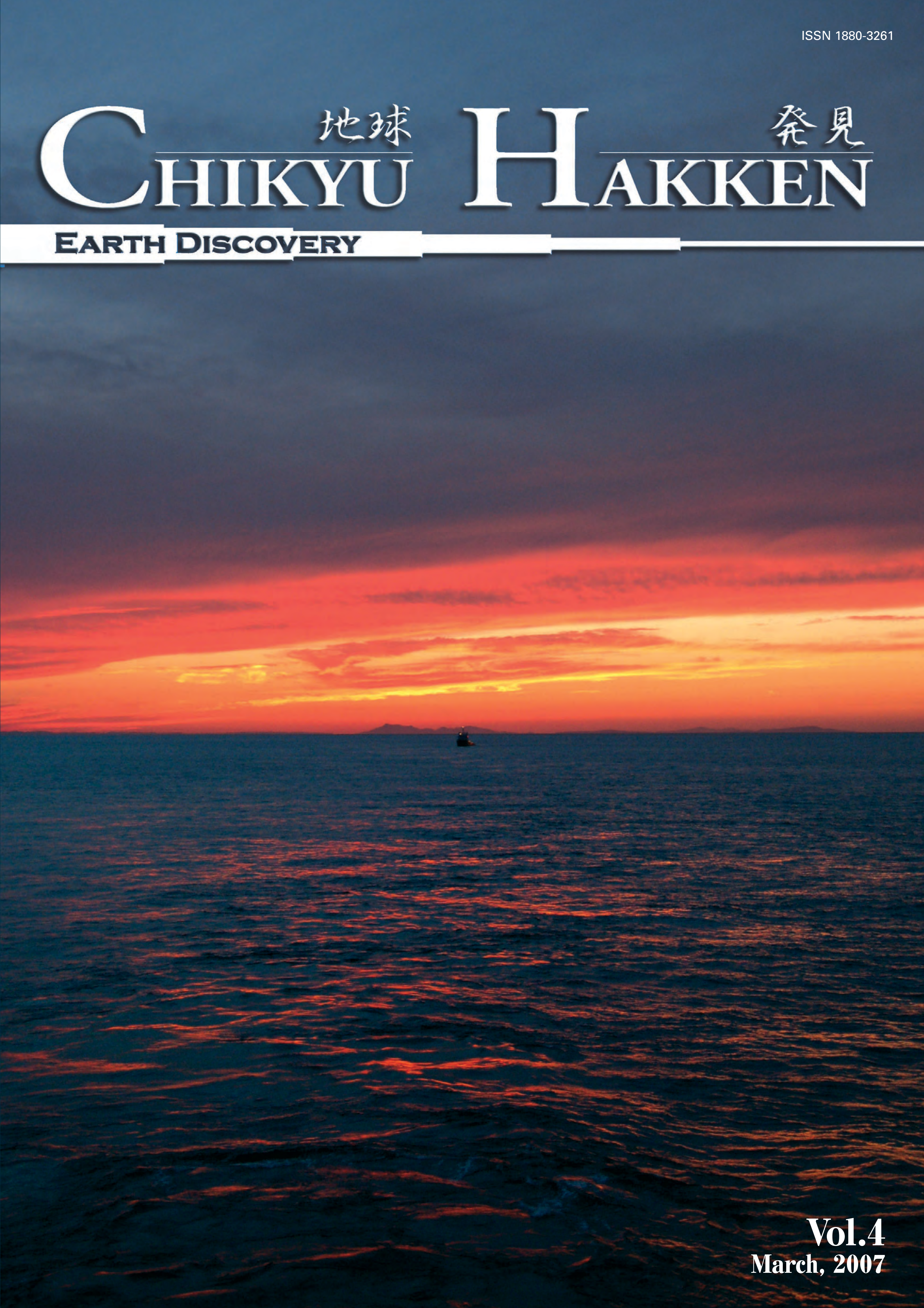
ISSN 1880-3261

地球 CHIKYU 発見 HAKKEN

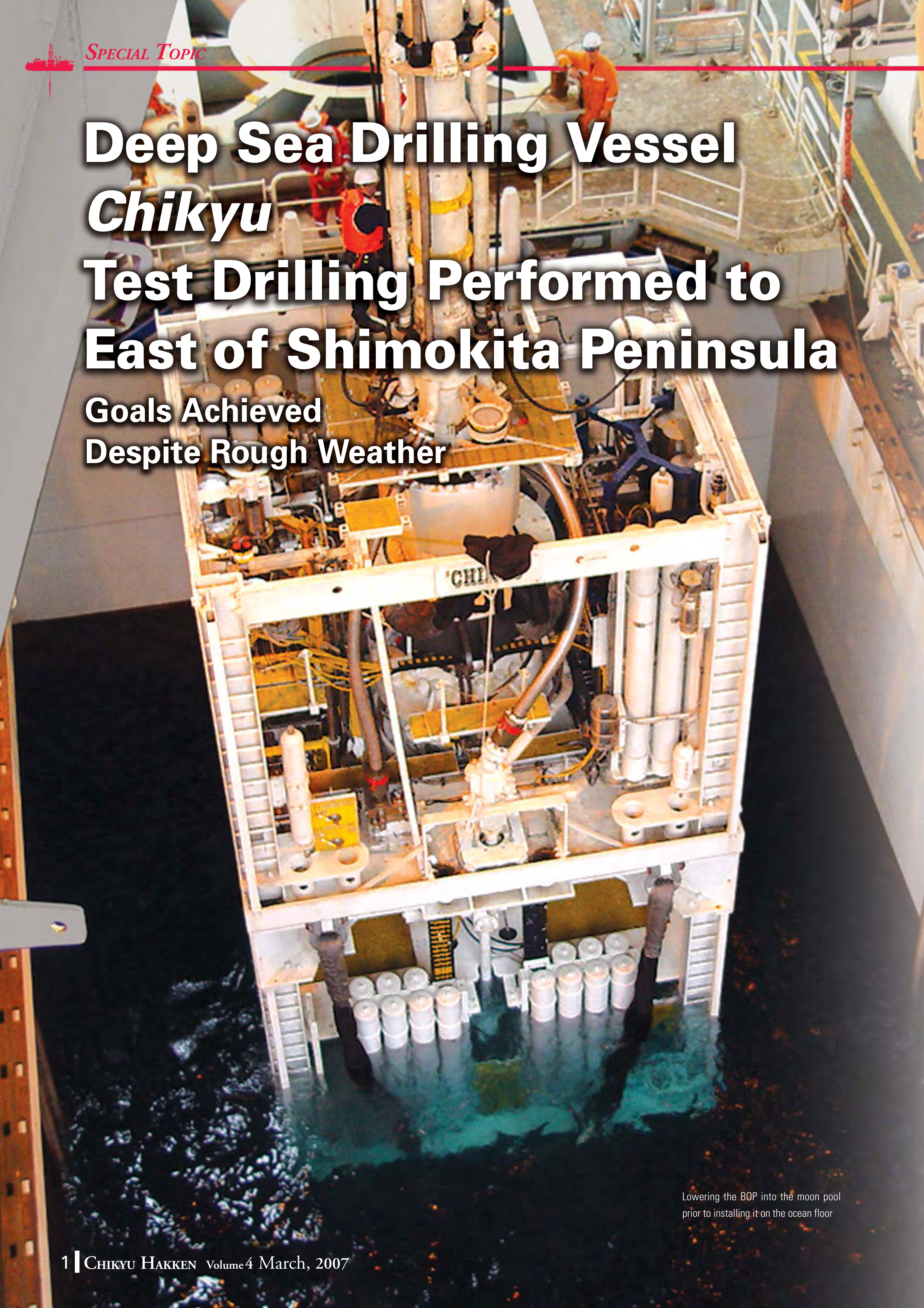
EARTH DISCOVERY



Vol.4
March, 2007

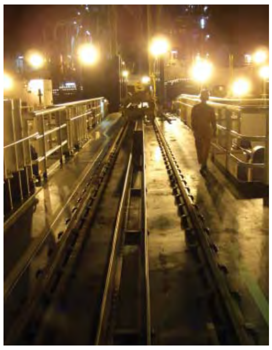
Deep Sea Drilling Vessel *Chikyu* Test Drilling Performed to East of Shimokita Peninsula

