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CHIKYU 地球 HAKKEN 発見

EARTH DISCOVERY

NanTroSEIZE Stage 2

The *Chikyu* Succeeds in the First Riser Drilling in the Nankai Trough Off the Kii Peninsula!

SPECIAL TOPIC 1:
IODP Expedition 319

New Possibilities Created by the Success of Riser Drilling

SPECIAL TOPIC 2:
IODP Expedition 322

Another Step toward Understanding Large Earthquakes and the Formation of the Accretionary Wedge

March 2010
Volume
8

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Deep Sea Drilling Vessel

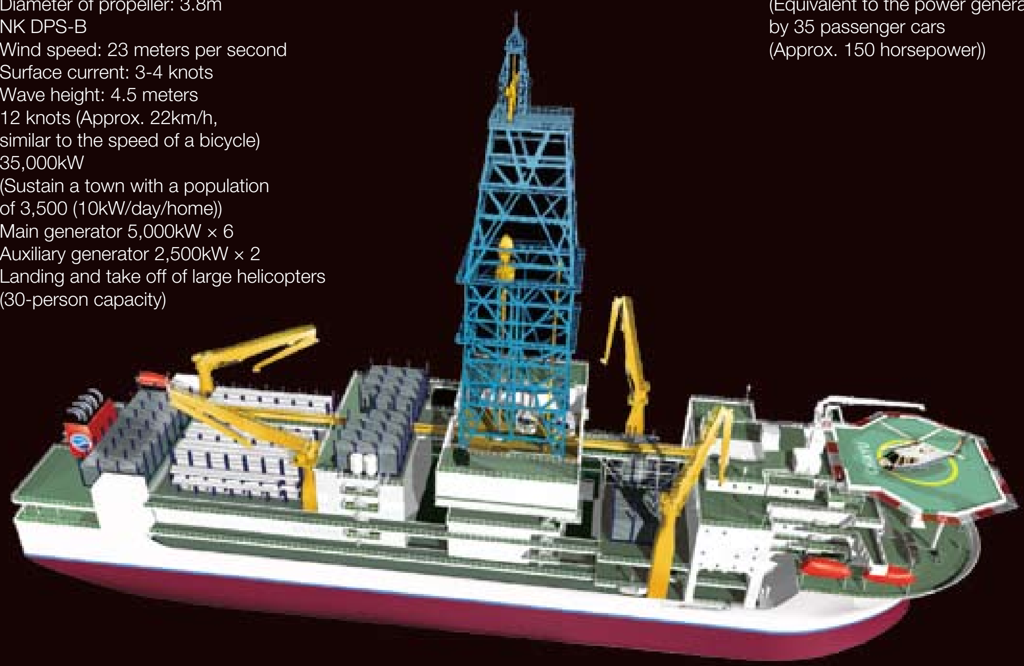
The *Chikyu*

General Data

Class	NK (Nippon Kaiji Kyokai)
Navigation area	Ocean going area (Worldwide)
Length	210m (Approx. eight SHINKANSEN cars)
Breadth	38.0m (The width of a futsal court)
Height (from the ship's bottom)	130m (A building with 30 floors)
Depth	16.2m (Approx. three times deeper than a pool)
Draft	9.2m
Gross tonnage	Approx.57,087 tons
Range	Approx.14,800 nautical miles (Full load condition, 10 knots) Approx. 27,410km (More than half the circumference of the earth: The earth's circumference is 40,000km)
Complement	150 people (Crew: 100, Scientists: 50)
Propulsion system	Side thruster 2,550kW (3,470PS) × 1 (The bow) Azimuth thruster 4,100kW (5,710PS) × 3 (The bow), 3 (The stern) Diameter of propeller: 3.8m
DPS	NK DPS-B Wind speed: 23 meters per second Surface current: 3-4 knots Wave height: 4.5 meters
Max cruising speed	12 knots (Approx. 22km/h, similar to the speed of a bicycle)
Generator	35,000kW (Sustain a town with a population of 3,500 (10kW/day/home)) Main generator 5,000kW × 6 Auxiliary generator 2,500kW × 2
Helicopter deck	Landing and take off of large helicopters (30-person capacity)

Drilling Data

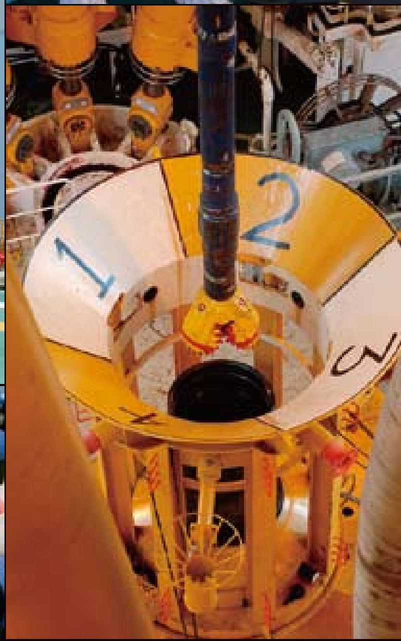
Drilling System	Riser drilling system, Riser-less drilling system
Max water depth	2,500m (Riser drilling)
Length of drill string	10,000m (Approx. three times the height of Mt. Fuji)
Blow-Out Preventer	Weight 380 tons Height 14.5m Pressure 103MPa
Riser pipe	Length 27m (each) Diameter approx. 50cm
Drill pipe	Length 9.5m (each) Diameter Approx. 14cm
Derrick	Height 70.1m Width 18.3m Length 21.9m Hanging capacity 1,250 tons
Moon pool	12m x 22m
Draw works	Lifting capacity 1,250 tons 5,000 horsepower (3,728kW) (Equivalent to the power generated by 35 passenger cars (Approx. 150 horsepower))











NanTroSEIZE Stage 2

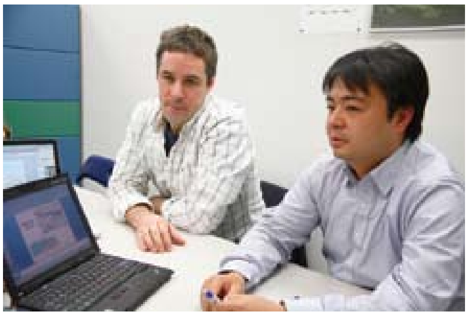
Success!

The Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) is a massive undertaking aimed at drilling directly into seismogenic zones to unlock the mysteries of how earthquakes happen. NanTroSEIZE progressed to the Stage 2 in 2009, successfully completing two expeditions.

Expedition 319 saw the first ever attempt at scientific riser drilling. Expedition 322 obtained rock samples before they could subduct into the large-scale earthquake zone. Each expedition produced successful results.

