D/V *Chikyu* IODP Operation History

Nankai Trough / Tohoku / Shimokita / Okinawa / Muroto / Other

※Exp= Expedition

2005
- **July 2005** — Chikyu was delivered to JAMSTEC

2006
- **Nov – Dec 2005** — Shimokita Shakedown
- **July – Nov 2006** — Shimokita Shakedown

2007

2008
- **Sep 2007 - Feb 2008** — IODP Exp. 314 / 315 / 316 NanTroSEIZE

2009
- **May - Oct 2009** — IODP Exp. 319 / 322 NanTroSEIZE C9 Riser/Inputs

2010
- **July 2010** — IODP Exp. 326 NanTroSEIZE C2 Riser
- **Sep - Oct 2010** — IODP Exp. 331 Okinawa Deep Hot Biosphere

2011
- **Oct 2010 - Jan 2011** — IODP Exp. 332 / 333 NanTroSEIZE LTBMS/Inputs
- **March 11 2011** — One thruster damaged in Hachinohe port by Tohoku Earthquake

2012
- **April - May 2012** — IODP Exp. 343 Japan Trench Fast Drilling Project
- **July 2012** — IODP Exp. 343T Japan Trench Fast Drilling Project II
- **Aug - Sep 2012** — IODP Exp. 337 Deep Coalbed Biosphere

2013
- **Oct 2012 - Jan 2013** — IODP Exp. 338 NanTroSEIZE C2 Riser Ⅰ

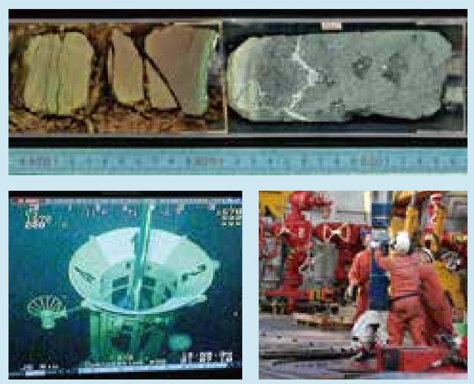
2014
- **Sep 2013 - Jan 2014** — IODP Exp. 348 NanTroSEIZE C2 Riser Ⅱ

2016
- **March - April 2016** — IODP Exp.365 NanTroSEIZE C10 LTBMS
- **Sep - Nov 2016** — IODP Exp.370 T-Limit of the Deep Biosphere

2018
- **Jan - Feb 2018** — IODP Exp.380 NanTroSEIZE C6 LTBMS

2019
- **Oct 2018 - March 2019** — IODP Exp.358 NanTroSEIZE C2 Riser III

Exp. 319 / 322 / 326 / 332 / 333



Exp. 343 / 343T

Exp. 365 / 370 / 380 / 358

D/V *Chikyu* IODP drilling records (as of March 2019)

Number of Expeditions	18
Expedition days	1,114 days
Drilling	45.2 km
Expedition holes	114 holes
Sampled core lengths	6 km
Number of cores	1,131 cores
Deepest water depth record	6,900 m (IODP Exp. 343)
Deepest hole record	3,262.5 m (IODP Exp. 358)