Goals Achieved Despite Rough Weather



Lowering the BOP into the moon pool prior to installing it on the ocean floor

The Deep-sea drilling vessel *Chikyu* left the port of Hachinohe on August 6, 2006, and carried out test drilling for a full 82 days off the Shimokita Peninsula in water 1,200 meters deep. The shakedown cruise included phase-two system integration testing, in a continuation of 2005 efforts, and *Chikyu* systems operational training. Despite the rough weather, the crew succeeded in installing the first Blow-Out Preventer (BOP) in deep water and in carrying out riser drilling.

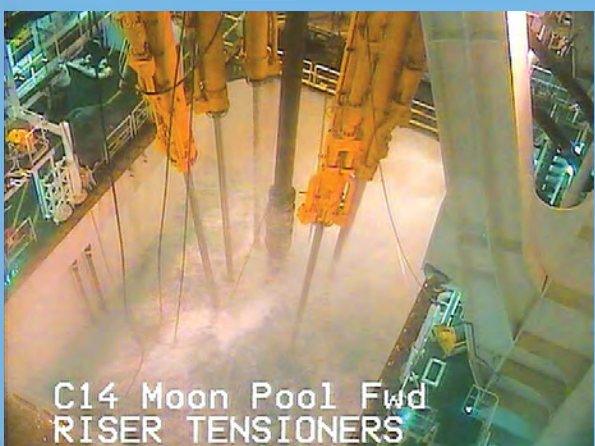


Work was interrupted, or put on hold, due to rough weather associated with typhoons 12, 13, and 14 in September and typhoons 16 and 17 in October, and significantly hindered the smooth progress of these drilling tests. In particular, the low-pressure system that rapidly developed on October 5 - 6, and reached typhoon class with a pressure of 964 hP on October 7, was so strong that ships were run aground off both Ibaraki and Miyagi prefectures, southeast of the drill site. During the four days of extremely rough weather that struck the drilling area, the *Chikyu* was buffeted by winds of over 30 meters per second (67.2 miles per hour). On the evening of October 7, the *Chikyu* performed an emergency disconnect of the riser pipe and Blow-Out Preventer (BOP) and waited at the drilling site for the weather to improve.

When the low-pressure system had passed, a remotely operated vehicle (ROV, an unmanned submersible) was dispatched to check the BOP. That inspection led to the discovery of damage to the connector section of the BOP. Our planning had called for test drilling to last only through October, since the area off the Shimokita Peninsula is known for rough weather from November on. As a result of the unexpectedly early storms and resulting damage, later drilling and the acquisition of core samples by additional riser drilling had to be abandoned.

For the drilling test of this cruise we had planned to drill to a depth of about 2,200 meters below the ocean floor, in water about 1,200 meters deep. Delays developed, however, due to a variety of system problems, bad weather, and the BOP damage that occurred while we were waiting out the storm. As a result, we were not able to drill to the planned depth and only reached 647 meters below the sea floor. We were, however, largely able to achieve our targets for system integration testing (for those results in detail, see pages 3 and 4), and were also able to get some results in the operational training area.

Although the extreme weather was not anticipated as part of our expedition, we learned much from the rough weather the *Chikyu* encountered. For example, the dynamic ship positioning system, which automatically maintains the *Chikyu* in a fixed position using GPS and acoustic transponders, worked extremely well. It was able to hold the ship within a 15-meter radius during the typhoon, when wind speeds reached 30 meters a second. Most important was that we were able to verify through the system integration testing that the *Chikyu* systems work: it did its job as a scientific drilling ship. We will, of course, be proceeding with further upgrades. Meanwhile, the trial cruises off the coast of Africa (Kenya) and off the coast of Australia through August 2007 will be opportunities to continue mastering operations on *Chikyu* and accumulate more technological expertise. We expect to be fully prepared when we start NanTroSEIZE, our first international expedition, in the fall of 2007.



Moon pool in strong weather due to a low-pressure system


On the drill floor while assembling the riser pipe

Successful System Integration Tests Prove *Chikyu*'s Performance as a Scientific Deep Sea Drilling Vessel

Connecting riser pipe using six enormous bolts

The staff watches as the upper part of the BOP is recovered aboard ship

System integration testing was a critical point in the test drilling carried out east of the Shimokita Peninsula by the *Chikyu* from August through October 2006. The battery of tests for phase 2 system integration testing, building on last year's tests, were carried out in parallel with drilling operations. The results demonstrated once again that the *Chikyu* delivers solid performance as an extreme deep-sea scientific drilling vessel.

Ikuo Sawada, Operation Superintendent
Drilling Operations Group
CDEX Operations Department

Motoki Kobashi, Assistant Group Leader
R&D Group, CDEX Technology Department

Yasuhiro Namba, Subsea Engineering Development
R&D Group, CDEX Technology Department

Basic Performance Verified by System Integration Testing

During phase 1 system integration tests off the Shimokita Peninsula and in Suruga Bay, we performed a variety of tests that focused on drilling equipment system performance, including drilling pipe assembly and hoisting/lowering. These included testing the system performance of the mud system, which is indispensable for riser drilling, testing the dynamic positioning system (DPS) that automatically maintains the ship's position, core sample acquisition tests, and Blow-Out Preventer (BOP) lowering tests. In phase 2, we followed up on those tests, during drilling offshore of the Shimokita Peninsula, with these five system integration tests:

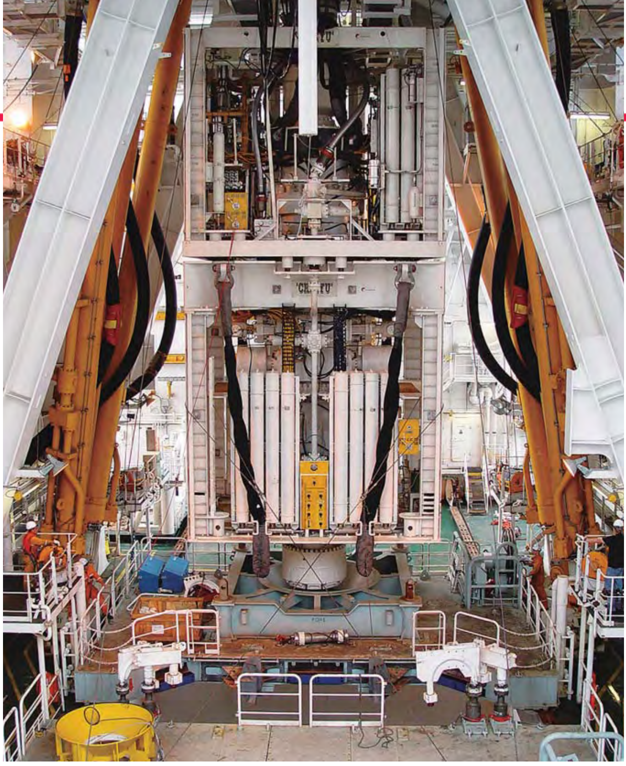
1. Lowering to the ocean floor and installing riser pipe and the BOP
2. Testing the riser pipe and BOP emergency disconnect sequence
3. Inserting casing pipe and cementing
4. Sea trial testing of the *Chikyu*'s core sampling system
5. Testing the wireline logging system

One of the main goals of this cruise was to verify, for deep-sea depths (over 1,000 meters), the basic functionality of the sequence of operations required for riser drilling.

