

## "Ultra Deep Science Drill Ship"

19th Jan, 2019 at 7:00 AM PST/ 16:00 GMT/ 24:00 JST

Abyss Observatory in JOGrid (OpenSim)

[hop://hop://jogrid.net:8002/Abyss Observatory/491/302/140](http://hop://jogrid.net:8002/Abyss%20Observatory/491/302/140)

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### Participants:

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### Organizer

Nymf.Hathaway @sciencecircle (Chantal), Agustin.Agnomen @sciencecircle (Agustin)

### Abstract

I was working on development of ultra deep science drill ship "Chikyu" ("the Earth" in English) from 2001 to 2005.

I built 3D model of "Chikyu" in Science Sim (one of OpenSim grids hosted by Intel) as joint project with ScienceCircle Foundation and JAMSTEC in 2011, but Science Sim was closed and I imported "Chikyu" to JOGrid (Japan Open Grid hosted by Tokyo University of Information Science) in 2014 and continue to improve until now.

"Chikyu" is first and only science drill ship which has well control capability for core sampling through

deeper penetration by 2,500 m Riser drilling system which has 9,000 m drilling strings, 2,500 riser pipes, Blow Out Preventer (BOP) and mud circulation system for cuttings recovery from drill hole compatible with commercial oil drilling.

<https://www.jamstec.go.jp/chikyu/e/>

In current phase, "Chikyu" is engaging at 2,500 m depth water and drilling 5,200 m from the seafloor in plate subduction zone under strong Kuroshio current (more than 2 m/sec).

Target is seismic zone of the plate interface fault system at a location where it is believed to be capable of seismogenic locking and slip, and to have slipped coseismically in the 1944 Tonankai earthquake.

[http://www.jamstec.go.jp/chikyu/e/nantroseize/expedition\\_358.html](http://www.jamstec.go.jp/chikyu/e/nantroseize/expedition_358.html)

In future phase, "Chikyu" will be upgraded for 4,000 m riser which enable to reach crust-mantle boundary. Chikyu's drill will have to go through 4000m of water and 6000m of crust to be able to reach the mantle, which makes up roughly 84 percent of our planet's volume.

The researchers also want to investigate the boundary between the oceanic crust and the mantle to figure out how the crust formed. Plus, they want to see if microbial life exists that deep inside the planet. To do this requires new techniques to drill out 7,000 m below the seafloor, in regions where ambient temperatures can reach 250 degrees C

<http://www.gm.univ-montp2.fr/spip/spip.php?rubrique185&lang=en>

Yan: Welcome everyone. I'll start.

(About JOGrid)

Yan: Here is the Japan Open Grid, JOGrid hosted by Tokyo University of Information Science. You know full region is 256 m square in SL. But this region is 512m square. So here is 4 full region size, but there isn't region boundary. There is even 2048 m square region in JOGrid.

Yan: These panels are teleporters. Lower large panel is Education Portal to OpenSim Grids and upper small panels are other exhibits in Abyss in JOGrid.



### (Crew transportation)

Yan: Here is Helicopter deck of Ultra Deep Science Drill Ship "Chikyu". "Chikyu" means "the Earth" in English. Once "Chikyu" starts drilling, "Chikyu" keeps this position at least half a year. So crew exchange relies upon this Helicopter.

Yan: "Chikyu" also gets supplies of Fuel oil and other consumptions by tankers and supply boats,.and gets off wastes including cuttings of drill hole by supply boats.

Yan: Why crew exchange don't use supply boats? Because transport of crew by a ship uses "personal basket" suspended from "Knuckle Jib Crane" and the personal basket is higher risk than a helicopter. Of course, helicopter has also risk, so all crew need to get training of escape from helicopter which crash landing on the ocean and upsetting.

### (Science Purpose)

Yan: Then I'll talk about scientific purpose.

Yan: Currently, Chikyu is engaging at seismogenic zone of Japan like this panel.



Yan: And final goal is to get Mantle sample. I'll explain from this panel.



[07:23] Dae: When are they going to be drilling to the mantle

(Yan's comment: It isn't fixed yet. Candidates are off Hawaii, off Mexico and off Costa Rica in Pacific Ocean.)

[07:23] Arianne: Now I'm taking pic for Chantal

Yan: These are "Oceanic Crust".

Yan: Under crust is "Mantle". Don't confuse "Mantle" and "Magma".