New Possibilities Created by the Success of Riser Drilling

In June 2009, the *Chikyu* began the first riser drilling in scientific history.
Drilling took place in the central portion of the Kumano Basin, located under the pacific off the Kii Peninsula, in an area known as "the birthplace of earthquakes."
The target depth was 1,600 meters below the 2,000-meter-deep sea floor.
There the crew, drilling engineers and researchers faced the daily challenges of handling technology new to science.



Leader of the 26 researchers Drs. Eiichiro Araki (right) and Sean Toczko (left), who oversaw researchers and other staff

Kunihiro Muta of the CDEX Drilling Management Group explains: "Put simply, riser drilling is a technology in which special mud water is injected into the drilled hole and cycled on board the drilling vessel during drilling." The mud water that is run down the drill pipe is then run back up (rises) through the outer riser pipes, giving the system the name "riser drilling."

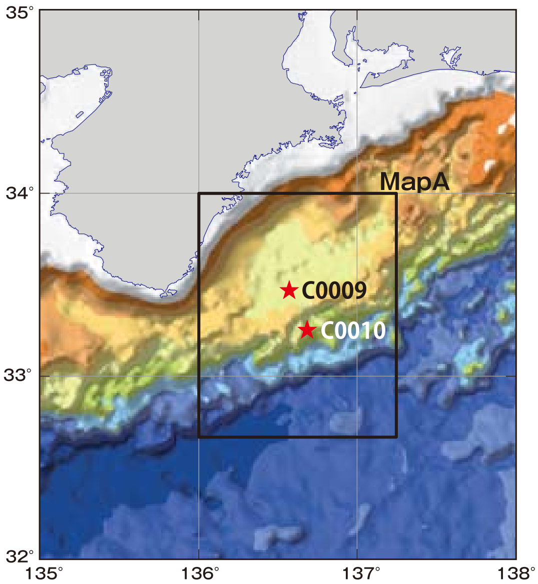
Mud water is used to provide a counter to the underground pressure that increases with drilling depth. With methods that use sea water, pressure causes the hole to collapse, and drilling thousands of meters below the ocean floor becomes impossible. In principle, riser drilling appears to be a simple process, but making it successful required careful preparation.

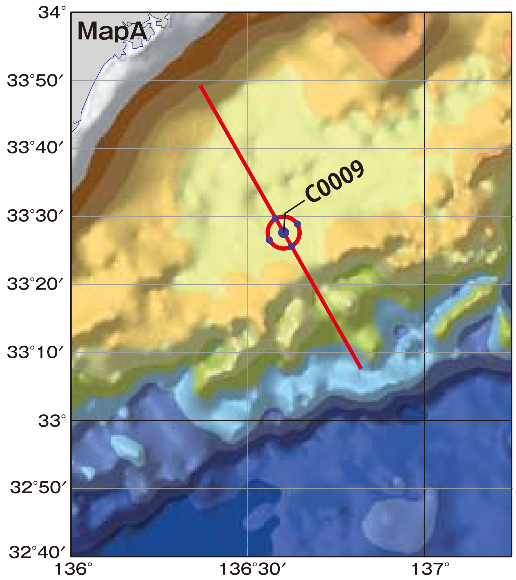
Days of Preparation

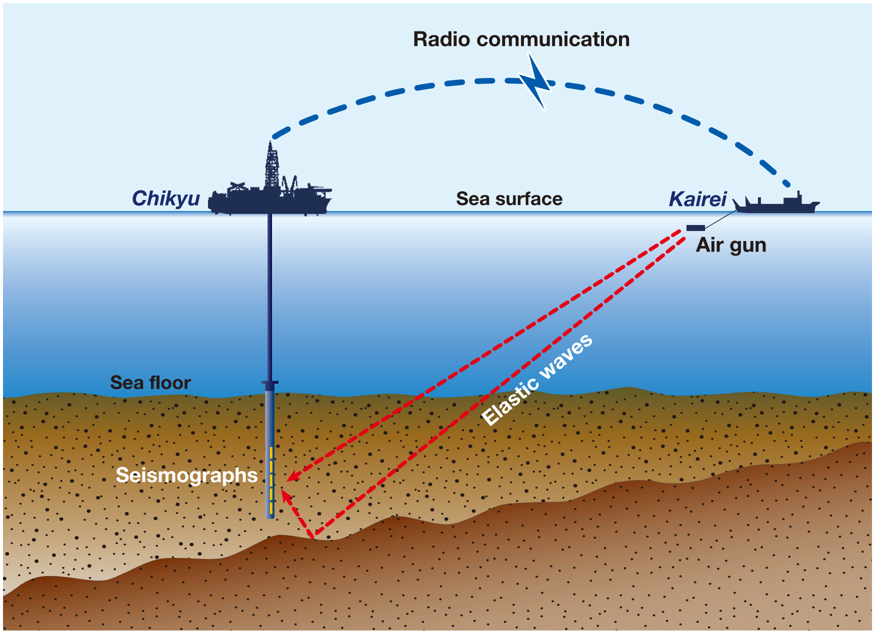
The *Chikyu* sailed May 10, 2009 on Expedition 319 of the Integrated Ocean Drilling Program (IODP). There were three drilling locations, each inside the Kumano Basin that lays below the seas off the Kii Peninsula. Riser drilling was scheduled for the central portion of the basin. However, even after the *Chikyu* arrived at the designated location and scientific teams came aboard on June 4, the drilling did not start right away—there was preparation to be done.

For example, the *Chikyu* is equipped with a Dynamic Positioning System (DPS), a system that keeps the ship in place. Using a GPS aboard the ship as well as transponders placed on the sea floor that send information regarding the distance and direction to the ship, the system constantly ascertains the ship's position and maintains it by means of thrusters on the bottom of the vessel.

Above: Scientists check gas monitoring equipment
Below: Riser pipes moving toward the derrick
Right: Blow Out Preventer (BOP), the keystone of the riser drilling system. Attached to the end of the riser pipes, it is lowered from the moon pool into the water.







Upper left: Drilling location in the Kumano Basin on Expedition 319. Riser drilling location is Site C0009.
Upper right: Survey line taken by the *Kairei* during Vertical Seismic Profiling (VSP). Seismometers were put in the drill hole at Site C0009 and on the sea floor at other sites (blue circles).
Left: Accurately synchronizing clocks by radio while firing air guns to measure seismic waves

Dr. Ryota Hino
Research Center for Prediction of Earthquakes and Volcanic Eruptions, Tohoku University

An unmanned Remotely Operated Vehicle (ROV) positions the ten transponders on the 2,000-meter-deep sea floor, after careful study of sea floor topography. Careful and accurate positioning of the ship is especially important in riser drilling.