The first test was an actual ocean field test of the core acquisition system during conventional riserless drilling before installing the BOP. Since the accretion layers on the ocean floor are comparatively soft, we acquired core samples using a core acquisition system (HPCS and ESCS coring) that basically jabs a core barrel down through the strata. These tests allowed us to verify the performance of these systems. Next, we performed a casing pipe and cementing operation test, which consists of installing a casing (to protect the borehole and stabilize the hole wall) and holding it in place with cement. Installing the 36-inch conductor pipe (about 60 m below the ocean floor) and the 20-inch casing pipe (about 520 m below the ocean floor) proceeded without difficulty.

In September it was time at last to lower the riser pipe and BOP to the ocean floor and install them. This operation consists of lowering the 380-ton BOP to the ocean floor as additional sections of riser pipe are attached to it. When it reaches the bottom, it's connected to the wellhead, which had been previously installed on the ocean floor at a depth of 1,200 m. Since we were performing this for the first time, we proceeded slowly and carefully. After an uneventful installation, we performed a variety of function and pressure tests. Then we went on to perform the riser pipe and BOP emergency disconnect operation test, again without any problems. The emergency disconnect operation consists of separating the upper part of the BOP from the lower part if, for example, the weather becomes rough, so that the ship can proceed to a safer ocean area.

After the successful emergency disconnect operation test, howev-



The BOP being loaded aboard ship. The BOP weighs over 380 tons.

Casing pipe used to protect the borehole

Retrieving the acquired core samples

The *Chikyu* is navigated and controlled from the bridge

er, we found that part of the hydraulic system in the upper part was not functioning when we tried to reconnect the upper part of the BOP to the lower part. Hauling the riser pipe and the upper part of the BOP onto the ship, we found that a valve had been damaged. It took two weeks to acquire a replacement part, repair the BOP, and reattach the upper part of the BOP. As a result, the planned riser drilling was delayed until October.

Core sample acquisition by riser drilling cancelled due to bad weather

The *Chikyu*'s first riser drilling operation started on October 4. Unfortunately, the weather deteriorated rapidly soon after drilling began, due to the impact of a low-pressure system that developed from two typhoons. We were forced to cancel our test of the rotary core barrel (RCB) core acquisition system, which had been planned for the sea trials of the riser drilling core acquisition and core acquisition system. The RCB is used to acquire cores while drilling through harder formations such as rock.

After the weather cleared, we recovered the lower part of the BOP that had been left on the ocean floor and performed the required cleanup operations on the borehole. Before that, however, we performed a physical properties wireline logging system test, which had not been carried out before. The term "physical properties wireline logging" refers to lowering measuring equipment into the borehole to measure physical, chemical, and structural characteristics of the strata. In this test, we verified the handling of the system as the equipment was lowered into and retrieved from the riser pipe.

Motoki Kobashi and Yasuhiro Namba of the CDEX Technology Department, who were in charge of the tests on the ship itself, reported on the system integration test as follows:

"Although we couldn't carry out all the scheduled tests, we largely achieved our goals. We also developed much greater confidence in the reliability of the *Chikyu*'s systems. The basics are now in place, and, while the *Chikyu* still has a lot of growing to do, I think we can say that it has finally arrived at the starting line. Our hope from now on is to respond better to the wishes of the scientists regarding technological developments and functional improvements to the *Chikyu*, so that it can make an even greater contribution."

Ikuo Sawada, who was the shipboard representative during this test drilling expedition, was also positive about the results.

"Verifying that the main job of installing the BOP and performing riser drilling can be performed reliably was a significant achievement. I'm sure that if the weather had been stable and there had been more time for drilling, we would have reached the planned 2,200 meter riser drilling depth. Knowing that the *Chikyu* carries leading edge equipment, never before available on a drilling ship, I think that both the equipment and the staff need to gain mastery and more efficiency through more actual operational experience."

The success of this test drilling expedition represents a large step forward for the *Chikyu* as we prepare for the scientific operation that is planned for September of this year.

Acquisition of Core Samples in Test Drilling

Observing and noting the features of the cores brought to the lab area

Drilling tests to the east of the Shimokita Peninsula included, in addition to the main hole in which riser drilling was used, two pilot holes drilled at locations about 100 meters away from the main hole. The core samples acquired in these drilling operations were brought to the research laboratories on board the *Chikyu*, where researchers performed a variety of measurements and analyses.

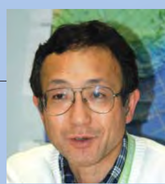
Research lab

The people behind the science

Engineering Site Survey

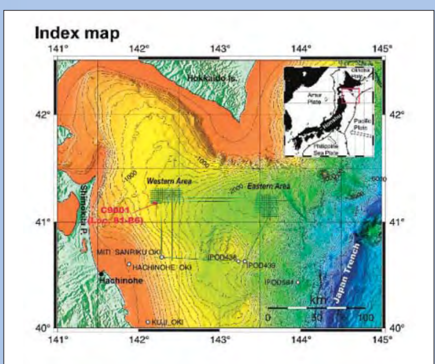
Atsushi Ibusuki

Geo-hazard Evaluation, Geological Evaluation Group, Operations Department.



A detailed feasibility study was carried out in preparation for the *Chikyu*'s first riser drilling trials, off the Shimokita Peninsula. "The Shimokita expedition was planned as a shakedown cruise to test the performance of the *Chikyu*," says Atsushi Ibusuki. "That meant we needed to do all we could to avoid risks arising from anything but the hardware itself. Above all, we needed to pick a safe place to drill." When narrowing in on candidates for the first drilling site, they sifted through publicly available data and publications, sorting out the risks and carefully considering their options. The Shimokita area was selected because drilling data were available, the site was away from ferry and other sea lanes, and the port of Hachinohe was close by for shipping supplies and other materials.

Next, the specific drilling site was chosen, based on more detailed geological surveys. In 2001, a two-dimensional seismic reflection study was carried out to learn more about deep, underground structure over a broad area. That study was followed in 2003 by a high-resolution seismic survey that revealed the shallower area in detail, since it presented a specific risk: if an accumulation of sand containing gas or water under high pressure lay at a shallow depth, the result might be an explosion at the start of drilling, and then there would be an out of control gusher on their hands. Avoiding that risk had to be a top priority. Ibusuki's team also assessed the likelihood of stores of gas under the extensive bottom-simulating reflector (BSR) discovered during the seismic survey. The team also confirmed that the seabed would support and be suitable for placing heavy equipment (the blowout prevention device, for example) by studying the slope and its' conformation with side scan sonar. A piston corer was used to return samples of the seabed to study the strength of the submarine strata. As a result of these meticulous studies, they finally decided on a drill site.