[07:23] Dae: We have mantle rocks in Virginia brought up by volcanoes that have olivine in them

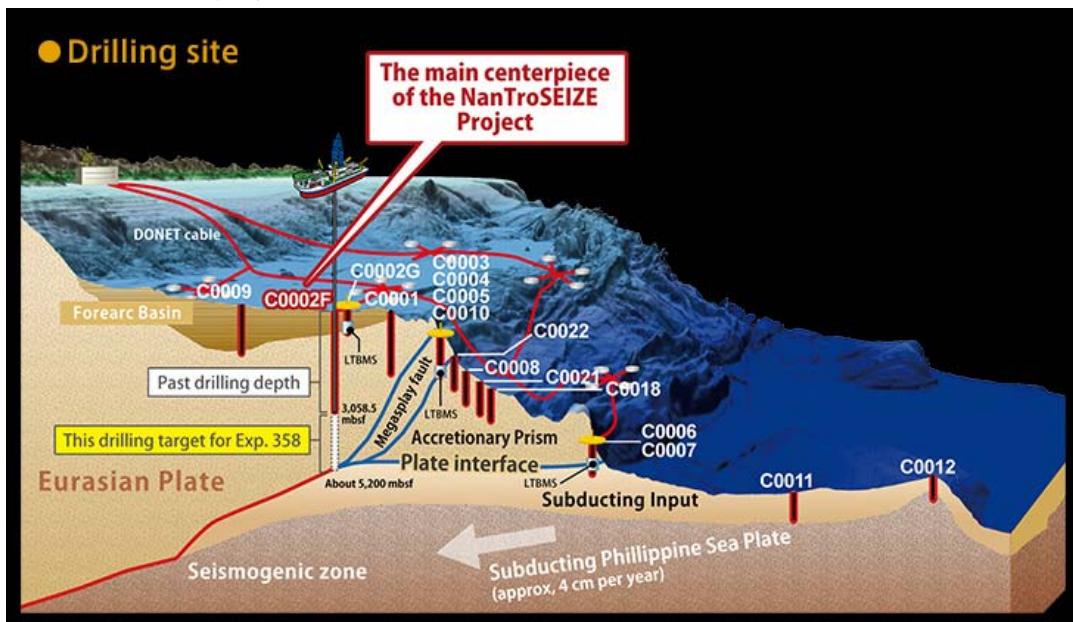
[07:25] Dae: Is there an island they are going to use to try to drill to the mantle?

(Yan's comment: It may be far away from any island. But candidates are selected in condition with distance from supply base on land.)

Yan: At the "spreading center of oceanic crust", or "Mid-ocean ridge" and "Hot spot" like Hawaii and "Island Arc" like Japan, Mantle is partially melting, or becomes "Magma", but almost mantle is solid. Yellow-green color means "Peridot", Birthstone of August.

Yan: At the spreading center, there is Hydrothermal circulation and forming oceanic crust. Upper cooler part of Mantle is called "Lithosphere" which behaves like a rigid plate with crust. So we call Crust and Lithosphere as "Plate". Oceanic Plate is forming, spreading, become cooler and heavier, and finally subducting into the hot mantle, caused volcanic and seismic at the Island Arc.

Yan: And here is current project.

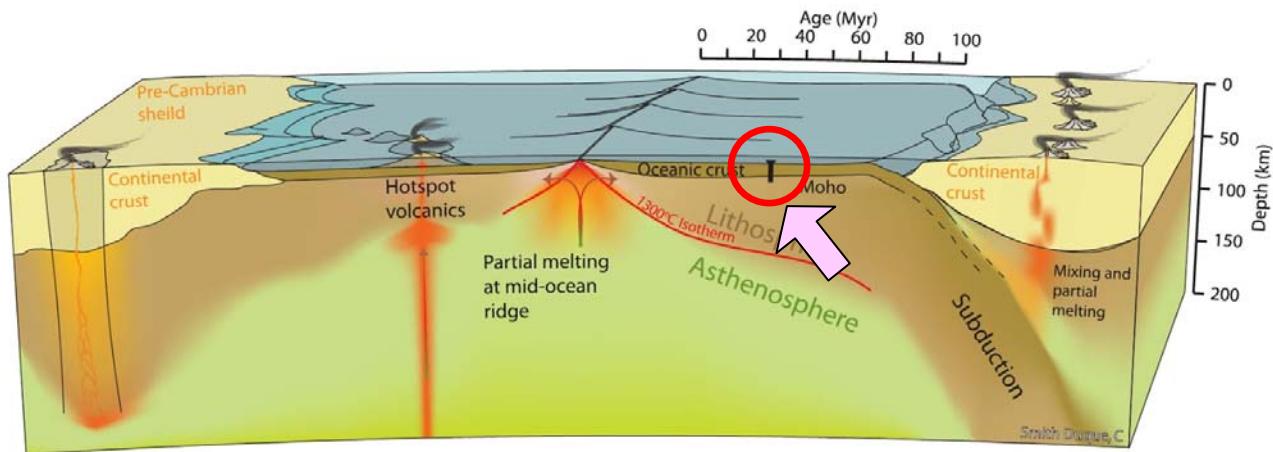


Yan: Oceanic plate comes from here, is subducting under Japan Island, convecting sediment of ocean floor forms "Accretionary prism".

