mantle. Its most prominent feature is that it is a riser drilling vessel. The drilling system uses a closed loop drilling mud cycling system, so that when drilling reaches 7,000m meters below the sea floor, a mud cycling system protects the drill bit from the high temperatures found that far underground and maintains pressure to prevent the hole from collapsing.

Her size is astounding: The derrick that lowers her drill from the surface of the sea towers a lofty 120 meters, and her four-story laboratory boasts a research lab to be easily be mistaken for a land facility. The laboratory is fully equipped with the latest in analytical devices, including a CT scanner, as well as other advanced research equipment. The *Chikyu*'s first IODP expedition began in September 2007. Since then, she has completed five drilling expeditions in the Nankai Trough Seismogenic Zone. In 2009, she succeeded in performing the first-ever scientific deep-ocean riser drilling.

## The *JOIDES Resolution*, or "*JR*": a ship of history and achievement

Well known among veteran researchers, the *JOIDES Resolution* has been sailing since 1985, the first year of the Ocean Drilling Program (ODP).

The name JOIDES is an abbreviation for the organization Joint Oceanographic Institutions for Deep Earth Sampling, which was responsible for the scientific planning the Deep Sea Drilling Project (DSDP) following the end of Project Mohole in 1966. With an unchanging "resolution" to perform deep ocean drilling, she continues to work for the IODP.

Having performed 16 out of 25 total IODP expeditions, *JR* was retrofitted with new laboratories and living quaters in early 2007-2008 and returned to sea in January 2009. Prof. Toshitsugu Yamazaki (please see P. 5) of the National Institute of Advanced Industrial Science and Technology (AIST) was on board

***Chikyu***

| | |
|---|---|
| Implementing Organization : | The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) |
| Drilling system : | Riser drilling system, riserless drilling system |
| Launched : | 2002 (Completed 2005) |
| Gross Tonnage : | 56,752t |
| Length : | 210m |
| Width : | 38m |
| Depth : | 16.2m |
| Drill string length : | 10,000m |
| Derrick height : | 70m |
| Maximum suspension weight : | 1250t |
| Crew capacity : | 200 persons (planned) |

***JOIDES Resolution***

| | |
|---|---|
| Implementing Organization | United States Implementing Organization (USIO) |
| Drilling system | Riserless drilling system |
| Launched | 1978 (Large-scale overhauls in 1984 and 2008) |
| Gross Tonnage | 9,589t |
| Length | 143m |
| Width | 21m |
| Depth | 9.6m |
| Maximum speed | 10.5 knots |
| Drill Strings | 9,150m |
| Derrick height | 62m |
| Maximum suspension weight | 545t |
| Crew capacity | 135 persons |

IODP/TAMU

for her first research expedition following the refit. “Crew quarters went from housing four people to two, and since you share a room with someone on an opposite 12-hour shift, each person essentially has their own room. The cafeteria got a lot brighter, and the laboratory floor space grew by about 50 percent. Experimental equipment has also been organized in order of core flow, making research much more convenient.”

It sounds like researchers have given the overhaul a big “thumbs up.”

## Taking on shallow and frozen seas: The *Mission Specific Platform (MSP)*

When drilling in places where the *Chikyu* and *JOIDES Resolution* can’t go, such as shallow or frozen seas, the IODP charters the *Mission Specific Platform (MSP)* from Europe.

For Arctic drilling, three icebreakers were dispatched: The *Vider Viking* performed the actual drilling, while the *Sovetskiy Soyuz* and the *Oden* kept the sites ice free. For the first marine drilling of a shelf-margin coral reef, performed in Tahiti, the renovated diving support operation ship *DP Hunter* was chartered. Recently, drilling by a jack-up rig vessel called the *Kayd*, which places three legs on the sea floor, photograph at right, was performed in the shallow, 40-meter deep seas that extend more than hundred kilometers off the coast of New Jersey.

None of these ships is a true scientific drilling vessel, so sampling and other scientific work is performed on land at the University of Bremen in Germany. European countries are considering the construction of an icebreaker class drilling vessel.

E. Gillespie © ECORD/IODP

***Mission Specific Platform***

| | |
|---|---|
| Implementing Organization | ECORD Science Operator (ESO) |
| Drilling system | Riserless drilling system |

Prof. Ando of Ibaraki University speaks about the *MSP* onshore party. His specialties are sedimentology and paleontology.