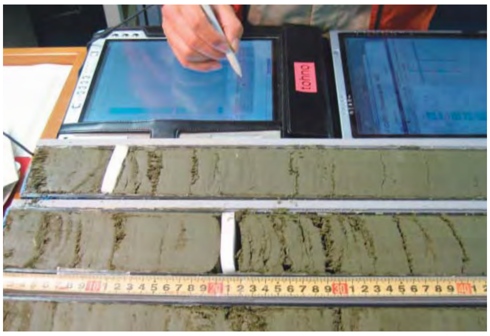


Overall image of the preliminary survey off the Shimokita Peninsula (The grid-like lines are the seismic survey measurement lines. The locations pointed out in red are the areas for this test drilling operation.)

Riser drilling always requires extensive planning. The researchers' plans must include, for example, inserting casings to enable their borehole to withstand the pressure of all the strata above and around it, and they need to order these materials well in advance. The preliminary work before the drill first starts biting into the sea floor takes four or five years—and even then unpredictable factors may enter the equation. For example, soaring oil and natural gas prices can make it hard to secure ships for seismic research. And with limited time available, the scientists may have to put up with bad weather and seasickness while conducting their studies.

The Kumano-nada expedition this year presents another set of difficulties, for many of the plans call for drilling into faults and crush zones associated with faults. In December of 2004, Ibusuki's team carried out a high-resolution seabed survey at 4-meter intervals. In April and May of 2006, they carried out a three-dimensional seismic survey in the approximately 55 by 11 kilometer area in which riser drilling will be concentrated. They are still at work analyzing those data, "But we've already produced important results, such as detecting underground structures that did not appear in two-dimensional seismic surveys," Ibusuki reports. "We're sure our research will lead to more successful drilling."

The transported core samples are cut into 1.5 m lengths at the core sample bench.



Tablet PC used for visual core description

In this test drilling operation, we were, unfortunately, not able to acquire cores from deep holes drilled via riser drilling. Nonetheless, we succeeded in acquiring cores through riserless drilling.

From the analysis of the volcanic ash and microfossils in the deepest cores recovered, we inferred that these cores include strata that were ocean floor about 650,000 years ago. The main constituent of those strata is material created by the accumulation of clay deposited by rivers, sand, marine plankton, and volcanic ejecta. Since the cores acquired during this testing include multiple wide-area volcanic ash layers that can be dated, we think that it should be possible to work from those cores to accurately determine the ages of the cores and decipher historical climate variations in the northeast region of Japan.

Some of the scientists who will participate in the *Chikyu*'s first scientific drilling operation in the Nankai Trough off Kumano, participated in this test drilling and also observed the drilling work and the core sample measurement and analysis in the research labs. These scientists made suggestions concerning the placement and set-up of equipment in the research labs, and they also had requests concerning the system (J-CORES) that will manage the measurement and analysis data. They seemed largely satisfied, however, with the work of the technicians who operated the large numbers of scientific instruments and performed the analyses.

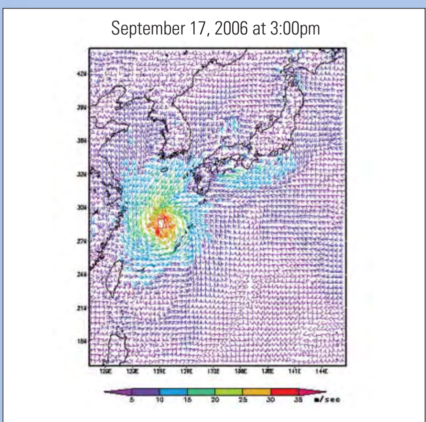
The people behind the science

Predicting the Course of Typhoons

Keiko Takahashi

Group Leader, Multiscale Simulation Research Group, Advanced Simulation and Technology Development Program, in the Earth Simulator Center

The *Chikyu*, with its tall drilling derrick, is extremely vulnerable to typhoons. Thus, when major low-pressure systems or typhoons threaten to approach the drill site, the crew of the *Chikyu* asks the Earth Simulator Center for weather prediction simulations. The center can offer predictions tightly focused on the drill site for the possible paths of a storm and the strength distribution of the accompanying winds. Its high-resolution simulations, on a 2.7 km^2 matrix, makes weather predictions for up to 72 hours into the future that the *Chikyu* team use to make decisions about their work schedules. “When a weather system is expected to approach the drill site, we get set well before the request comes from the *Chikyu*,” Dr. Takahashi told us. “Then when the request does arrive, we treat the weather simulations as a priority Earth Simulator job and spend 4-5 hrs, once or twice a day, running them.”



Earth Simulator-predicted wind direction and speed distributions.

Typically, the strength of a typhoon's winds varies. While drilling off the Shimokita Peninsula during the shakedown-cruise, the crew was able to use the wind strength prediction data for Typhoon 13 to effectively adjust the work schedule. Judging the danger from Typhoons 16 and 17 to be very high, Earth Simulator Center scientists started simulation runs two days before the request came in from the *Chikyu*. Unfortunately, those two typhoons combined to form a severe tropical storm that became stationary over the Shimokita area and produced extremely unusual weather: four days of continuous strong winds. “When we saw the results indicating a high likelihood of winds of 30 to 40 kilometers an hour, we were dismayed,” Takahashi recalled. “We rushed to let the *Chikyu* know, but time was already running out for them to evacuate.”

Learning from the 2006 experience, the group at the Earth Simulation Center is already at work developing an even higher precision model. This year, the *Chikyu* will commence international operations in an expedition to Kumano-nada, off the Kii Pensinsula of Japan, an area on a known typhoon route. To achieve greater predictive accuracy, Takahashi's group, using its coupled atmosphere-ocean model, will factor in the effects of ocean currents such as the Kuroshio Current, waves, and other oceanic phenomena. It also hopes to make longer-range predictions and to increase the resolution of its weather model to a 1 Km^2 scale, making it easier to address sudden squalls and similar events. It plans to boost the accuracy of its predictions even further, using meteorological data fed back from the *Chikyu*

Preparation for Drilling in the Nankai Trough Seismogenic Zone, Starting in Fall 2007

Message from the co-chief scientist aboard during test drilling

Nankai Trough seismogenic zone drilling-NanTroSEIZE-will be the first scientific project for the Deep-sea drilling vessel *Chikyu*. In preparation for that drilling expedition, due to start in September 2007 at Kumano-nada off the Kii Peninsula, many scientists who will be participating in NanTroSEIZE shipped on board the *Chikyu* during the Shimokita shakedown cruise to observe the drilling and on how well the research areas on the vessel are outfitted. We asked two of the NanTroSEIZE co-chief scientists for their thoughts on the *Chikyu* and on the drilling project that begins this fall.

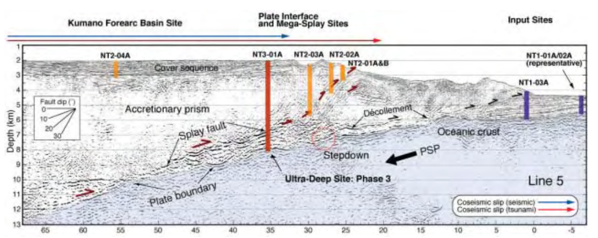
It will be the first expedition. We face enormous unknowns, but expect to bring home major scientific results.