Yan: And here is "Plate interface", boundary of "Eurasian continental plate" and "Philippine Sea oceanic plate", and Red line is "seismogenic zone". Here is 2500 m depth and drilling 5200 m from ocean floor, then reaches on target with in a few months.

Drilling point is at the edge of seismic zone avoiding Seismogenic zone which repeat coupling and slip. (Blue lines are derivative faults, so safer than seismogenic zone.)

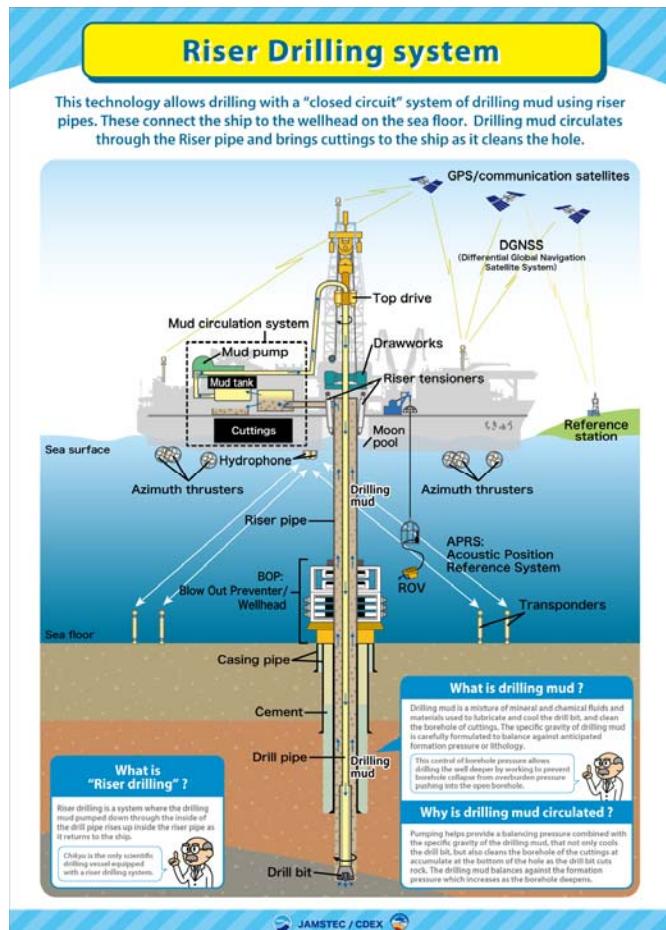
Yan Then, return to this panel again.



Yan: Here is drilling site to the Mantle. At 4000 m depth ocean floor, 6000 m drilling in the crust under the ocean floor, and additional 1 km drilling in the Mantle. It is a dream of Project Mohole in 1961, more than 50 years ago

(How to drill)

Yan: Then, this is how to drill ocean floor.



Yan: This is "Drill Pipe". Total 9 km length. At first, sea water is sending through Drill Pipes to discharge cuttings out from hole.

Yan: Next, insert "Casing Pipes" to prevent collapse of drill hole. But deeper the drill hole, harder to discharge cuttings out from hole, then "Chikyu" lowered "Riser Pipes" and "Blowout Preventer, BOP", and connect with well head, and send special drilling liquid, called "Mud" through inner Drill Pipes and discharge cuttings through outer Riser Pipes to on board "Chikyu", and processing and re-circulate.

Yan: This is a riser pipe and a drill pipe.

Yan: Current Riser is 2500 m. So to get Mantle sample, "Chikyu" need to be upgraded to 4000 m Riser, needs additional fund.