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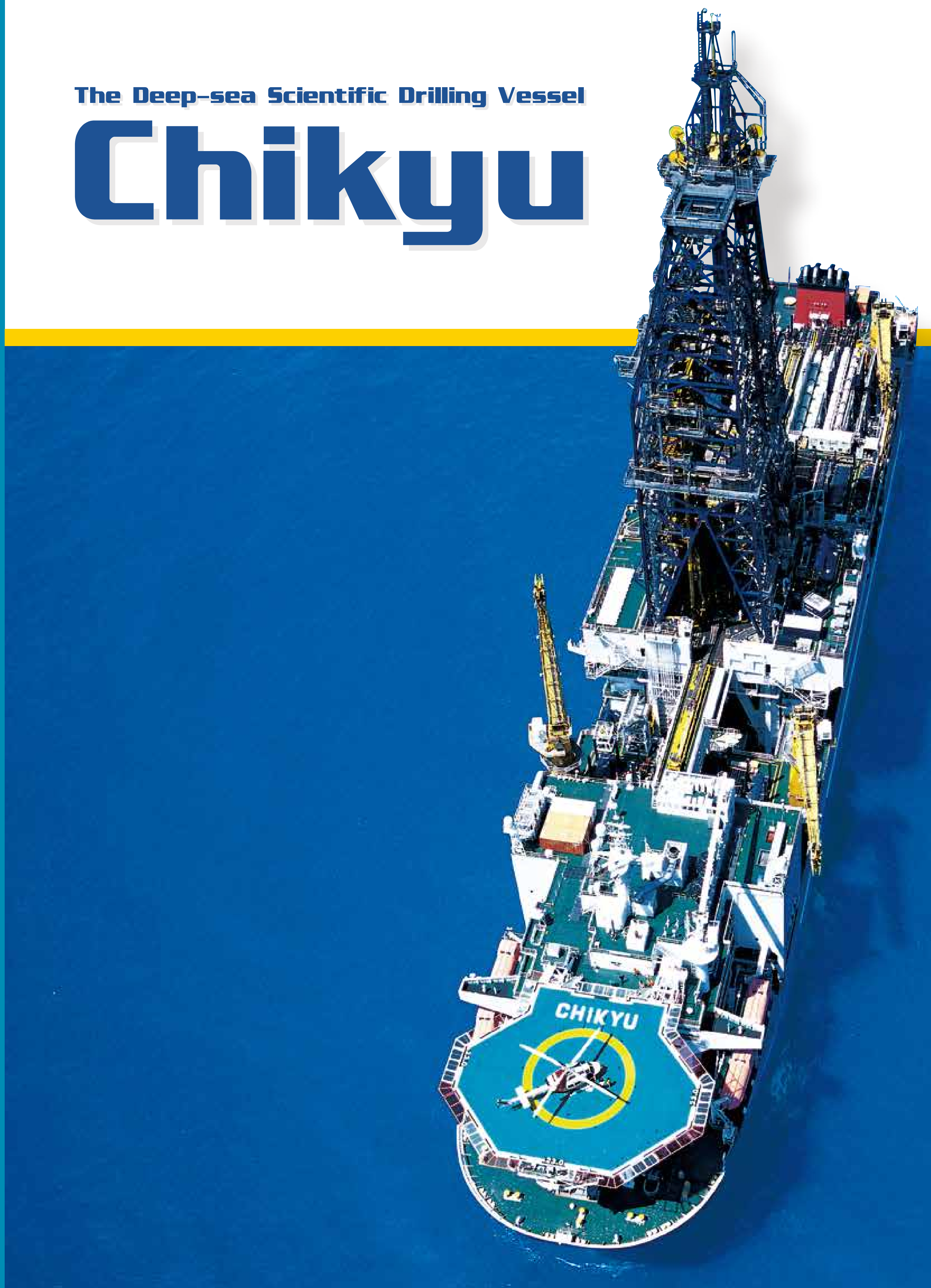
Revised : March 2020

The Deep-sea Scientific Drilling Vessel

Chikyu



Chikyu – The World's Largest Scientific Drillship

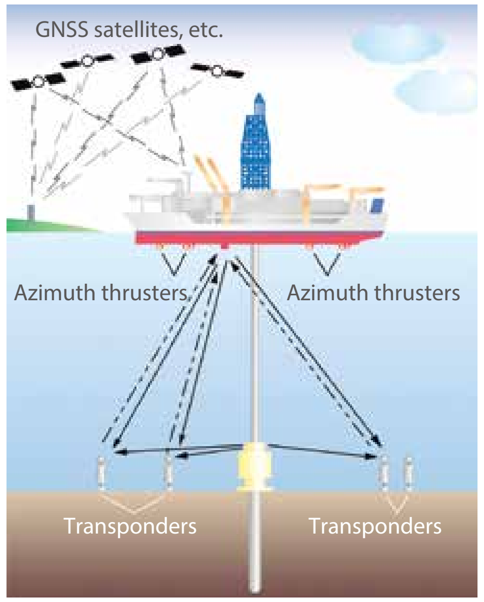
The deep-sea scientific drilling vessel *Chikyu* is the world's first riser-drilling system equipped scientific drillship, with an ultra-deep drilling capability, that puts the seismogenic zones of megathrust earthquakes and possibly the mantle within scientific reach. Measuring 210 m in length, 38 m wide, and with a derrick rising 130 m from the bottom of the hull, the 56,700 ton *Chikyu* features fully-equipped geological, geochemical, and biological labs, equal to any shore-based research institute. The *Chikyu* can remain on site, drilling, for several months at a time, all while providing a home and work place for up to 200 researchers, technicians, drilling and ship crew. This is *Chikyu*, Japan's contribution to scientific ocean drilling and the International Ocean Discovery Program, all in one vessel bringing together a world-class team of international researchers and support staff.