Masataka Kinoshita
Group Leader, Institute For Research on Earth Evolution, JAMSTEC

I shipped aboard the *Chikyu* during its shakedown cruise. That gave me a chance to familiarize myself with the atmosphere of the ship, and the time I spent in discussions with the many technicians and scientists on board was rewarding. There are still issues with respect to the research area systems and facilities, but the response to our feedback has been quick, and it was reassuring to see the improvements happen. I was encouraged to observe that the technicians who handle the measurement equipment are enthusiastic, study hard, and listen carefully to the scientists.

The first thing I noticed after coming aboard was that all the announcements were in English. I had been wondering to what extent the *Chikyu* was supporting international projects, but the operations side is well prepared. In ship handling, drilling, and other divisions, the crew and staff are superbly professional. My impression was that a truly high-level support structure was in place.

Our complex seismogenic zone drilling operation in the Nankai Trough will finally get started in September of this year. In Stage 1, which will last about half a year, we will carry out five riser drilling expeditionss, drilling at six sites. In the first expedition for which I will serve as co-chief scientist, we plan to spend about two months drilling at all six sites. We will not take core samples, but will simply push forward with the drilling while measuring the surrounding structures and a variety of physical properties using the logging while drilling (LWD) method. (For more information, see page 11.) We plan to drill to about 600 meters below the sea floor at the shallow sites and to about 1,340 meters at the deeper sites, acting on our plan to assess the situation by drilling at each site before taking cores. This phase includes the idea of drilling to determine how deep we can actually drill.



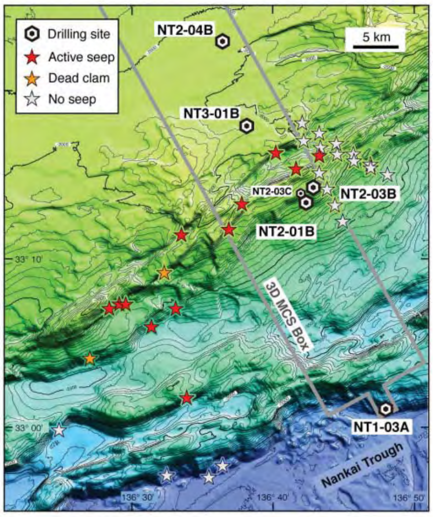
The underground structure of Nankai Trough seismogenic zone. The vertical lines (purple, orange, etc.) reflect drilling locations chosen after the seismic reflection survey.

What I see as problematic, is that this expedition will be the first scientific drilling expedition for the *Chikyu*. If the *Chikyu* were an experienced scientific drilling vessel, it would be possible to estimate in advance how much we could do under certain conditions. The *Chikyu* has superb capabilities, I know, but it is difficult to estimate how far we can drill given the effects of rough weather and the Kuroshio current system, and of the strata conditions that we drill through. It will be my job as co-chief scientist to decide if we should keep drilling at one site, or if we should give up and move on to the next drilling site. With so many unknowns facing us, making those decisions may be tricky. The key will be to perform a variety of simulations in advance and then to facilitate close communication among the scientists, the ship operations, and drilling divisions. Still, these difficulties make drilling expeditions a fascinating challenge-and one I am confident will produce many scientifically important results.

Revealing the Mechanisms of Marine Trench-type Earthquakes.

Juichiro Ashi, Assistant Professor

Graduate School of Frontier Sciences,
The University of Tokyo
Ocean Research Institute, The University of Tokyo



The drilling sites in the Nankai Trough seismogenic zone as located on a bathymetric chart of the Kumano-nada off the Kii Peninsula.
Cold seeps were discovered at red stars, and *Calyptogena soyoae*, a kind of chemosynthetic clam, were collected at the orange stars.

Unfortunately, I wasn't able to be present during this test drilling at the moment when a core was lifted from the ocean floor. However, having examined the results of the physical measurements already conducted on the cores, I understand the process by which the measurements and analysis have proceeded.

While some of the measurement, data entry, and data recording methods are still at the trial-and-error stage, the technicians are already making significant progress, and the methods used will continue to improve. There are still details to be worked out—whether brighter lighting should be provided at Lab, for example—but in general, the lab areas on the *Chikyu* are well thought-out. There is plenty of room for the work we need to do, and our living quarters are more than adequate. On the *JOIDES Resolution*, we had to share rooms, but we have individual cabins on the *Chikyu*. Yes, they are small, but they've got desks and washrooms and so on and give each of us space in which we can relax. The down side is that it was quite possible never to set foot out of one's room outside of working hours. On my next time on board the *Chikyu*, I really should use the gym and spend time in the recreation room.

This fall we will be drilling in the earthquake zone associated with the Nankai Trough—Nankai Trough Seismogenic Zone Drilling, or NanTroSEIZE. The same top scientists who worked together on the NT2-03 drilling project will be working again as a team on this challenging project. We will be drilling near the up-dip end of the seismogenic zone, in strata broken up by splay faults resulting from earthquake activity, and drilling to a depth of 1,000 meters. This project will, in addition, serve as a pilot study for the planned Stage 2 riser drilling project into the ocean floor some 3,500 meters below the surface.

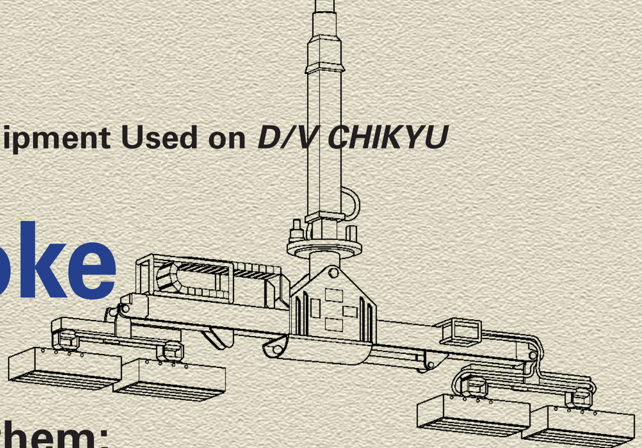
The major goal of this study is to gain a better understanding, through the sediments and broken strata in this relatively shallow part of the trough, of the temporal and spatial processes by which splay faults are formed, and to shed light on the related sedimentary history of the Kumano Basin. Sediments formed by ocean floor slippage during earthquake activity accumulate in this location. By analyzing cores containing these sediments, we can better understand when strata moved and gave rise to this slippage.

Another major point of interest is fluids. It has been demonstrated that there are exotic fluids in the cold currents welling up from the depths near the dip-end of the trough. These fluids well up from sea-floor springs and mix with sea water; but it remains unclear what they signal. By drilling in this area and retrieving fluids from greater depths, we hope to find evidence of rock damage resulting from broken strata. There are also numerous other themes that we hope to research.

Our drill site, the Nankai Trough, is a region in which major earthquakes have repeatedly occurred, and more are expected. By having *Chikyu* drill in this zone, we hope to discover more about the mechanisms that produce earthquakes and to contribute

The crew watches as the drill pipe is transported.

The samples for analysis are acquired from half-cut cores in the research lab.