Samples from the shallow seas off New Jersey, mixed with shells and other material. Researchers first examine cores with the naked eye, recording data in core description charts.

## *MSP* onshore party

Researchers on the *Chikyu* and *JOIDES Resolution* perform onboard initial analysis and measurement, and on collected cores, sending immediate science reports to shore. However, in cases where a vessel is not sufficiently equipped with analytical equipment, onshore parties are organized to carry out sample extraction and analysis a few months later at land facilities, as a continuation of initial scientific results. For example, in the shallow-sea drilling off New Jersey researchers gathered at the University of Bremen six months after the expedition concluded, as an onshore *MSP* science party.

“We compiled core sample analysis records pulling 12-hour shifts for a month straight. It was tiring. But when we cut the last core, the head researcher played “Also sprach *Zarathustra*” and gave a wonderful speech. It was a great atmosphere, and the systematic way of doing the work taught me a lot,” reflects participant Prof. Hisao Ando of the Ibaraki University College of Science. IODP provides researchers not only with core samples and data, but also excellent opportunities for intellectual exchange.

# Mud: The Magic Potion that Makes Riser Drilling Possible

**It is impossible to talk about riser drilling without mentioning mud. Here is how this "magic potion" has solved the difficulties of deep sea drilling.**

Top: Mud, created by adding various materials to sea water. This photo depicts mud that has been circulated back aboard.
Center: Circulated mud is run through a screen, by which cuttings are gathered.
Bottom: Cuttings separated out from the mud. These are eventually carried to the laboratory, where they are studied by researchers.

## Mud has multi function

In riser drilling, a special liquid is circulated through the drill pipe and back up the riser pipe, carrying cuttings out of the hole. This liquid is called "mud."

Mud expert Kenichi Kubo of the CDEX Operations Department explains "Not only the *Chikyu*, but any other drilling operation faces an array of potential problems. 'Kick,' where gases or other materials from the geologic layers flow into borehole, 'lost circulation,' where the mud is lost by leakage into a layer, 'caving,' where the hole being drilled collapses and 'stuck pipe,' where the drill pipe is not controllable—these are some of the typical troubles we experience. Mud is used partially as a way to prevent these problems."

This means that mud needs to control flow of material like gas or other liquid from geologic layers, protect and stabilize drilling holes, and ensure lubricity. Therefore, mud is carefully formulated to achieve physical properties such as a certain specific gravity, viscosity, and filtration properties, as well as chemical properties such as alkalinity and salinity. "Further, drilling with the *Chikyu* is done in deep enough water that we have to take into account the near-zero temperatures found near the sea floor."

## Mud prepared on board

Mud is prepared from liquids such as water and oil, then mixed with a variety of other materials. Mud used on the *Chikyu* is prepared with fresh or sea water that is mixed with liquid and powdered materials on board and at the quantity needed for each occasion. Freshly mixed mud is pumped down through the drill pipe, then returns back up through the riser pipe. Mud that has returned is then carefully adjusted to required properties and again pumped down through the drill pipe.