Drilling Begins!

After determining position and preparing the pipes, drilling finally begins.

"We first drill to 700 meters below the sea floor without risers, then insert a casing to protect the hole walls and place cement between the pipe edge and the hole to harden the borehole. Next, we lower a riser pipe with a Blow Out Preventer (BOP) on its front end, down to the casing to which it audibly attaches. This completes riser preparations," says Muta.

Riser drilling began on June 25. During drilling, a special device called a Modular Dynamic Tester (MDT) was lowered to gather information on pressure and stress in the hole walls. That data alone contains valuable information about the surrounding geologic layers, but is also used to adjust the specific gravity of the mud water that is cycled through the risers.

Data Collection and Coring

"When riser drilling begins, cuttings and gas from the hole come up to the ship, mixed with the cycled mud water. Here is where the scientific teams really begin their work," says Dr. Eiichiro Araki, one of the Co-Chief Scientists on Expedition 319. Gas is constantly monitored for its type and volume, while cuttings are transferred to laboratories in the ship and analyzed by scientists. Both of these materials are priceless specimens that would be unattainable if not for riser drilling.

Logging While Drilling (LWD), where sensors attached to the ends of drill pipes measure geologic layer density and porosity, was also performed during this drilling. However, researchers were most eager to obtain cores, or cylindrical chunks of rock samples.

"The cuttings produced by drill bits vary in properties such as density and hardness. In order to accurately learn about the status of geologic layers and faults, it is best to have cores," says Dr. Araki.

Coring began on July 20, at drilling depths exceeding 1,500 meters. To change drill bits to ones that can collect cores samples, the drill pipe that is now at 3,500 meters below the ship must be brought up and then lowered again. This task takes over half a day. Drill bit load and the number of revolutions must also be adjusted according to geologic layer conditions. All that work was worth it, however, because the operation yielded very high quality, crack- and damage-free cores.

Next, VSP

Coring is the most fascinating task, and during it, one researcher waited excitedly aboard the marine research ship *Kairei*, some 30 kilometers south of the *Chikyu*. The researcher was Dr. Ryota Hino, the Principal Investigator (PI) of a Vertical Seismic Profiling (VSP) from Tohoku University.

VSP is a process where numerous seismographs are strung together like beads and placed deep in the drilled hole, where they detect seismic waves that travel through the sea floor in response to an air gun being shot by another ship (in this case the *Kairei*). The seismic waves detected under the sea floor provide valuable data in exploring geologic structures and layers, because they are normally obstructed by sedimentary layers on the sea floor, damping and ambient noise.

"Even after the scheduled date, we still hadn't received contact to let us know they were ready. Since the *Kairei* was to be used for other matters soon, I was getting nervous." VSP finally commenced on the night of July 24. For 16 hours continuing to July 25, the *Kairei* fired its air gun while moving along a survey line from a point 30 kilometers south to 30 kilometers north of the *Chikyu*, which was recording the seismic waves. "Since we picked up good data for S-waves, and not just P-waves, we discerned detailed structures that are normally difficult to see. We learned a lot by essentially peeling away the sedimentary layer. I think it was innovative in terms of seismology."

*

The *Chikyu* continued its expedition until the end of August, producing other results, such as drilling and placing sensors in a Mega-splay fault.

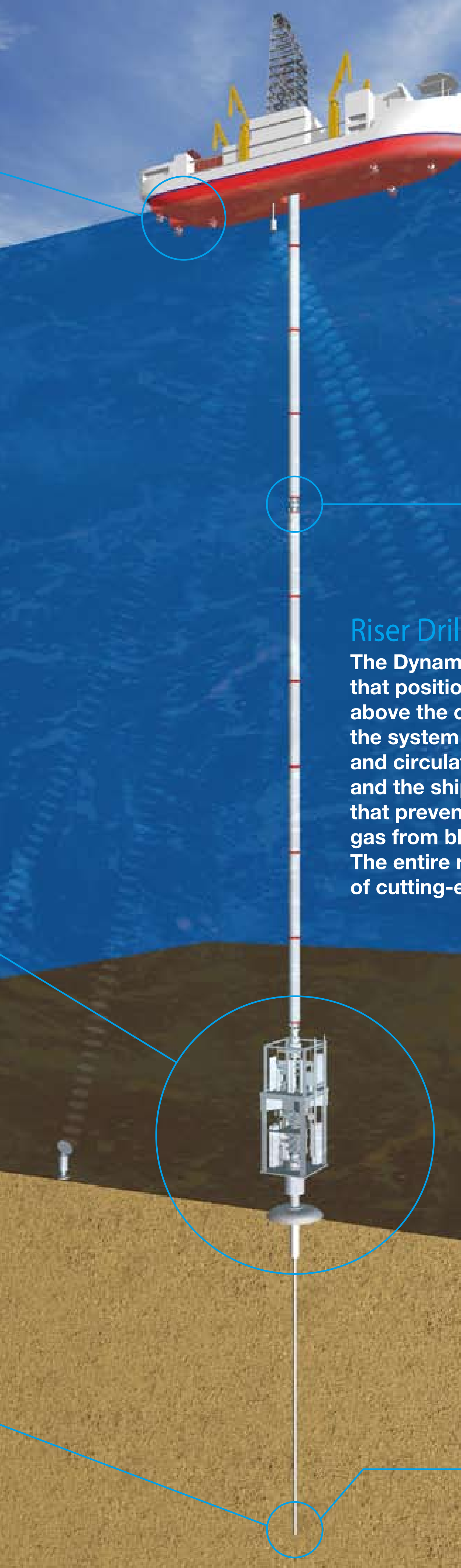
"It was a great atmosphere, perhaps because there were so many young people. In that regard, I think it was a successful expedition," remarks Sean Toczko, who coordinated support for 26 researchers from eight countries while serving as the Expedition Project Manager, in summarizing Expedition 319. ■

Thrusters
These ensure that the ship constantly maintains the same position.
The thruster system consists of three azimuth thrusters each at the bow and the stern, and side thrusters at the bow.
Azimuth thrusters are able to turn their propeller direction freely at 360 degrees.
The *Chikyu* also uses two azimuth thrusters on the stern for normal ocean travel.

Blow Out Preventer (BOP)
This device prevents dangerous gases from blowing up through the riser pipes to the *Chikyu* when the drill comes into contact with gas layers.
It is attached to the bottom of the riser pipe just above the top of the hole drilled in the sea floor.

Transponders
This communication device measures the distance and angle from the sea floor to the *Chikyu*.
Two lines of five transponders each are positioned in a pentagonal pattern around the hole on the sea floor.
In concert with GPS and devices that detect the ship's position, these are an important part of the positioning equipment that makes up the Dynamic Positioning System (DPS).