The Magnetic Yoke

A powerful magnet handles the drill pipes without damaging them; delivers a large improvement in crane handling stability

The *Chikyu* is equipped with four deck cranes, two fore and two aft, to lift and manipulate drill pipes, riser pipes, and other supplies to and from supply boats as well as to moving them around aboard ship. Ordinary loads are lifted using hooks and wire cables, but handling the lengths of drill pipe, casing pipe, and riser pipe requires special yokes that attach to each end of the pipes. One type of replaceable yoke, the magnetic yoke, has four rotating electromagnetic cells, which can move the drill pipes magnetically. The gripper yokes have four claws to grasp a pipe, while the riser yoke is dedicated for use in handling the riser pipe, which comes in 30 m lengths weighing about 30 tons.

The drill pipe is made of special steel, treated for extra strength, coupled with resistance to hydrogen sulfide. Any damage to the drill pipe increases the likelihood that it will break during drilling. Therefore, the major objective of using the magnetic yoke is to minimize the chance of scratching or otherwise injuring the pipe, which would be likely if drill pipes were handled with the usual gripper yoke. Using gripper yokes to lift pipes from the pipe rack could even damage the pipes lying beneath it. This is not a problem with the magnetic yoke. It also balances the pipe stably, making handling easy and fast.

The magnetic yoke is magnetized by passing an electric current through it, and it remains magnetized until the current passes through it again, demagnetizing via the on/off switch. Thus, if electric power were lost during handling of a pipe, the yoke would remain magnetized and the pipe would not fall. For heavy pipes, the magnetic cells are arranged vertically to maximize the contact area. For lightweight pipes, they are arranged horizontally to grip several lengths of pipe at once. The yokes can safely handle up to 5 tons at once. Drill pipes are each about 10 meters long and weigh several hundred kilograms. Since four are connected in drilling, the magnetic yoke was designed to handle four at once.

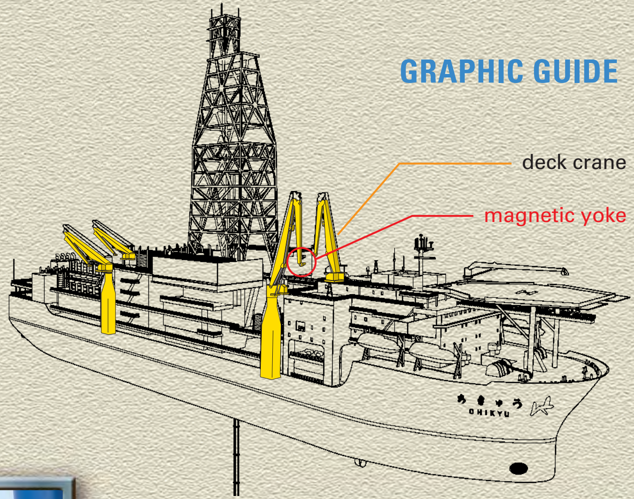
One concern was whether the magnetic yoke might affect the paelomagnetism recorded in the cores. Minerals in the earth, exposed to the earth's magnetic field, become magnets; their orientation being fixed when the strata solidify, turning them into fossil compasses. Measuring their fields and comparing them with other measurements of the earth's magnetic fields allows us to use these fossil compasses to gauge the age of the rocks in question. Studying the magnetic properties of cores to measure their age is thus a critical task carried out on board the *Chikyu*-but if residual magnetism in the pipes affected the cores, the results would be worthless. Thus, the possibility of the magnetic yoke's affecting the pipe was explored in detail. The results were good since the north and south poles of the cells alternate on the yoke, when lifted, the pipe itself does not become one big magnet, as scientists studying the earth's magnetic field had feared. Thus, the use of the magnetic yoke does not affect the collection of paelomagnetic data from the cores.

(News collaboration between Tomoya Inoue, CDEX and Toshiya Kanamatsu, IFREE)

The magnetic yoke attached to the large deck crane.

The magnetic yoke is mainly used with the center pipe rack, right behind the drill floor. The pipes are lifted onto a long cart called the pipe transfer system. To avoid inadvertently changing the orientation of the pipe, the system is set up so that, in auto mode, the tip of the pipe is always toward the front. Pipes are carried to the drill floor by the crane, and racked by the Hydraracker in the finger board inside the derrick.

GRAPHIC GUIDE



Arranging the magnetic cells horizontally permits handling up to five lengths of drill pipe at once. Here, the crew is lifting only one pipe, to investigate the effect of the magnetic yoke on the pipe's magnetism.

The pipe rack and deck crane at the rear of the *Chikyu*. The aft rack mainly holds riser pipe. The riser/pipe transfer system is visible in the center.

When the yoke is replaced, the system automatically checks the yoke signal, to make sure that the proper operation using the right kind of yoke is carried out. If the yoke is overloaded, an alarm goes off and the crane will not move.

When handling long, heavy pipe, the cells are arranged vertically to maximize the magnetic yoke contact area, for greater stability.

Logging-While-Drilling (LWD) technology and plans for NanTroSEIZE Stage 1

Moe Kyaw Thu
Staff Scientist, Program Operation Group, CDEX IODP Department

During the Nankai Trough SEIsmogenic Zone Experiment (NanTroSEIZE) Stage 1, five expeditions are planned with two drillships, and its first expedition will use state-of-the-art Logging While Drilling (LWD) technology for all six sites before continuing core sampling and wireline sampling in four subsequent expeditions. In the typically unstable formations associated with riserless drilling in the accretionary prism environment, LWD is the only option by which high-quality geophysical logs can be obtained, as demonstrated in other plate convergent margins by ODP Legs 156 and 171A (N. Barbados Ridge), 170 and 205 (Costa Rica), and 196 (Nankai Muroto transect).

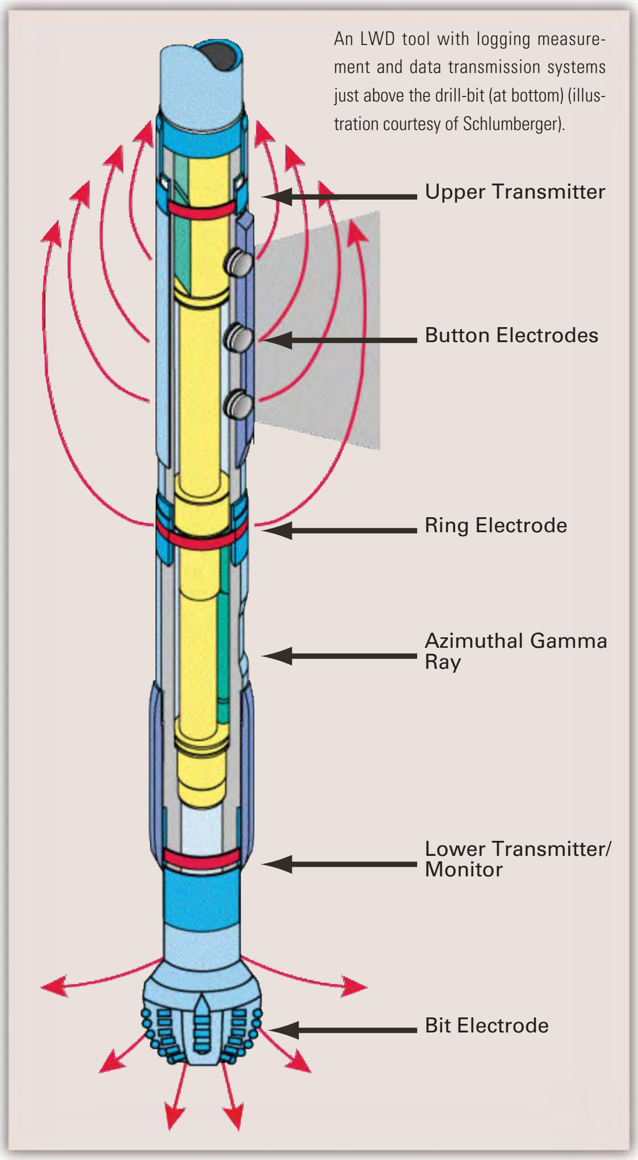
What is LWD and how important is its' technology in scientific drilling? Logging While Drilling is a technique of measuring continuous and in-situ geological formation properties while drilling. LWD, along with Measurement While Drilling (MWD) and various measurement systems, provides real-time wellbore directional surveys, petrophysical well logs, and drilling information.