Chikyu Specifications

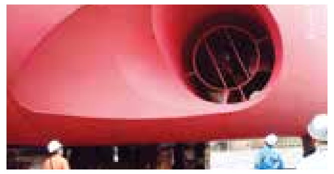
Class	NK (Nippon Kaiji Kyokai)
Navigation area	Ocean going areas (Worldwide)
Length	210 m
Beam	38 m
Depth	16.2 m
Height (From sea Level)	121 m
Height (From ship bottom)	130 m
Draft	9.2 m
Gross tonnage	56,752 tons
Cruising speed	12 knots
Main propulsion system	Diesel electric propulsion
Complement	200 people
Range	Approx.14,800 nautical miles (Full location,10 knots)
Propeller	Azimuth thruster 4,200 kW (5,710PS) x6 Side thruster 2,550 kW (3,470PS) x1
Power generator	5,000 kW x 6, 2,500 kW x 2
Dynamic Positioning System	NK DPS-B
Drilling system	Riser drilling system
max water depth	2,500 m (Riser drilling)
max Length of drill strings	10,000 m
Ship equiqment	Helicopter deck etc.
Keel-laying ceremony	25 April 2001
Launching ceremony	18 January 2002
Delivery ceremony	29 July 2005

Dynamic Positioning System (DPS)

This system continuously maintains *Chikyu*'s precise location in the ocean, unaffected by winds or currents. Both satellite-based GNSS and acoustic positioning - using transponders installed on the seafloor - are used to confirm *Chikyu*'s position. The DPS uses 6 azimuth thrusters, each capable of rotating 360º, and a side thruster to maintain the ship in a specific position and orientation.



Azimuth thruster



Side thruster

Transponder to be installed on the ocean floor for acoustic positioning.