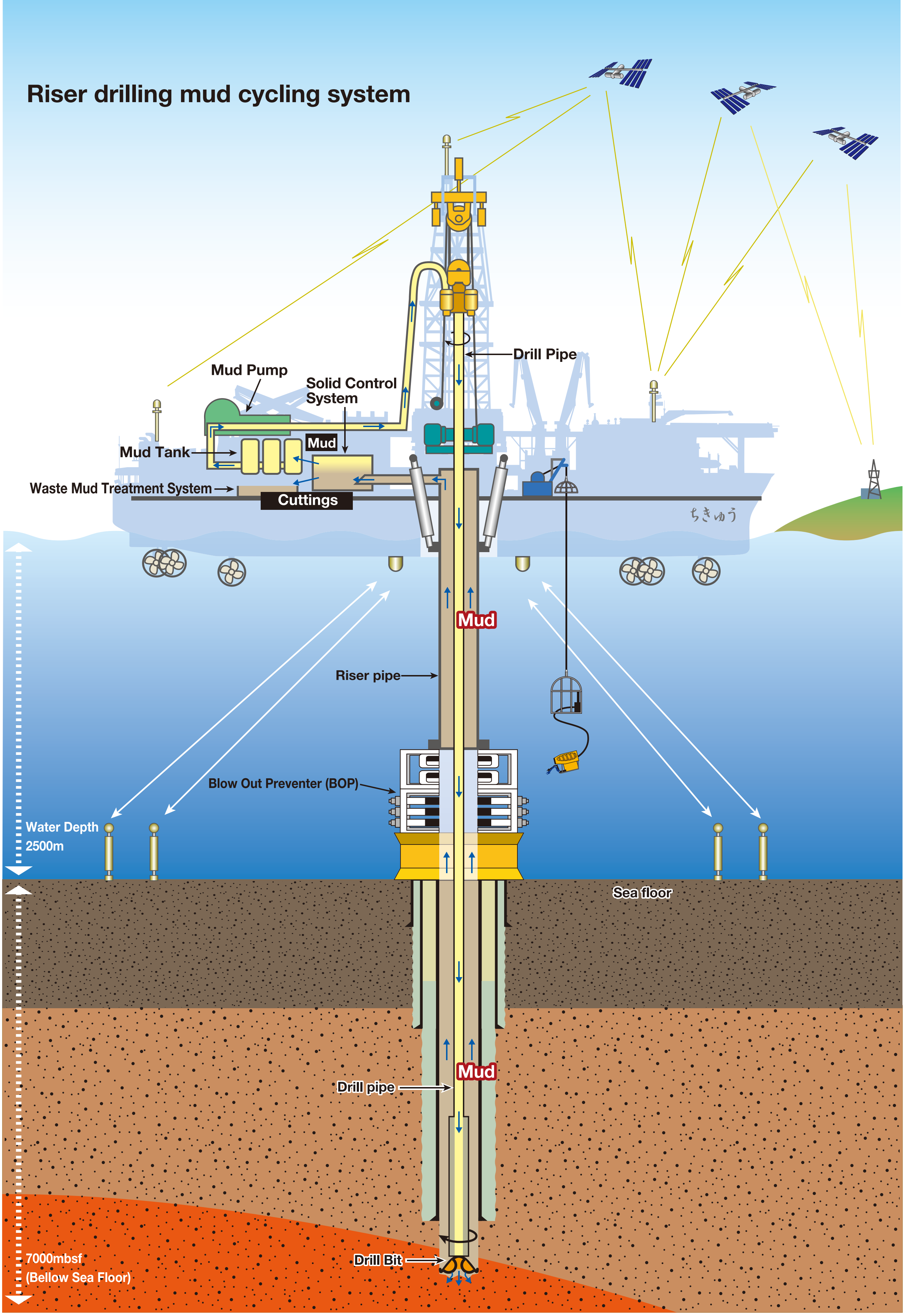
Experts known as "mud engineers" continue to confirm mud throughout the circulation process, monitoring its properties and the conditions of the cuttings it brings aboard. On a research expedition last year, engineers used mud formulated with potassium chloride, sodium chloride, and several polymer compounds. It was able to maintain hole stability and handle the very low temperature. "It was an excellent water-based mud."

## The *Chikyu* mud system is environmentally friendly

The mud circulating system on the *Chikyu* includes equipment to separate cuttings and remove gases, sand, and even finer material from mud that has come back aboard, as well as facilities to store mud and related wastes. In addition, mud and cuttings are never released back into the ocean, thanks to processing equipment on the *Chikyu* that allows all materials to be transported to land.

Though its name is simple, the mud and accompanying system on the *Chikyu* are an environmentally friendly and highly valued concentration of technology and expertise.

In order for the *Chikyu* to attempt drilling down to the earth's mantle, it will need mud that can withstand high temperatures—up to 300°C—found at such depths. It is necessary to develop mud for that day which has stable properties and can withstand ultra-high temperatures. ■




Top: Mud is pumped down to the sea floor by pressure from a tank on board the *Chikyu*, then returning up to the ship through the inside of the riser pipe
Bottom: Various materials used in mud. These include materials for adjusting viscosity, specific gravity, pH (alkalinity), and other properties.

# To Learn about the Crustal Stress that Causes Large Earthquakes

**A stress state normal fault regime in the Nankai Trough?!**
**New discoveries and possibilities, gained through detailed research of core samples obtained on the IODP NanTroSEIZE drilling expeditions**

Interview● **Dr. Weiren Lin**
of Kochi Institute for Core Sample research,
Japan Agency for Marine-Earth Science
and Technology (JAMSTEC)

"The Nankai Trough is where the Philippine sea plate subducts under the Eurasian plate. That is why we assumed that the maximum principal stress would be in the same direction as the plates are pressing against one another. However, stress measurements from cores obtained there gave us unexpected results," explains Dr. Weiren Lin at Kochi Institute for Core Sample Research, who participated in Expedition 319 of the Integrated Ocean Drilling Program (IODP) and studied in situ stress state in the Nankai Trough.