An LWD tool consists of three elements: downhole logging sensors, a data transmission system and a surface interface. The logging sensors are placed just behind the drill bit in specialized drill collars (length of reinforced drilling string) and are active in the hole during drilling. The signals and data recorded by the sensors are transmitted to the surface by pulse telemetry through the drilling mud and collected by surface receivers. The formation is therefore logged very soon after drilling, a matter of minutes to several hours, depending on drilling rate and the distance between the bit and the downhole sensors.

LWD tools are of critical importance and provide the only in-situ measurements for various cases, such as in the top interval just beneath the seafloor, alternating hard and soft rock sequences, gas hydrates, etc.

In six months time, NanTroSEIZE Stage 1 will begin with the LWD-only expedition of *Chikyu*, and will deploy the most extensive and advanced LWD system to date in the 40-year history of scientific drilling. In conjunction with the cores taken from later expeditions, the principal goals of the LWD program are to document: *in situ* physical properties; lithostratigraphy; stratigraphic and structural features; sonic to seismic scale velocity data for core-log-seismic integration; geology; mechanical state, fluid content, and stress conditions.

The depth objectives for this expedition range from about 500 to 1400 m below the sea floor (mbsf), while minimum measurements will include: natural gamma radiation, azimuthal gamma-ray density, neutron porosity, full waveform sonic velocity, azimuthal resistivity imaging, zero-offset vertical seismic profile (VSP), ultrasonic caliper, and annular fluid pressure. In addition, the potential for using a sidewall pore fluid pressure and permeability-measuring tool is under investigation.



An LWD tool with logging measurement and data transmission systems just above the drill-bit (at bottom) (illustration courtesy of Schlumberger).

Chikyu's Scientific Research Managers

Staff Scientists Coordinate On-board Researchers

Kan Aoike (in front)
Staff Scientist, Program Operation Group, CDEX IODP Department

Hideki Masago (in back)
Staff Scientist, Program Operation Group, CDEX IODP Department

The most important job of the Science Planning Division's staff scientists is to manage deep-sea drilling expeditions conducted by the *Chikyu*. As expedition project managers, they are responsible for managing the drilling expeditions and are constantly in touch with co-chief scientistsrs; coordinating scientist activities and providing liaison support and arranging schedules between the ship's crew and the drilling team members.

That is not, however, all they do. Their contributions begin more than a year before a drilling expedition begins, as they work with scientists to develop the drilling plans for the *Chikyu* and help implement the science plan. This task begins with the preparation of a scientific prospectus outlining the drilling plan details. When the drilling expedition is completed, they hold meetings with the science party and assist with the preparation of science reports.

Starting in September 2007, Hideki Masago is one of the staff scientists for the Nankai Seismogenic Zone Drilling (NanTroSEIZE) project in the seismically active Nankai Trough region. Masago asked expedition managers for other ODP international deep-sea drilling projects, "What is the most important qualification for an expedition manager?" Their instant reply was "Patience." his instant reply was "Patience." On-board researchers continually come up with one request after another. The expedition manager has to listen carefully, pull all the different views together, and then negotiate with the ship's crew and drilling team members before drilling can proceed. "You can't do this work if you have a short temper," says Kan Aoike, who was in charge of last year's shakedown cruise drilling experiment east of the Shimokita Peninsula.

Drilling at sea doesn't always go as planned: equipment breaks down, the ship has to take shelter from storms, and the project may fall behind schedule. Problems with the drill pipe may also occur, putting a halt to the drilling. It can be difficult reaching consensus on whether or not to keep drilling in the same spot or to move to the next borehole.

It isn't easy keeping things going smoothly on a drilling expedition when people are arguing from radically different positions. "Safety has to be the No. 1 priority. After that, we have to do everything possible to maximize the scientific results. That's our job," says Masago.

What, then, is the appeal of this work for these two men? "The science that the *Chikyu* will be doing will take us to places that no one has ever gone before. In these international projects, our nation's prestige will be on the line. To be able to work at the core of this kind of research is fascinating," says Aoike.

"There are limits to what any one person can do by himself. The work we are attempting with the *Chikyu* is a huge challenge. At the same time, this project combines so much talent that I take pride in (being part of the team) pulling it all together," says Masago.

Staff scientists must be not only talented scientists but also capable managers. These are people who thrive on challenges: the more difficult their work is, the more meaningful it is for them.

Crew and technicians in a meeting.

Kan Aoike, CDEX staff scientist, examines core samples.

Wanting to know more! The world of the new earth sciences.

At last, it´s really begun. With the beginning of international operations by the Deep-sea drilling vessel *Chikyu* in the fall of 2007, the dream of 21st century science to examine Earth system science and pioneer new discoveries in the biological and earth sciences has come a step closer to reality. The event information provided here is intended to stimulate interest and deepen understanding of the earth sciences, a field that is attracting attention from all around the world.

The Sand for Students Program

Finding solutions to the world´s mysteries in grains of sand

Sand for Students is an IODP education and outreach program in which junior high and high school students collect, investigate and analyze sand from nearby riverbanks or seashores and contribute their results to the creation of a global sand database. Sand may look the same wherever we find it, but in fact there are differences that reveal all sorts of interesting things about the parts of the world from which they come. Sand carried to the sea by rivers forms layers of sediment. These slowly pile up and become the surface of the earth on which we all live. We want participating students to understand this process and acquire a deeper interest in earth and environmental sciences.

The data collected by this program will be added to that collected by the *Chikyu* and other experiments related to the earth´s core collected through deep-sea drilling – the total amount of data collected will be huge. Other benefits include enjoying nature as they engage in the manual and physical exercise involved in doing fieldwork. And nothing would make us happier than encouraging and stimulating students to think more deeply and show more curiosity about the world in which we live.

For details, please see our website.

SAND FOR STUDENTS

[Sand for Students] Website URL : http://www.sand4students.net/

Journey to the Center of the Earth!

Mantle and Earth Movements—Surprises from the Earth's Core at the National Science Museum

In December 2006, the National Science Museum in Tokyo (Ueno) opened its new Theater-360 (SanRokuMaru), incorporating a 360-degree spherical image system unveiled at EXPO 2005 in Aiichi Japan. Images are displayed inside a giant dome, on a scale 1/1 millionth of that of the Earth itself.

Three videos are currently being shown. One is an original film about mantle convection and global tectonics arranged by JAMSTEC. Taking full advantage of the 360-degree perspective the theater provides, this film provides an easy-to-understand introduction to the key features of the Earth's internal structure and changes over the last four billion years. It shows the forces driving the earth's movements, the cold plumes sinking toward the Earth's center as hot plumes well up toward the surface, creating convection currents in the mantle. Tectonic plates move, volcanoes erupt, and mountains are formed.