Helicopter Deck

Living Area

Mess room

Cabin

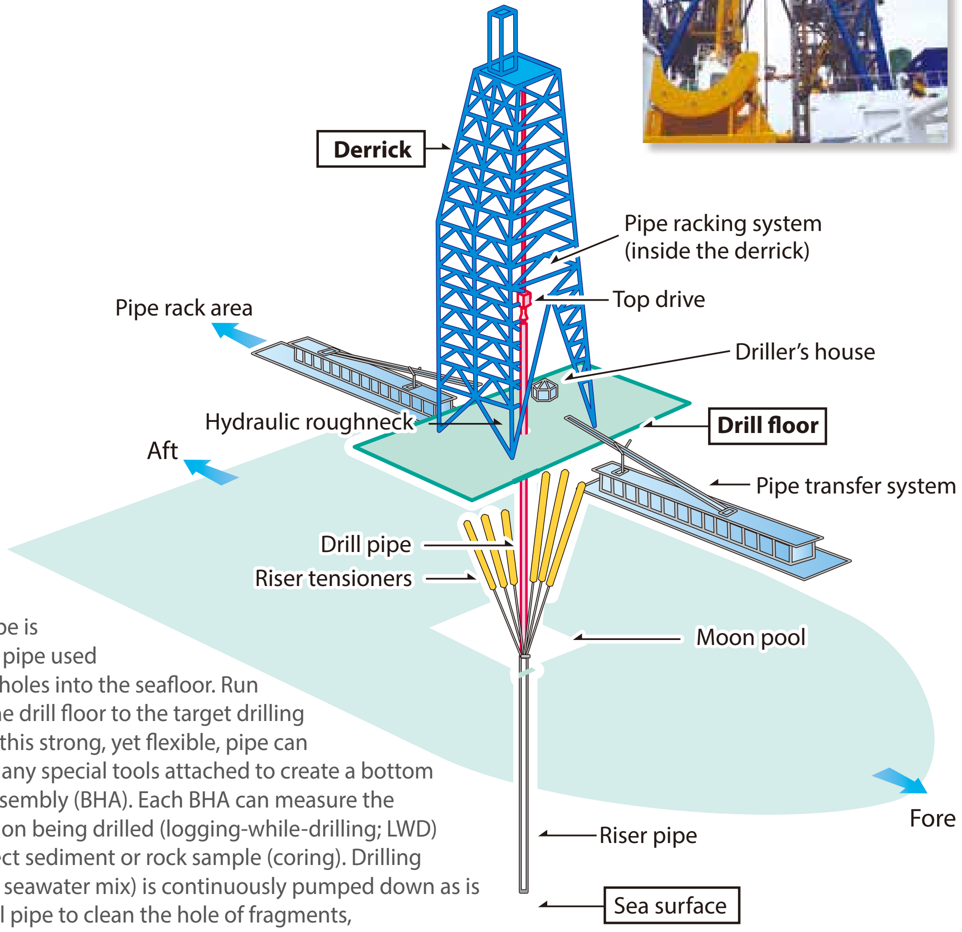
Bridge

Drill floor

The Drill Floor is the Gateway to the Earth's Subsurface

Derrick

The *Chikyu*'s amidships derrick towers 121 m above sea level. The derrick is capable of suspending a load of 1,250 tons.



Pipe rack

Pipe racks (fore & aft) store drill pipes (each joint ca. 9.5 m) and casing pipes. 10,000 m of drill pipes can be stored. Other tools and equipments for downhole can be stored here as well.

Drill pipe

Drill pipe is special pipe used to drill holes into the seafloor. Run from the drill floor to the target drilling depth, this strong, yet flexible, pipe can have many special tools attached to create a bottom hole assembly (BHA). Each BHA can measure the formation being drilled (logging-while-drilling; LWD) or collect sediment or rock sample (coring). Drilling mud (a seawater mix) is continuously pumped down as is the drill pipe to clean the hole of fragments, preserve the borehole wall, or cool the BHA as the borehole is extended deeper.

Top drive system

Top Drive System (HPS: Hydralift Power Swivel) is a special motor inside the derrick that raises, lowers, and rotates the drill pipe, and also allows drilling mud to be pumped, downhole. The HPS can hold 10,000 m of drill pipes and tools.

Hydraulic roughneck

The "Iron Rough neck" tightens and loosens all drill pipes and casing pipes joints from each other.

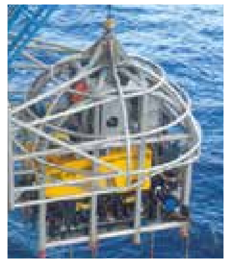
Driller's house

The driller's house ("Dog House") is where all drilling and downhole operations are controlled and monitored. A modern digital system assists the drillers in manipulating all tools and equipment on the drill floor, and monitors downhole conditions in realtime. The BOP control system are also controlled and monitored from here.

Blow-Out Preventer (BOP)

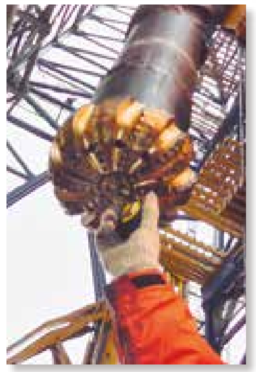
BOA is a special stack of high-pressure valves designed to seal the borehole and the riser pipe, in the event strong backpressure from the formation pushes into the borehole. The BOP can separate into 2 halves, so that the borehole can be left in a stable posture if *Chikyu* needs to leave in an emergency, such as bad weather or electrical blackout on the ship. *Chikyu* can then return and safely continue drilling. 14.5 m tall & weighs 380 tons.

Remotely Operated Vehicle (ROV)



The *Chikyu* has an ROV able to operate ca. 3,000 m below sea level. The ROV is equipped with B/W and color TV cameras, 2 manupulator arms, and can use other tools as needed.