Drill bits
These are the blades used to drill into bedrock.
Blade tips are affixed with artificial diamonds.
When the bits rotate at high speed, they are able to drill into the bedrock under only the weight of the drill pipes.

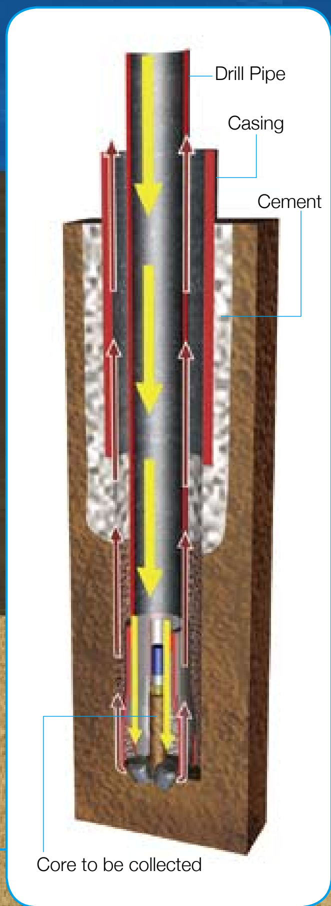


Riser pipes

The main steel pipe has a diameter of 50 centimeters, but because buoyancy module is attached to reduce underwater weight, the entire structure is approximately 1.2 meters in diameter.
One pipe is 27 meters long.
The pipe in the middle is the drill pipe, through which mud water is transported downward (downward arrow), and then back upward between the drill and riser pipes to the ship (upward arrows).
Surrounding pipes contain communications cables, etc.

Riser Drilling Illustration

The Dynamic Positioning System (DPS) that positions the *Chikyu* directly above the drilling hole, the system for mixing drilling fluids and circulating between drill bits and the ship, the Blow Out Preventer (BOP) that prevents dangerous gas from blowing into the ship: The entire riser drilling system consists of cutting-edge technology.



Drill pipes and casing

When drilling has progressed to a certain point below the sea floor, the casing is lowered into the hole and cement is placed between it and the hole walls to prevent the hole from collapsing.
Then the drill pipe is lowered to drill even deeper.
Attached to the drill pipe pictured here is a drill bit with a hollow center designed especially to obtain core samples.

Another Step toward Understanding Large Earthquakes and the Formation of the Accretionary Wedge

Drilling during the Expedition 322 recovered a precious sample that was cause for excited celebration by the research team. The results of that expedition brought both the mechanisms of large earthquakes and the formation of the Japanese Islands a little closer to light.

"This is exactly the kind of core we've been drilling for!" exclaims Co-Chief Scientists Drs. Saneatsu Saito (left) and Michel Underwood (right), and technicians, upon confirming the "miracle core" as it arrives in the passage connecting the drill floor and laboratory. Cores and cuttings pass through here on their way to being analyzed in the laboratory.

The "Miracle Core"
Sedimentary rock (above) and pillow basalt (below) recovered at site C0012. The very boundary between two kinds of rock was perfectly recovered like a miracle.

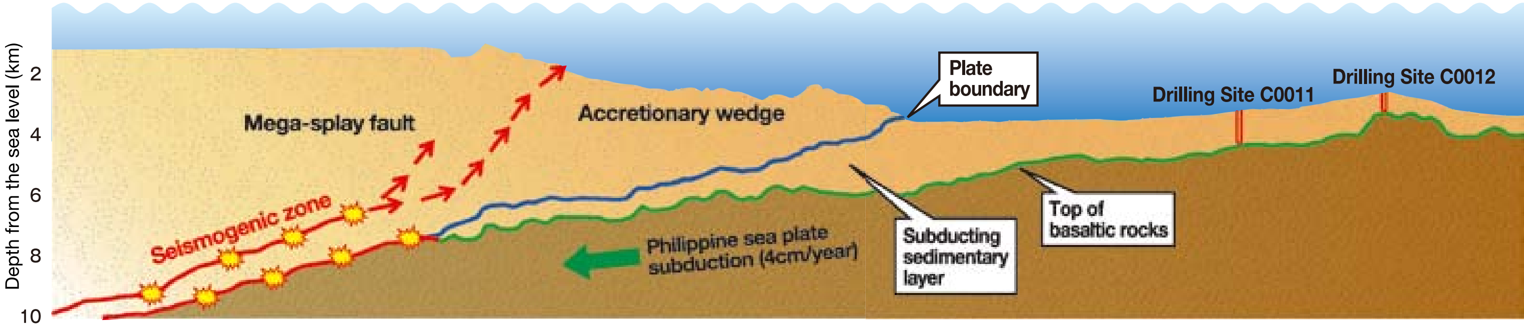
The Integrated Ocean Drilling Program (IODP) Expedition 322 by the *Chikyu* began on September 1, 2009, spanning 40 days and finishing on October 10. The drilling site was 150 kilometers southwest of the Kii Peninsula at a water depth of about 4,000 meters.

"That is the place where the Philippine sea plate is subducting beneath the Eurasian plate. We wanted to recover the initial material to be subducted. Obtaining such a sample was our biggest goal," explains Dr. Saneatsu Saito, Co-Chief Scientist of Expedition 322. Including Drs. Saito and Underwood, 26 researchers from eight countries set sail on September 4 with drilling beginning on September 8. At the first drill site, Site C0011 the drill bit encountered friction at about 880 meters below the 4,050-meter deep sea floor. Drilling had to be abandoned there, and was moved to a site about 10 kilometers away at a depth of 3,510 meters (Site C0012), where the team again attempted coring to recover sample.

With only one week remaining in the expedition, they finally found what the team was looking for, at 540 meters below the sea floor. "We obtained a beautiful core that clearly showed the boundary between the basement basalt and the sedimentary rock above it. I was so happy that I couldn't help but pump my fist!"

The researchers referred to the core, which perfectly captured the geologic boundary, as the "miracle core."

"The same layers can actually be seen on land. However, those basalt and sedimentary rocks have metamorphosed over a million years, and physical and chemical properties differ greatly from the rocks that are presently subducting. That is why we were so eager to find a "raw" sample." The plate where the "miracle core" was found is moving about four centimeters to the northwest each year as it subducts under the Eurasian plate. In over one million years, it will reach a depth of approximately seven kilometers and become a layer that causes large earthquakes. Therefore, to learn the characteristics of this "raw" sample



The upper layer of the Philippine sea plate where drilling was performed is expected to arrive at the seismogenic zone after more than one million years of plate subduction.