"Stress" refers to the force that occurs inside a solid body as a result of external pressure. "Pressure" is an easily understood term, but because the phenomenon includes both the magnitude and direction of forces occurring inside underground rock, the term "stress" is used to express the difference.

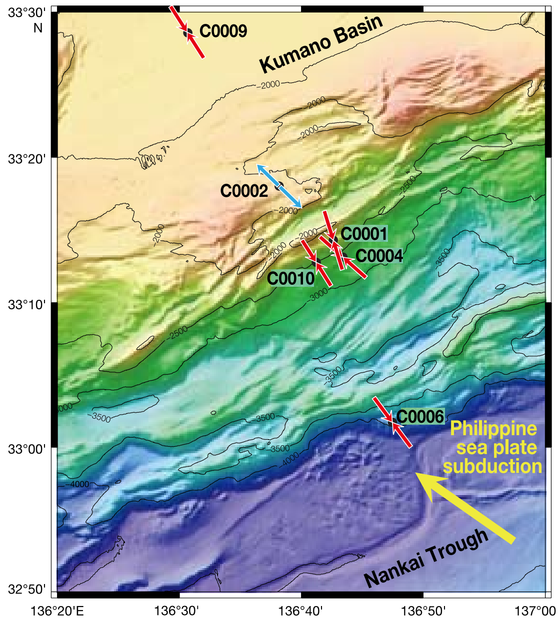
Measuring in situ stress by using cores is a hard work. "After all, the stress occurring in underground rock is released instantly as we take the sample. But the stress does leave an imprint, which we are able to measure." The "imprint" refers to strain in the rock attributable to stress, a phenomenon known as Anelastic Strain Recovery (ASR) in which time-dependent strain releases through days and weeks after removing the cores. The amount of this time-dependent strain is small, but precise measurement allows an accurate determination.

Dr. Byrne, University of Connecticut, Dr. Lin and the other researchers found from data obtained this way that the maximum stress at Site C0002 was apparently in a near vertical direction. When seen horizontally, the maximum stress is not in the direction where the plates push against each other but in a direction nearly at right angles to it. This is consistent with observations of borehole.

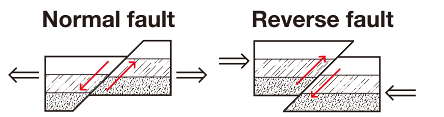
"In other words, the Nankai Trough area is convergence margin which is dominated by "reverse faults", that location above the mega-splay reverse fault was instead normal faults. This discovery amazed everyone." Dr. Lin explained that in computational models, normal faults such as the one found at the site can occur under special conditions—namely, when resistance to fault slip is very low. He continued, "To offer a somewhat bold theory, it might be that because that particular location in the Nankai Trough has little friction between the fault blocks and slip becomes very pronounced when an earthquake does occur, resulting in big ruptures and large tsunamis."

The Showa Nankai Earthquake in 1946 caused large-scale tsunami damage, and this new theory may explain the mechanism that caused that event. However, Dr. Lin points out that a final conclusion will require further research at the next stage of the experiment, penetrating into the mega-splay fault and the plate boundary. He looks forward to further developments that will next drilling expedition. ■

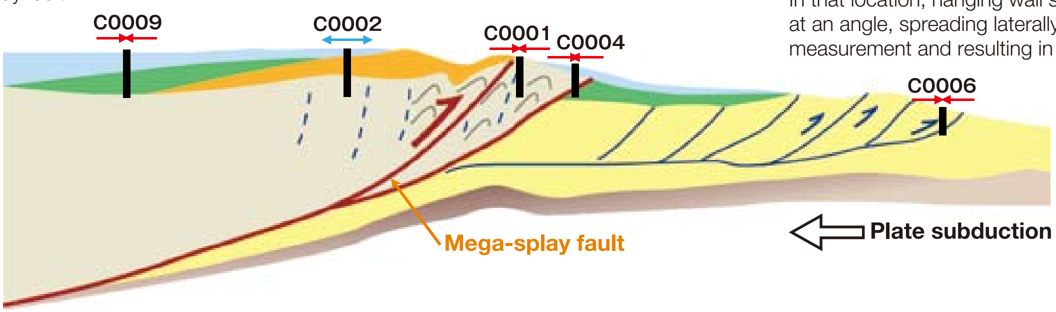
Attaching strain measurement sensors to measure ASR in nine directions in a core sample
(Jointly performed with Dr. Byrne of University of Connecticut and others)




Right: Drilling sites in the seas off the Kii Peninsula and the horizontal stress direction below the sea floor there. Site C0002 shows extension.
Below: The geological structure in NW-SE section below each drilling site. Site C0002 lies directly above a mega-splay fault.