Core bit



Poly-crystalline diamond compact (PDC) core bit drills and trims core samples. The coring systems are designed for differing sediment or rock hardness, and the PDC bits are also specifically designed according to the formation being drilled.

Moon pool

A 22 m x 12 m rectangular opening located amidship. All drilling, coring, and riser operations use this opening to the sea floor.

Riser tensioners

Special hydraulic pistons to secure the riser pipe to *Chikyu*, which also can apply slack or tension on the riser pipe, as needed. They help neutralize some of the heave from *Chikyu*'s motion in the ocean while drilling under DPS.

Pipe racking system

The pipe racker moves pipe stands (3-4 connected joints of drill pipe) from the standby vertical pipe racks to the well center in the middle of the drill floor. There are 23-armed pipe rackers on the rig floor, remotely controlled from the driller's house.

Riser pipe

Special larger diameter, bouyant pipe to connect the mud circulation system to the seafloor, making the circulation a closed system. Drill pipes and tools pass through the center, and drilling mud and cuttings return to *Chikyu* for recycling.

Casing pipe

Special large-diameter pipe placed inside a borehole, to protect the borehole from collapsing. Casing pipe allows a borehole to be re-entered with special logging tools, coring tools, deepen the borehole, or place special sensors to measure and record the characteristics of the deep sediment/rock formations.

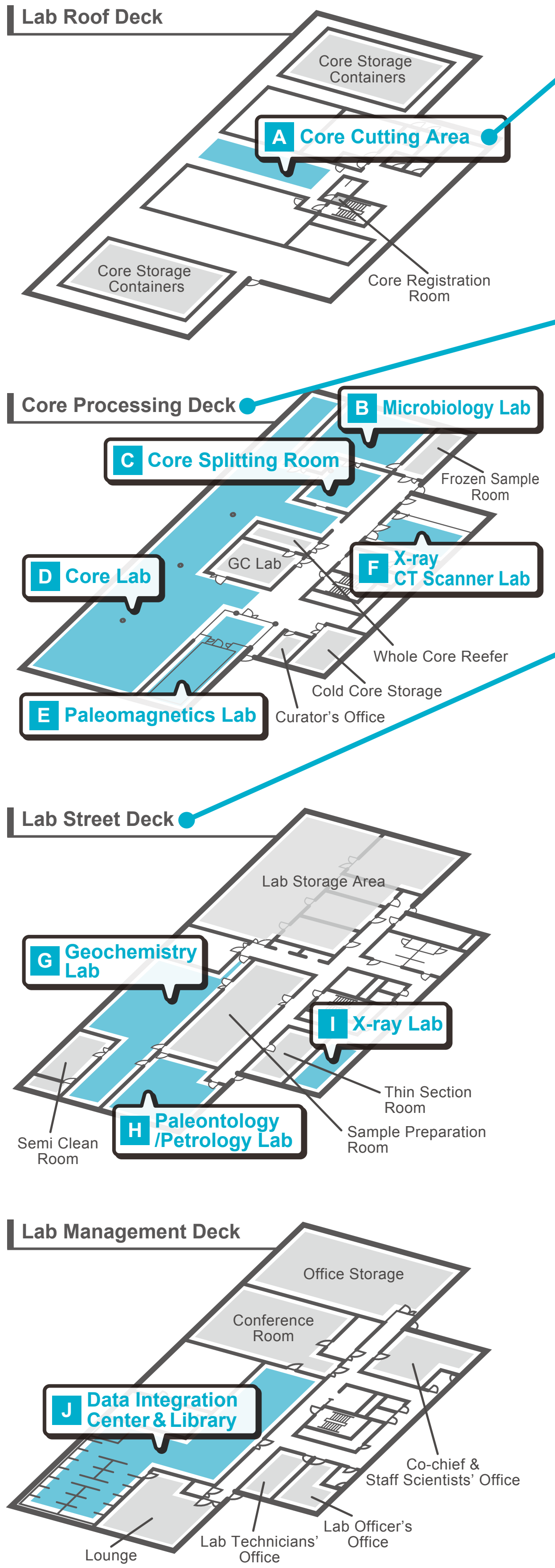
Pipe transfer system

The riser pipe transfer system (RTS) helps move riser pipes to and from the rig floor, and it can be used to move other heavy objects to the rigfloor as well.