0 10
km

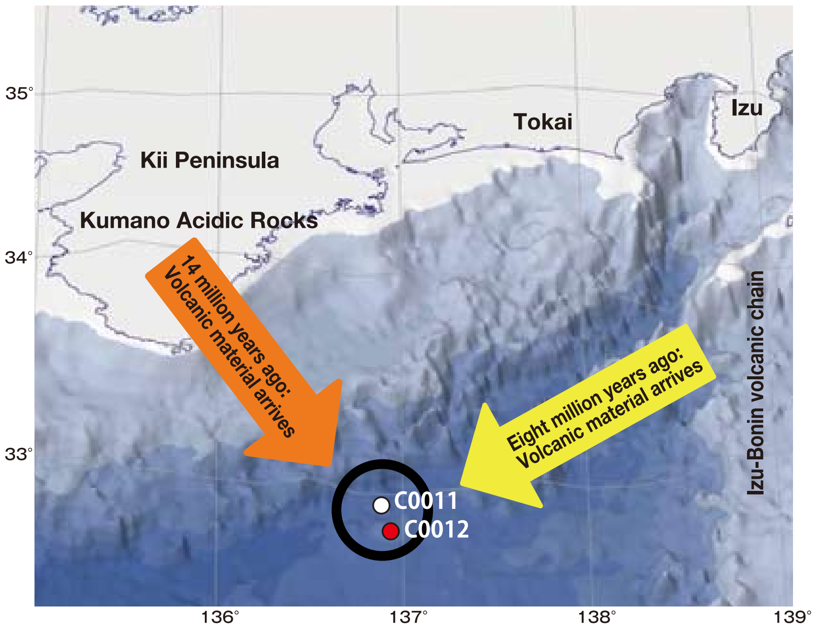
"helps greatly in understanding the mechanism of earthquakes occurring at a seismogenic zone that is seven kilometers deep," comments Dr. Saito.

Water containing high level of methane gas was also obtained from the sedimentary rock samples, and studies are underway to see if the water is rising from the deeper part of the plate subduction zone. In addition, the sedimentary succession above the basalt contains volcanic sandstone layers which are thought to have originated from volcanic activity in the Kii Peninsula 14 million years ago. The layer above that, which is eight million years old, contain tuffaceous rocks which are likely to have originated from the Izu-Bonin volcanic arc. A very large pyroclastic flow probably extended around 200 kilometers from that area to arrive here.

"Continuously drilling into a hole is just like watching a video of the earth's history. Plate subduction zones are basically mountain factories. They resulted in the formation of the Japanese Islands and continents. We are hopeful that the samples obtained here will explain another piece of that process," says Dr. Saito. Expedition Project Manager Yusuke Kubo also proudly points out that "Many future researchers will look at the drilling data we obtained here in the course of studying seismogenic zones."

Under NanTroSEIZE Stage 3, drilling will commence into the seismogenic zone and across the plate boundary into the subducting Philippine sea plate.

The drilling sites of the Expedition 322.
Site C0012 is where the "miracle core" was obtained.
The sedimentary core contain evidence of two different periods of volcanic activity.



A core containing pumice and amphibole in eight million-year-old tuffaceous sandstone from the Izu-Bonin volcanic zone.
This is the first discovery of sediments that were transported from the Izu-Bonin area as far as the Kii Peninsula.

A sandstone core containing volcanic sediments that are deposited on the sea floor during a period of intense volcanic activity in the central Kii Peninsula 14 million years ago.

Riser Fairing System Tames the World's Fastest Currents

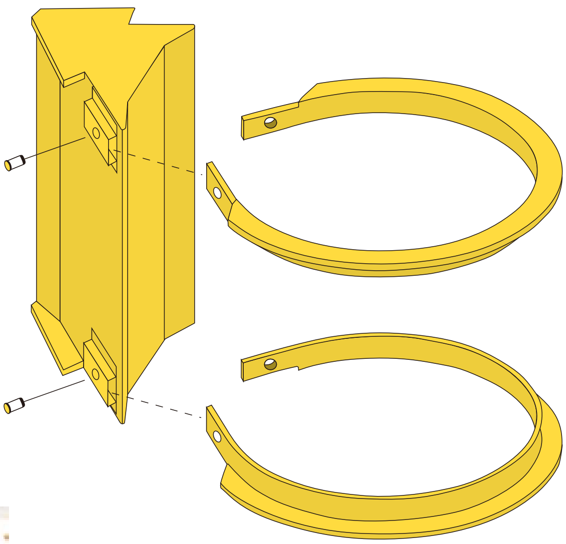
Sailing in the seas off the Kii Peninsula engaged in research, a major problem required resolution before riser drilling could succeed: the swift flow of the Kuroshio Current. What innovative technology was developed to protect the riser pipe from ocean currents?

The *Chikyu* sailed to drill under the seas off the Kii Peninsula and shed light on the mechanism causing earthquakes and tsunamis in the Nankai Trough. That area has one of the world's fastest currents including the Kuroshio Current—which can flow at more than three knots (1.5m/s).

One of the toughest problems is therefore how to handle the Kuroshio Current. When the 1.2-meter-diameter riser pipes were lowered from the *Chikyu* and deployed to the seafloor drilling site, how would they handle the strong lateral current? The riser would shake causing the metal to fatigue and to eventually break.