Faults are discrete surfaces separating two rock masses, but their slip direction depend on orientation stress. In the Nankai Trough, normal faults were found that differed from a reverse fault at a mega-splay fault. In that location, hanging wall slipped down at an angle, spreading laterally at the point of measurement and resulting in horizontal extension.



# Laboratory Technicians: All for High-quality Samples and Data

**From the operation and maintenance of the latest analytical equipment to the management and supply of such essential items as work clothing and ballpoint pens, this group of experts is there to support researchers aboard the *Chikyu*. Lab technicians find their greatest joy in obtaining high-quality samples and data that lead to excellent research.**

Around 20 laboratory technicians are on board during each *Chikyu* expedition. Their profession is one that people rarely hear about, so let us take a closer look at exactly what they do. We spoke to Hiroaki Muraki, Lab officer in charge of the 20 technicians at Marine Works Japan.

"First, our job on the *Chikyu* entails guiding researchers in the laboratory, explaining points of caution as well as methods for using equipment. When onboard researchers are not used to using analytical equipment, we explain to them from the ground up about how to make an analysis.

When drilling commences and core samples begin to come up, things get very busy, very fast.

"First we cut the cores into several sections, and then analyze them by CT scan. After this, we measure things like density and natural gamma rays using a multi-sensor core logger. The next steps are to cut the cores in half, photograph and measure their surface color spectrum, and then refrigerate them. It is a continuous process that cannot be stopped mid-process."

Day or night, as long as specimens are coming up, the work goes on. Work schedules consist of 12-hour shifts beginning at noon and midnight. Even when drilling stops, the operation of analytical equipment, their repair and maintenance as well as detailed tasks such as the supply of work clothing, paper and pens, etc. remain. Mr. Muraki commented that the lab technicians spend four continuous weeks at sea followed by four weeks on land. "I personally spend about 150 days a year on the ship."

Sometimes, lab technicians also come face-to-face with danger.

"We have sensors in the core-receiving area that detect a variety of gases, and we even wear hydrogen sulfide sensors on our arms. Hydrogen sulfide is detectable by its smell, but the nose cannot determine immediately when too much gas is present. It is dangerous to simply rely on our noses."

Most of the lab technicians are certified in X-ray operations and radiation handling, and all "have the prerequisite electronics skill to be able to change circuit boards in electronic devices."

So what part of their work makes them happy? "Data quality depends greatly on the support of technicians, so I feel happiest when we gather good data, on schedule, which are then used by researchers in their papers." ■

Busy lab technicians take newly retrieved cores directly to the laboratory, dividing them (upper left) and using the multi-sensor core logger to study density, natural gamma rays, magnetic susceptibility and more (lower right).

The CT scanner on board the *Chikyu*—the first of its kind to be installed on a scientific drilling vessel and an indispensable tool for lab technicians in core analysis—has the same functions as a medical CT scanner.

# Visiting the *Chikyu* at Shimizu Port

**An on-board school for young researchers, teachers, and museum staff, a parent-child tour where families learn together, and an open house. Here is a report of the three public events held on the *Chikyu* as it harbored in Shimizu Port from January to March, 2010.**

## On-board School

CDEX held an on-board school for young researchers and high school teachers, etc. in four sessions across January and February. Classes for teachers and museum staff were themed on creating materials for use in the classroom, and included programs where participants could experience research aboard the *Chikyu*. Amazed at the dynamic riser system on the drilling floor, attendees used core samples to work on creating reports as they experienced scientific operations just as on-board researchers do.

"Now we can confidently answer our students when they ask about life on the *Chikyu*." It is exciting to consider how and in what kinds of classes teachers will utilize their invaluable experiences aboard the *Chikyu*.

Left/ Observing microscopic fossils with an electronic microscope
Right/ Mr. Yasushi Obi of Sagamihara-Seiryo high school, who participated in core sampling, remarked "I hope to use what I have learned on the ship in teaching my students."