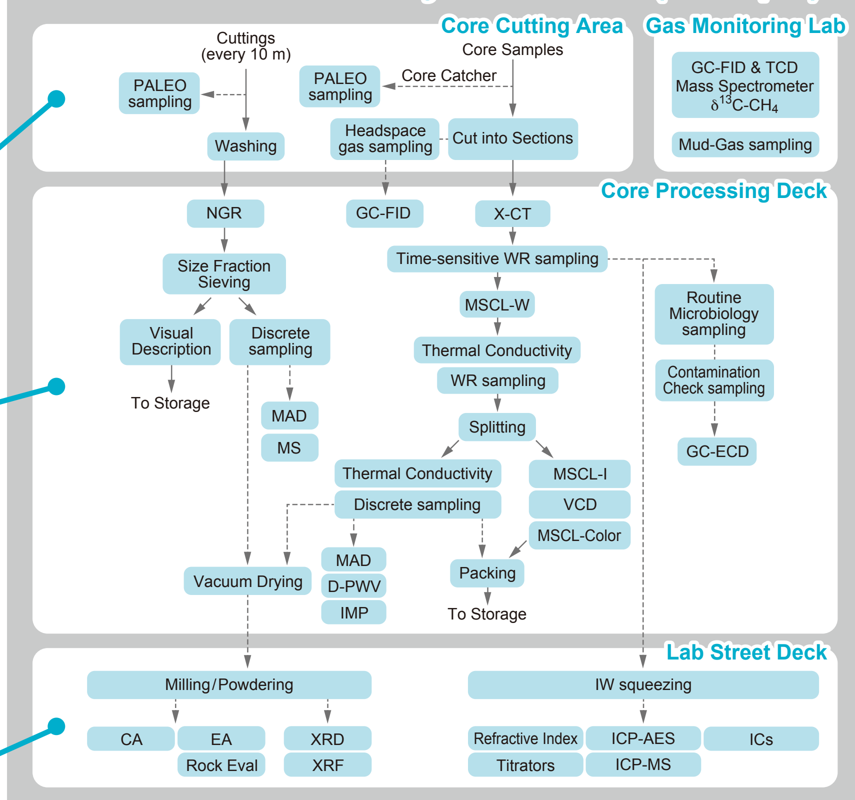
Shipboard laboratory, the first place scientists make new discoveries

Laboratory Area

This is where the main scientific work of the expedition happens. Lab Roof Deck is for initial core preparation, Core Processing Deck and Lab Street Deck are for sampling and sample analysis, and Lab Management Deck is for meetings, discussion and administration.



Chikyu Core Flow (Example)



CA: Carbonate Analysis
EA: Bulk C, N, S Analysis
D-PWV: P-Wave Velocity Measurement with Discrete Sample
GC-ECD: Contamination Test with chemical tracer
GC-FID: Headspace Hydrocarbon Gas Analysis
GC-TCD: Headspace Inorganic Gas Analysis
ICs: Measurement of Major Cation and Anion Content in IW
ICP-AES: Measurement of Minor Element Content in IW
ICP-MS: Measurement of Trace Element Content in IW
IMP: Resistivity Measurement with Impedance
IW: Interstitial Water
MAD: Moisture And Density Measurement
MS: Magnetic Susceptibility Measurement
MSCL-C: Color Reflectance Measurement
MSCL-I: Core Image Scanning
MSCL-W: Nondestructive Physical Property Measurement
NGR: Natural Gamma Ray Measurement
PALEO: Micropaleontology Analysis
Titrators: Measurement of pmH, Alkalinity and Chlorinity in IW
VCD: Visual Core Description
WR: Whole Round Core
X-CT: X-ray Computed Tomography
XRD: X-Ray Diffraction Analysis
XRF: Bulk Major Elements Analysis

What is done in the laboratory?

A Core Cutting Area

This is where the 9.5 m long core samples are cut into sections, labelled, and registered in the database. Some gas and geochemical sampling takes place here as well.