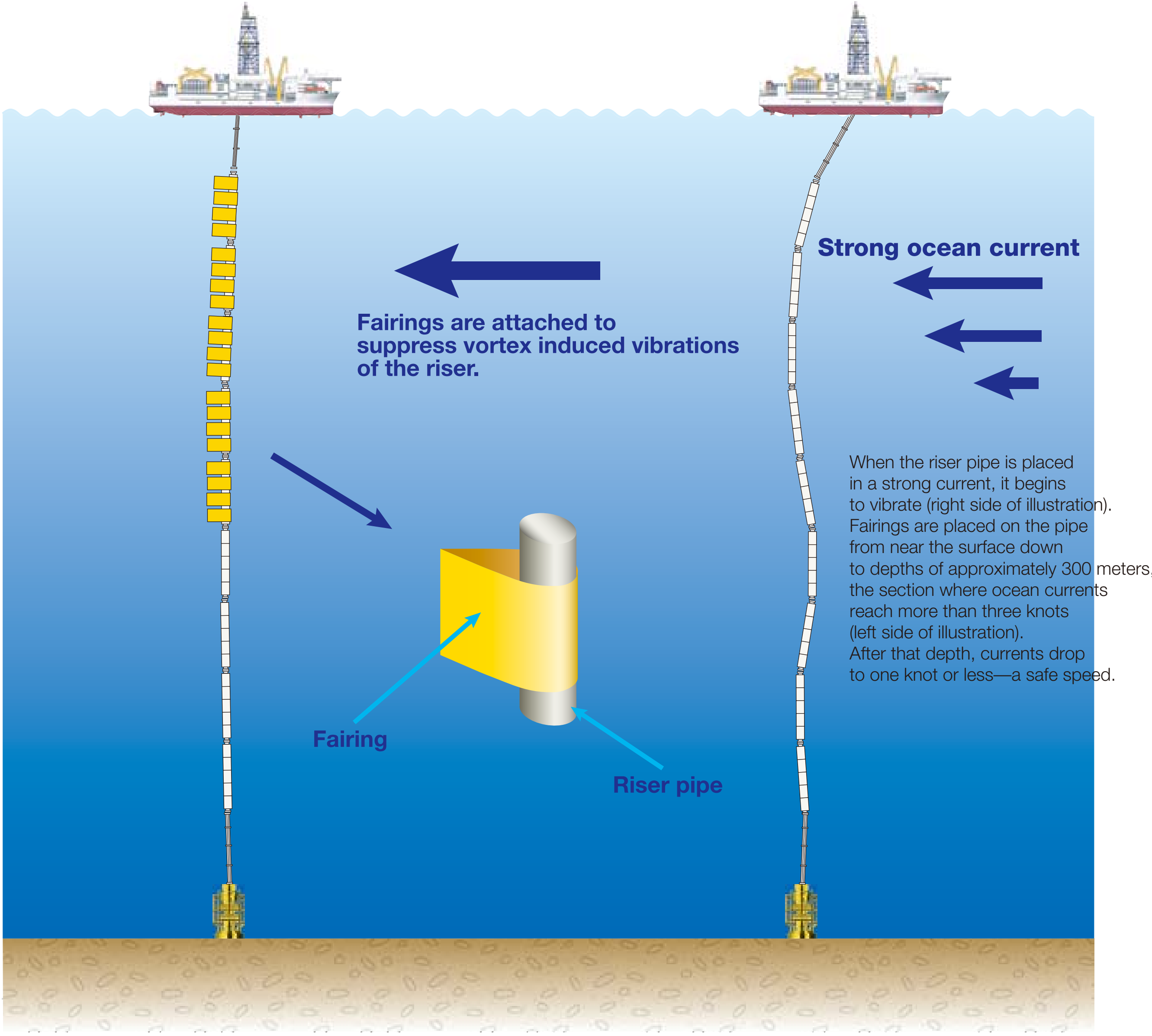
"Since regular drill pipes frequently move up and down, vibration isn't normally a problem. In the case of riser drilling, however, riser pipes are fixed while drilling is going on, causing the vibrations to concentrate on the same pipes resulting in significant damage," explained Eigo Miyazaki of the CDEX Engineering Department, who oversaw the development of the *Chikyu*'s subsea equipment.

The researchers knew why vibrations were occurring. When a cylinder is placed in a current an alternating vortex (called a Karman vortex) forms on the downstream side of the cylinder. Vibrations occur



A fairing, shaped like an arrow when viewed as a horizontal cross section. Made of plastic, it is attached to the pipe by two straps.

Above: The riser pipe with fairings attached. The picture shows fairing tails pointed in various directions, but they point the same way when placed in an ocean current.
Right: Attaching the fairings. One strap is attached using just two pins.



when two of these vortexes alternately pull at one another, causing a phenomenon known as a "vortex induced vibration." In order to avoid this, the cylinder—in this case, the riser pipe—had to be reshaped so as not to cause a Karman vortex. Researching what would be the best shape, Miyazaki decided to attach a "fairing" cover to the pipe.

"I initially thought it would be pretty easy, but the triangular horizontal cross sections we first made were a complete failure in water tank experiments. After that we pursued a variety of initiatives, trying to attach a triangular edge, streamlining, and adjusting the length of the tail portion. Logically, making the fairing at least twice as long as the pipe diameter should have had the greatest effect. But, when we tested it that was not the case. It ended up taking two years just to complete experiments in the water tank."

After extensive trial and error, Miyazaki and his team came up with a fairing that was shaped like an arrow when viewed as a horizontal cross section. The fairing was attached to the pipe by two straps, one upper and one lower.

The fairings finally made their ocean debut in 2009, sailing to the seas off the Kii Peninsula on IODP Expedition 319, and were a rousing success. Lowered approximately 300 meters below the surface, the riser pipe equipped with 132 fairings showed almost no vibration despite currents reaching speeds of three knots—this was confirmed by sensors placed strategically on the fairings, as well as by analysis of data collected from a logging system that recorded the movements of the riser pipe. Miyazaki's tireless efforts had finally paid off.

In the future, the *Chikyu* is scheduled to perform riser drilling in ocean currents of three knots or more. This is the year that the fairing system will come into full use, further proving its true worth. ■

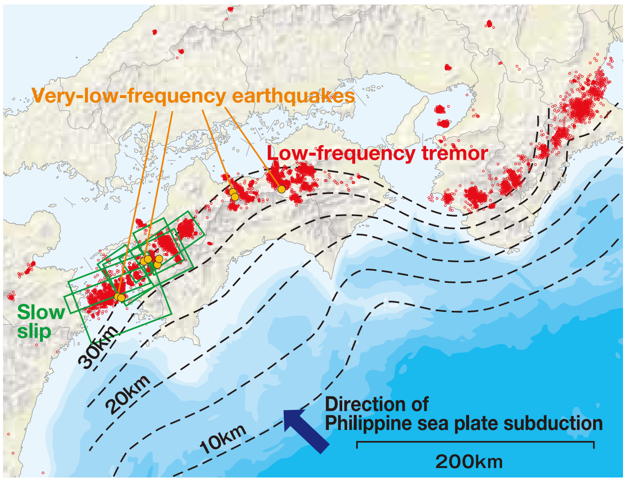
The silver pressure vessels attached to the riser connector are sensors and batteries that record movements.

Slow Earthquakes Reveal More Detailed Information About the Mechanisms of Large Earthquakes

GPS systems that can measure continental drift in units of centimeters per year together with advanced seismographs that can detect the slightest tremor have brought to light the existence of earthquakes that move slower than usual, garnering attention from researchers.

Interview● **Dr. Yoshihiro Ito**
of the Research Center for Prediction of Earthquake and Volcanic Eruptions, Tohoku University

One slow earthquake zone spreads from Shikoku Island to the Kii Peninsula. Slow earthquakes were occurring at 30 to 35 kilometers below the surface on the Philippine sea plate, which is continually sinking. The zone 30 kilometers and higher on the south side of this area is where the epicenter of the Nankai Earthquake (1946) was located.