## Parent-child Tours

(Held by the School of Marine Science and Technology, Tokai University on February 27)

Twenty selected sets of parents and their children toured the inside of the *Chikyu*, viewed foraminifer fossils on microscopes, and thoroughly enjoyed a rare opportunity to spend time on the *Chikyu*. Some of the comments from the children: "The experiment where we looked at fossils in microscopes on the ship was fun;" "I was able to see really well what the sea floor is like." We hope this experience helped to spark an interest in science among the children.

## Open Ship

(March 6-7)

This marked the 12th open house on the *Chikyu* since its launch in 2005. Both days of the event were marred by rain, yet more than 8,000 visitors came aboard the *Chikyu*. A port call commemorative symposium entitled "Earthquake and Disaster *Chikyu* Symposium in Shimizu: The *Chikyu* and Front Lines of Seismology" was held simultaneously as well, garnering many attendees from the general public.

# The *Chikyu*'s Scientific Drilling Takes on New Challenges

**CDEX Director General Wataru Azuma gives his outlook**

The *Chikyu* expedition schedule is getting firm for fiscal 2010 and beyond. After docking until the end of May for scheduled inspections, we look to sail on an Integrated Ocean Drilling Program (IODP) expedition to the Nankai and Okinawa trough, and the seas off the Shimokita Peninsula. The Shimokita expedition plan will drill 2,500 meters below the sea floor in 1,000- to 1,200-meter-deep waters, with the purpose of studying how such microscopic organisms as methane-producing bacteria grow in the lignite geologic layer. This research relates to $CO_2$ sequestration in geologic layers, a technology developed in recent years. We feel that the expedition will provide basic information about the process by which these organisms transform $CO_2$ into methane.

Stage 3 of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) will include the preparation of a riser top-hole, installing for long-term hole observatory and other preparatory measurement experiments. As the first full-fledged drilling in the strong Kuroshio Current, it will be challenging in terms of drilling technology. We expect it to be the first research expedition of Stage 3 in the NanTroSEIZE, wherein we will finally drill down to the mega-splay faults and the plate boundary fault part of seisomogenic zone.

In the seas off Okinawa, the *Chikyu* will study microscopic organisms living under sea-floor hydrothermal deposits. I like to think of this as a deep-sea microscopic organism incubation experiment, since we will drill a hole—essentially a large test tube—and place several varieties of microscopic organisms inside.

After these IODP expeditions, the *Chikyu* may set sail on non-IODP expeditions, so research expeditions will be on hold for a short time. However, we expect that the five months following that will be spent entirely on riser drilling in the Nankai Trough. Our mission at that time will be to drill to directly above the mega-splay fault and secure a foothold for drilling into the seismogenic zone below.

## Toward a New Stage

We are currently at the threshold of Stage 3 of the NanTroSEIZE. In terms of drilling targets, we have reached as far down as faults located where plates begin to subduct and the shallow portions of mega-splay fault layers, meaning we are on the cusp of drilling to the depths where earthquakes occur—seismogenic zones. We are confident that we can achieve the initial goals of the IODP by fiscal 2013, which is that program's final year.

Following 2013, the monumental plan of drilling down to the earth's mantle awaits. Studies are already underway regarding activities for the *Chikyu* in the next ten years, but if the mission is indeed to drill to the mantle, it will require not only scientific, but drilling engineering and operations planning as well. Managing these three important aspects is an important task for us.

Scientific drilling by the *Chikyu* is a massive research project that is only possible through large-scale funding by the governments. In order to obtain the understanding and interest of the general public, we hope to continue research not only of a basic scientific nature, but also in pursuit of problem-solving research that contributes to society in areas such as disaster prevention and global warming countermeasures.

We hope that you are as excited as we are about the future results of scientific drilling by the *Chikyu*. ■

C L O S E U P

## Viewing Mount Fuji from the *Chikyu*

After concluding her expeditions for 2009, the *Chikyu* dropped anchor at the Port of Shimizu in Shizuoka Prefecture. Situated on the south side of the port is *Mihono Matsubara*, a place with white sands and green pines that affords a beautiful view of Mount Fuji. With the *Chikyu* harbored at the port, her heli-copter deck offered a stunning view of the mountain. At the same time, with her tower rising high above and visible from various locations throughout the Shimizu area, the *Chikyu* actually competed quite well with Mount Fuji as an impressive presence during her port call.

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