B Microbiology Lab

This lab contains clean bench, fume hoods, incubation chambers and freezers for storing microbiological samples. Anaerobic glove box and other equipment are available as needed.

C Core Splitting Room

A whole round core section is split into working and archive halves in this room. A diamond band saw is used for splitting hard or brittle samples to minimize possible disturbance on the sample. Other tools and methods are also available depending on the type and size of samples.

D Core Lab

This multipurpose space is designed for the efficient examination, description, and sampling of split core sections. Special facilities for processing cuttings samples from riser drilling are also available.

E Paleomagnetics Lab

Magnetic properties of cores are natural archives of the Earth, and often provide highly sensitive indicators of climate, environment and age of the penetrated formations.

F X-ray CT Scanner Lab

The CT Scanner, and control station, are located here. All images scanned are available on a separate work station for scientists.

G Geochemistry Lab

An extensive and well-equipped geochemistry lab, including hoods, and a semi-clean room.

H Paleontology / Petrology Lab

Microscopes for paleontological research are available in this lab.

I X-ray Lab

The XRF and XRD tools, and other analytical devices are located here.

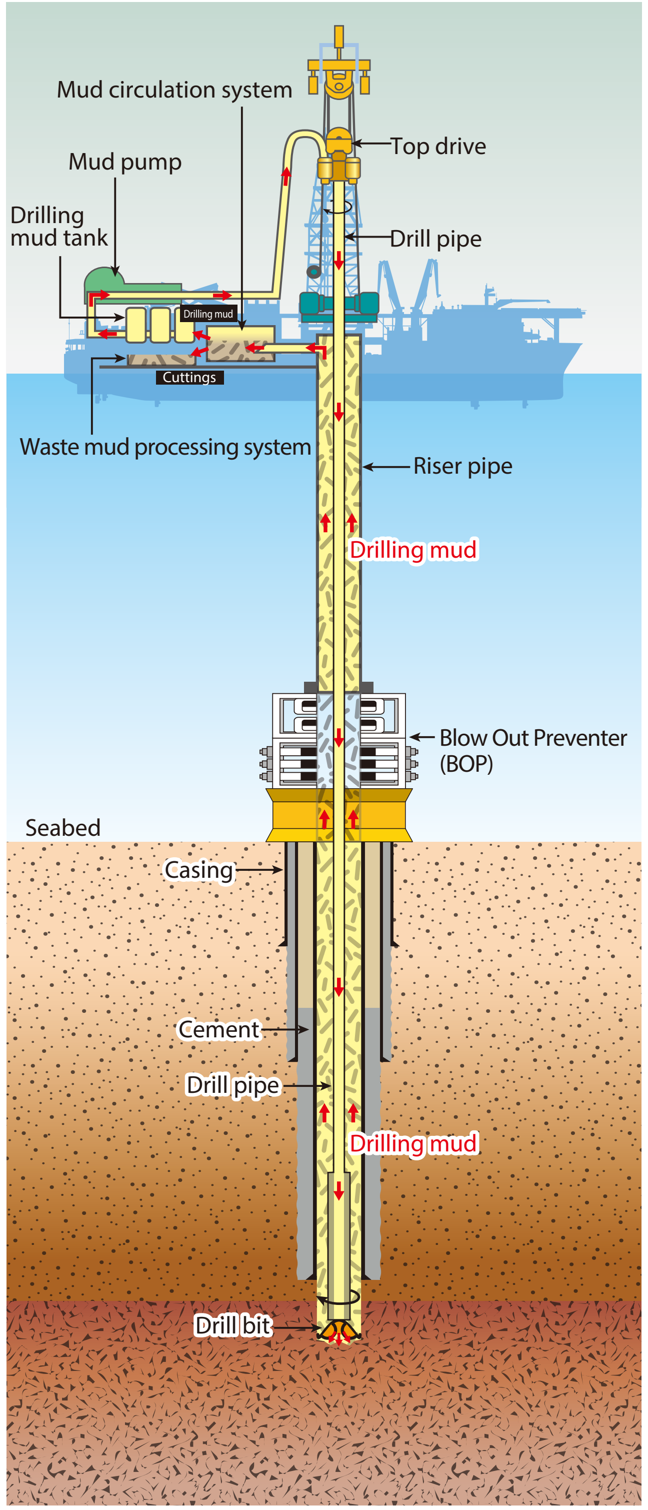
J Data Integration Center & Library

Individual working desks and several working spaces for expedition scientists. A large work table, and work stations for logging analysis and CT images, are found here.