Dr. Yoshihiro Ito

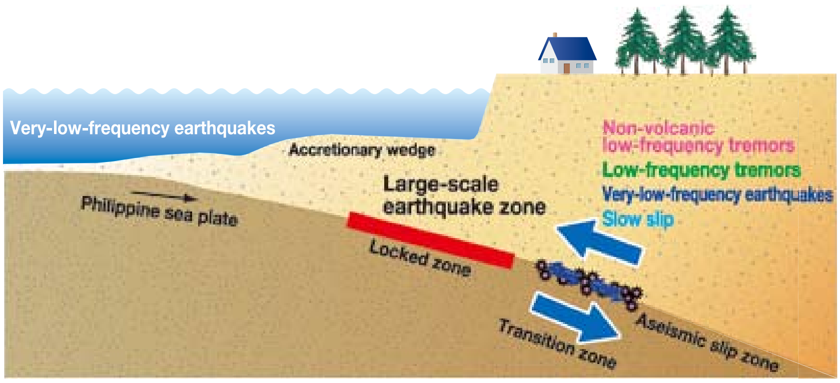
In contrast to earthquakes where layers travel several meters in a few seconds or minutes, a phenomenon known as slow slip also exists, in which slower movements of a few centimeters a year occur. Because the movements are so slow, they are naturally undetectable by humans. At the same time, they often fail to show up in previous seismograph readings.

Slow slip was first detected in the 1990s in areas where oceanic plates were subducting under continental plates. The depth at which movement (sliding) occurs is about 30 kilometers below the earth's surface, where the epicenters of large-scale quakes usually lie. In addition, it has recently become known that due to slow slip, a special kind of (low frequency) earthquake has been occurring in which tremors last longer and produce lower frequency vibrations than normal earthquakes. These are variously called "non-volcanic low-frequency tremor," "low-frequency tremor" and "very-low-frequency earthquakes" and are known collectively with slow slip as "slow earthquakes." In other words, they put out few seismic waves.

From analyses of the faint aseismic waves of slow earthquakes, the process of plate subduction as well as earthquake mechanisms are coming into clearer detail. There are three types of zones on the boundary between continental and oceanic plates. In each zone type, plate slippage is different: locked zone; transition zone that produce slow slip; and aseismic slip zone. In locked zones, the subduction force exceeds the force holding the plates together, resulting in a sudden release and movement which progresses into a large earthquake. On the other hand, in transition zones where the force holding plates together is weak, the phenomenon of slow slip occurs as movements proceed little by little, causing non-volcanic low-frequency tremors (earthquakes) and very-low-frequency earthquakes (see illustration below). This conclusion is based on the latest theory. If the earthquake-causing process of this theory could be modeled, it could facilitate the prediction of future (normal) earthquakes through the measurement of such slow earthquakes as slow slip.

Dr. Yoshihiro Ito of Tohoku University identified low-frequency tremors by analyzing the seismic waves of earthquakes occurring in southwest Japan. "Some slow slips occur slowly for a few days to a week. There are others—much slower than the large earthquakes that occur once in tens or hundreds of years—that we can monitor from start to finish through several cycles over short periods such as six months or a few years. I think these will be very important to research as we attempt to model earthquake occurrence mechanisms."

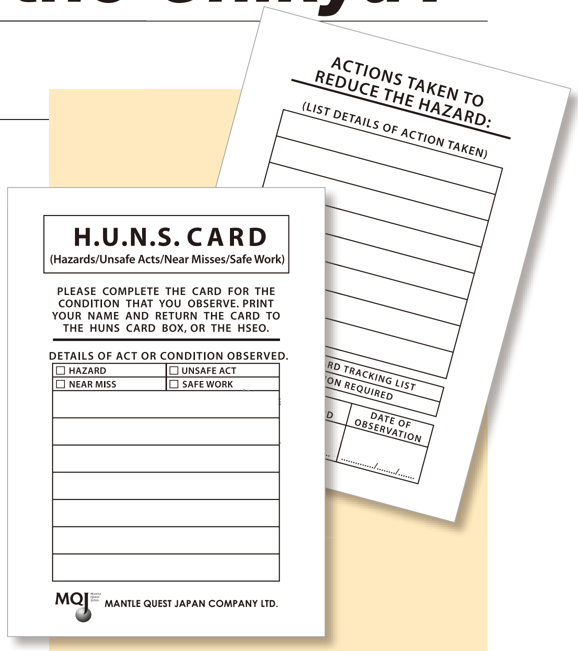
Dr. Ito also states that "In order to model the earthquake process, data from earthquake zones is indispensable." Collecting data such as rock samples from deep below the earth's surface is the mission of *Chikyu*. The *Chikyu*'s crew look forward to working alongside these slow earthquake researchers going forward as well. ■

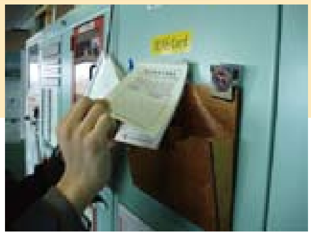


Near transition zones, slow earthquakes, in which faults form more slowly than normal seismic events, occur repeatedly over a short period of time.

Who ensures safety on the *Chikyu*?
The HSE Group

Approximately 150 crew members board the *Chikyu*, a deep—sea drill ship loaded with riser pipes, dangerous equipment and large machines. Managing and ensuring safety on the ship is no small task. Who maintains the ship's unblemished history of never having recorded an serious injury or accident?





HUNS (Hazards/Unsafe Acts/ Near Misses/Safe Works) cards (above) are filled out and placed in boxes placed around the ship (below).

Two Health Safety and Environment (HSE) officers are on board the *Chikyu* at all times

Their job is to protect the health and safety of everyone on board the *Chikyu*—which can mean as many as 150 people at peak times—from work accidents, and also to ensure that the activities of the *Chikyu* do not damage the environment. "Of course," says CDEX HSE Group leader Tomohisa Nawate, "the ship is large, meaning that just two HSE officers can hardly patrol the entire vessel. That is why the ship uses what is called the HSE Management System—a regime that prevents accidents and illnesses while minimizing environmental pollution."

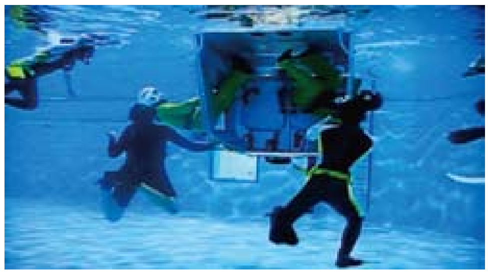
There are numerous training sessions and meetings required under the HSE Management System. They include meetings to confirm overall work scheduling and safety checks, as well as meetings within each ship division including research, drilling, on-deck machinery and others. In addition, meetings are held prior to drilling, a time during which accidents are most likely to occur. Training encompasses an endless list of activities including evacuation and firefighting.