The film's powerful imagery unveils the mechanisms that make mantle convection one of the prime shapers of the global environment. As it concludes, the film introduces the Deep-Sea Drilling Vessel *Chikyu*, with which the world is beginning to explore the mantle. It reveals a world full of surprises. Don't miss experiencing them for yourself!

[National Science Museum, Tokyo]
Website URL: http://www.kahaku.go.jp
Address: 7-20 Ueno Park, Taito-ku, Tokyo

International Year of Planet Earth (IYPE), 2007-2009

2008 was proclaimed the International Year of Planet Earth by a unanimous vote of the 191 members of the UN General Assembly in response to an initiative from the International Union of Geological Sciences (IUGS) and UNESCO. "Earth sciences for Society" is the theme of the year, whose outreach activities will in fact stretch over a three-year period from 2007 to 2009 and include ten scientific topics: disasters, resources, health, climate, groundwater, oceans, soil, the interior of the earth, megacities, and life. In Japan, numerous symposia and events at museums of science and technology are being held under the auspices of the Science Council of Japan. JAMSTEC is also cooperating in IODP outreach activities. by the International Ocean Drilling Program (IODP).

planetearth® Earth Sciences for Society

[International Year of Planet Earth]
Website URL : http://www.esfs.org/

For the FUTURE Perspective of CDEX Director-General Asahiko Taira

The NanTroSEIZE Expeditions Are Ready to Go!

2006 heralded two important events for the Deep-sea drilling vessel *Chikyu*; the Shimokita shakedown cruise and test drilling in the waters east of the Shimokita Peninsula, and the deep-sea drilling experiment, conducted within the framework of overseas test drilling, in the ocean off Kenya. To me the implications of these two events can be summed up as follows: "We're much more confident." The *Chikyu*'s capabilities, and especially the dynamic positioning system that enables us to maintain the position of so large a vessel, are truly outstanding. The drilling equipment is extremely complicated, but after a few difficulties were overcome, and the system as a whole operated smoothly. Being able to operate successfully during such a long period of tests, both off the Shimokita Peninsula and overseas, gives us great confidence.

Our New Challenge in the Nakai Trough

Because drilling in the seismically active zone around the Nankai Trough is a long-term project, it might be said that this year our first objective is just to get our toe in the water. I myself have been involved in four scientific drilling expeditions to the Nankai Trough, on the *Glomar Challenger* and *JOIDES Resolution*, so I know from personal experience how difficult drilling in this region can be. Our problems include, of course, the Kuroshio Current and typhoons. But the biggest single issue is the geology: alternating bands of sand and mud facies. The bands of sand have undergone little solidification, because without a rise in temperature and new limestone or magnesium carbonate as glue, grains of sand do not pack together. Thus, while the mud on the sea floor has solidified, the sandy strata remain soft and friable to a considerable depth. That means there are two points that make drilling at the Kumano-nada more than a little challenging. First, we do not have any idea how deep the sand is. If a thick band of sand is widespread on the Kumano-nada sea floor, we simply may not be able to drill there. The second problem is the force of the Kuroshio Current and the pressure it will exert on the riser pipe during drilling. That is a difficulty we had anticipated, and with our greater confidence in the *Chikyu*'s capabilities, we are increasingly certain that we will be able to overcome it.

The preparations for drilling in the Nankai Trough are formidable, but will be, we are sure, productive. We are acquiring valuable experience and putting what we learn into practice. It is certainly true that drilling at depths never before attempted by human beings is a huge challenge. But our commitment to overcoming all the obstacles is what drives us to ensure that the Nankai drilling will be a scientific success.

Until recently, the Nankai Trough seismogenic zone, source of massive earthquakes, had seemed quiescent. Now, however, we understand more about the slow slip events and other movements taking place in this region. Our core samples, borehole monitoring, and other research into changes in the earth's structure will give us a clearer picture of activity taking place in the trough. Our ultimate aim is to obtain information on the mechanisms of earthquakes, providing significant result that will contribute to future earthquake prediction systems.

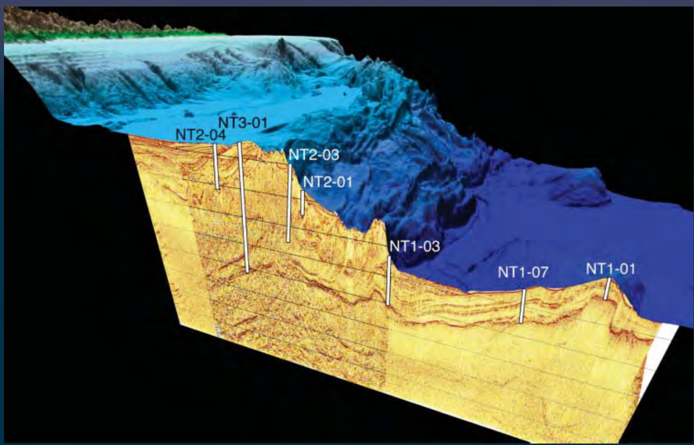
A Challenge for the Whole World

We are pleased, indeed, that the state-of-the-art Deep-sea drilling vessel *Chikyu* is Japan's contribution to a truly global effort, the Integrated Ocean Drilling Program (IODP). It is, at the same time, an opportunity for Japan to assemble the expertise of scientists from all over the world to study the seismogenic zones that have such profound effects on Japan itself. US will be contributing a successor ship to the *JOIDES Resolution* to join us in this drilling project. Fully living up to its name, the IODP is a truly outstanding example of international cooperation.

All of the participants in this international project are eager to increase interest in the earth, this planet on which we all live, and to stimulate the curiosity of people everywhere. It is our mission to communicate to everyone just how important the *Chikyu* is to this international effort.

Close Up

Topographic chart of the Nankai Trough sea bottom off the Kii Peninsula and it´s underlying structure mapped using 3D seismic reflection imaging



Here we can clearly see the internal structure of the seafloor where the subducting Pacific Plate pushes under the Eurasian Plate. These images are from the 3D seismic reflection survey for IODP Nankai Trough Seismogenic Zone Experiment, or NanTroSEIZE. This project is scheduled to include drilling in a total of six spots on the Pacific Ocean floor, into deposits in front of the subducting plate, the subduction zone itself, the slanted face of the trough, and forearc sediments. The project´s aims include sequential understanding of changes in the biology and petrology of deposits created by subduction. Topics for Stage 2 and subsequent stages include drilling directly into seismically active layers, allowing direct investigation of the mineralogy and sources of earthquakes. Measurements taken in the borehole will investigate long-term changes in seismically active zones.

Cover's Note

Sunrise over the distant Shimokita Peninsula as seen from *Chikyu*

CHIKYU HAKKEN
— EARTH DISCOVERY —
IODP JAPAN Implementing Organization Report
Volume 4 March, 2007
IODP INTEGRATED OCEAN DRILLING PROGRAM
Published by the Center for Deep Earth Exploration, Japan Agency for Marine-Earth Science and Technology,
3173-25 Showa-machi, Kanazawa-ku, Yokohama, 236-0001 JAPAN, TEL: +81-45-778-5643, FAX: +81-45-778-5704,
EMAIL: cdex@jamstec.go.jp, Website: http://www.jamstec.go.jp/chikyu/