Rig floor Gas Monitoring Lab

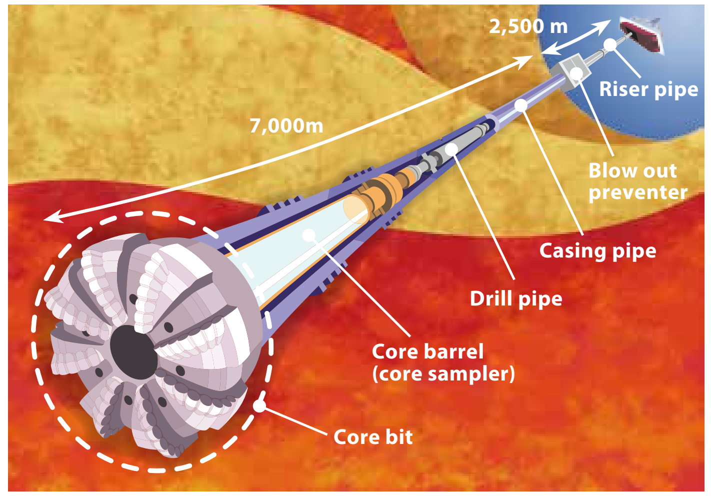
This new lab contains all the analytical and sampling equipment needed to collect gas samples from riser drilling mud. This lab is within a container located aft of the rig floor.

What is Riser Drilling?



Riser drilling is a method of drilling that uses riser pipes and a seafloor BOP to control the drilling mud, the density and viscosity of the drilling mud, while also cleaning the hole of accumulated cuttings. One important safety feature is controlling downhole pressure in the event that the formation pressure spikes, creating a "kick" that can create a dangerous overpressure situation. All this is done by using riser pipes and the BOP to essentially extend the borehole, or "well", all the way back to the ship. The riser pipes act as a kind of "artificial well" and the BOP is the "faucet", a safety device that allows the borehole to be sealed at the seafloor, through a series of valves. These valves can be operated from the driller's house (directly or remotely), or at the seafloor by a remotely operated vehicle (ROV). This technology allows sub-seafloor drilling beyond the limits of riser less drilling, 10's of kilometers deep, compared to ca. 2,500 meters deep with riserless techniques. All manner of tools and equipment can be lowered down through the riser pipes: every possible LWD tools, downhole sampling tools, coring tools, all manner of casing pipes, monitoring tools, etc.

However, one drawback is that logistical preparations take a great deal of time. Once on site, an ROV survey of the seafloor confirms that there are no obvious hazards or obstructions, and then the ROV deploys seafloor transponders for the dynamic positioning system (DPS). The DPS uses Global Navigation Satellite System (GNSS) and a seafloor transponder system to continuously update the ships' precise position and maintain a stationary position relative to the seafloor wellhead for drilling, regardless of ocean currents, winds, or waves. A special wellhead is set into the seafloor to ca. 700 meters below seafloor (mbsf) to support the great weight of the BOP and riser pipes, and cemented into place with special cement. Once the wellhead is stabilized, the BOP can be lowered onto the wellhead via the riser pipes, and pressure testing to confirm the integrity of the well can begin.



Mud circulation system

The key difference between riser and riserless drilling is the circulation and recycling of the drilling mud. This allows for precise monitoring of downhole conditions, and tailoring the viscosity, specific gravity, and other chemical and physical components of the drilling mud to: 1. create a good mudcake on the borehole walls, enhancing borehole stability, 2. maintain a pressure balance with the formation and 3. clear the borehole of cuttings and cavings, allowing good drilling, coring, and downhole measurements. The drilling mud also cools and lubricates the drillbit, as it cuts through the formation. The cuttings, cavings, and formation gases recovered can also give valuable insights to the formation and downhole conditions.