On the ship, the Hazards/Unsafe Acts/Near Misses/Safe Works, or "HUNS" card—an on-board reporting system—ensures HSE. People who witness near-misses, failure to wear helmets or harnesses, and even smaller problems, write what they have seen on forms placed around the ship. HSE officers collect and analyze these reports, bringing up issues in the next day's management meeting, where appropriate measures are discussed and then implemented.

"When we are at sea, we receive between15 to 30 HUNS cards each day; not only the HSE officers, but also each of the 150 crew members is keeping a keen eye on the ship's safety."

Everyone, including researchers, who board the *Chikyu* for the first time, is required to first undergo strict safety training, which includes HUET (Helicopter Underwater Escape Training) as well as sea survival training. This leaves each person on board with a heightened awareness of safety and danger.

"I'd like the researchers to take home not only their basic research, but also some of what they've learned about HSE while on board," a confident Mr. Nawate comments while smiling. ■



HUET (Helicopter Underwater Escape Training) is a training regiment that all crew members must clear before boarding the *Chikyu*. This harsh training includes being submerged in a pool while strapped to a simulated helicopter seat.

"Sand for Students" Outdoor Course

Learning Earth History from Sand

With the aim of having junior and senior high school students participate in efforts to gather sand from local riverbeds or beaches and then enter their results into a global sand database, the Center for Deep Earth Exploration (CDEX) conducted the Integrated Ocean Drilling Program (IODP) Hands-on Outreach Program "Sand for Students" in Hyogo, Kyoto and Kagawa prefectures in 2009.

The students first headed to familiar riverbeds. There they learned that a portion of the bedrock had been carved away by the river, getting finer as it was carried away resulting in the formation of the rocks and sand found there today. They then looked through magnifying glasses to view the beautiful world of minerals and tried understand why sand color differs between riverbeds.

The course gave students a keen sense of understanding that even the minerals and rocks where they live had been formed by geological changes over long periods of time.

Sand is the most familiar earth history teacher we have!

Observing riverbed rocks and sand during the outdoor course
http://www.jamstec.go.jp/chikyu/sand/en/

From Academic Conferences around the World

For five days from August 11 to 15, 2009, a lot of participants from 54 countries gathered at the Suntec Singapore International Convention and Exhibition Centre for the 6th Asia Oceania Geosciences Society (AOGS) Annual Meeting and Geosciences Exhibition. We took the opportunity to highlight the appeal of the IODP to many Asian researchers. ★ The 116th Annual Meeting of the Geological Society of Japan was held from September 4 to 6, 2009 at Okayama University of Science. In addition to operating an exhibition booth, the IODP held lectures for the general public, which were well attended. ★ The 2009 Fall Meeting (was held in San Francisco) of the American Geophysical Union (AGU). There, at its exhibition booth, the IODP outlined the expedition implementation status of its new three-ship fleet system, which it had launched in earnest. An explanation was also provided about how to participate in the IODP.

IODP Exhibition at AGU Town Hall Meeting

Chikyu Media Coverage

Dr Harold Tobin, Chief Project Scientist for NanTroSEIZE being interviewed by the BBC
http://www.jamstec.go.jp/chikyu/eng/Expedition/NantroSEIZE/index.html#PR

Appearance on BBC World News

In May 2009, a crew from the British Broadcasting Corporation (BBC) came aboard the *Chikyu*, which was drilling in the Nankai Trough, to conduct in-depth coverage. The significance of the IODP drilling as well as activities onboard the *Chikyu* were broadcast over a period of a week.

Live Broadcast from the *Chikyu*

On May 4, 2009, the Japanese public broadcast network NHK conducted a live broadcast that simultaneously connected astronaut Koichi Wakata aboard the International Space Station (ISS), the Bahamas, the NASA Johnson Space Center in Houston, Shibuya in Tokyo, and an area 1,000 meters below the surface of Suruga Bay in Japan.

New Director-General Speaks about CDEX Now and in the Future

**Wataru Azuma was appointed Director-General of CDEX in July 2009.
What does CDEX look like through fresh eyes?
Here are his first comments since becoming Director-General.**

I became CDEX Director-General last summer.
For the time being, my duties will include both CDEX and the Directorship of the Kochi Institute for Core Sample Research. I believe that I am expected to promote cooperation between these two entities to ensure that all of JAMSTEC (Japan Agency for Marine-Earth Science and Technology) can efficiently carry out IODP (Integrated Ocean Drilling Program).

Closing out a fulfilling 2009

The year 2009 was a very productive one for the IODP, not least because the year saw all three IODP platforms operate simultaneously for the first time. The three are Japan's *Chikyu*, which drills deep into the earth; the American *JOIDES Resolution*, which drills more shallowly in comparison; and the European Mission-Specific Platform (MSP), which can drill in areas where other platforms are unable. Each of these ships was able to carry out its scheduled mission in 2009, and this achievement is the fulfillment of the dream we envisioned when planning the program in 2003.

The *Chikyu*, operated by CDEX, succeeded in the first-ever "scientific riser drilling." More than two-thousand meters under the sea surface off the coast of Wakayama Prefecture, the ship drilled 1,600 meters below the ocean floor and obtained very wonderful, high quality rock core samples. Indeed, this year left me convinced that the riser drilling method is an excellent technology, and one we must continue to employ.

The Nankai Trough is an area seen as a hotbed of large plate boundary earthquakes, and the vast data we acquired there will undoubtedly be utilized in predicting Nankai earthquakes and other plate boundary earthquakes in general. It is sure to result in substantial disaster-prevention measures: For example, it could be needed in tsunami simulations to determine how high tsunami walls should be in what places.

Looking ahead

In 2010 and beyond, CDEX will continue researching the Nankai Trough, keeping to its mission of contributing to the Initial Science Plan (ISP) set forth by the IODP in 2003.

In addition to drilling deep into the earth, the *Chikyu* will assist in such activities as the deep biosphere research, exploration of new energy such as gas hydrates and other undersea mineral resources, and research on undersea carbon dioxide sequestration. With the *Chikyu* as our tool, our research involves the basic sciences of geology, geophysics and biology, but can also contribute to finding a wide range of applications to benefit society. I hope that many people will hear about this great work. ■

CLOSE UP

Message from aboard the *Chikyu*

Each year in October, Pink Ribbon Month is held to raise awareness of the fight against breast cancer and encourage women to receive screenings. During the month, walking events are held around the world to help communicate the Pink Ribbon message.
Chikyu researchers also participated, holding a walk on the ship's helicopter deck. They walked about, feeling the comfortable sea breeze and chatting. Researchers hope that their message was heard around the world!

CHIKYU HAKKEN
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