#### (Navigation Bridge)

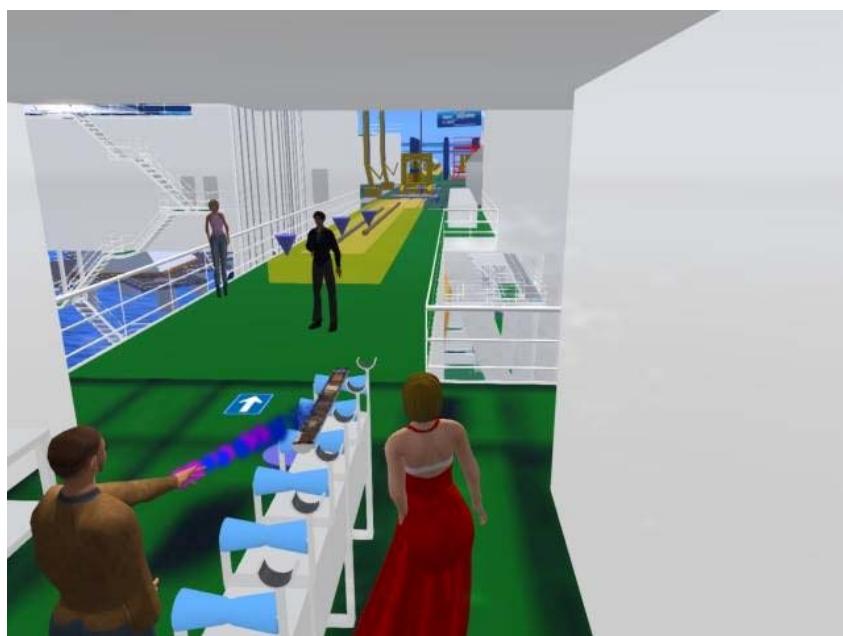
Yan: Let's go to under this Heli deck.



Yan: Look backward, there is Navigation Bridge, almost same function with usual ship. Difference is only Dynamic Positioning System.

#### (Core sample)

Yan: Here is core cutting area.



Yan: Core sample is 9 m in length, and cut to 1m each at this area. Please look at this 1 m core sample.



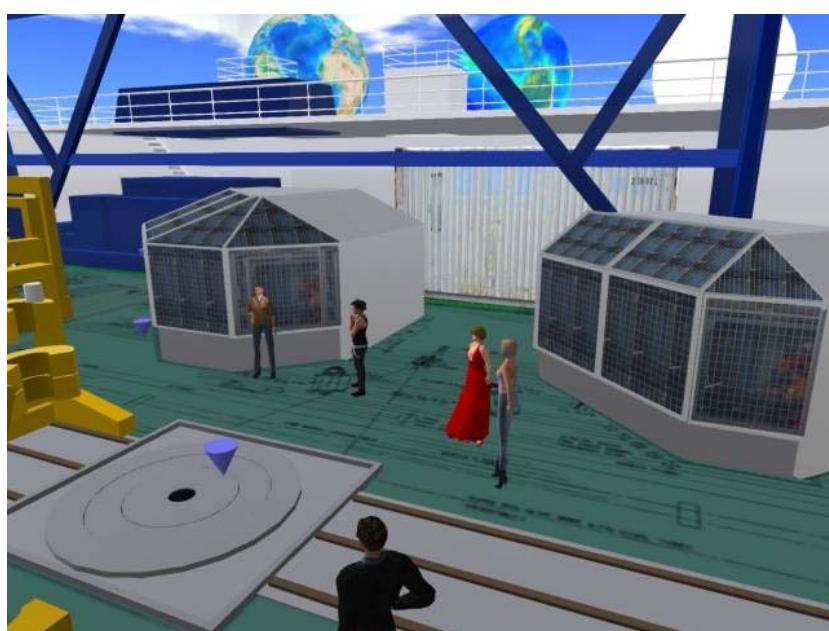
Yan: When "Chikyu" drills 9 m deeper, one drill pipe length, then 9m Core Sample is obtained within a "Core Barrel" attached at the bottom end of drill pipes. Please look at this.



Yan: Core Barrel is almost same size with one drill pipe but a little smaller. Core Barrel is pulled by wire line from top end of Drill Pipes, and empty new core barrel is throw into drill pipes from top end of drill pipes, go down to bottom end of drill pipes, then "Chikyu" drills 9 m deeper, and new core sample will be recovered again.

#### (Drill Floor and Derrick)

Yan: Let's go to the Drill Floor. Here is most important but most dangerous place. The tower above Drill Floor is called "Derrick".



[07:52] Dae: So is the plan to drill to the mantle from a ship?

(Yan: Current mission is drilling to the seismogenic fault. Mantle drilling is future plan. We need to upgrade Chikyu from 2500m riser to 4000m riser and we need new budget.)

[07:53] Arianne: yes

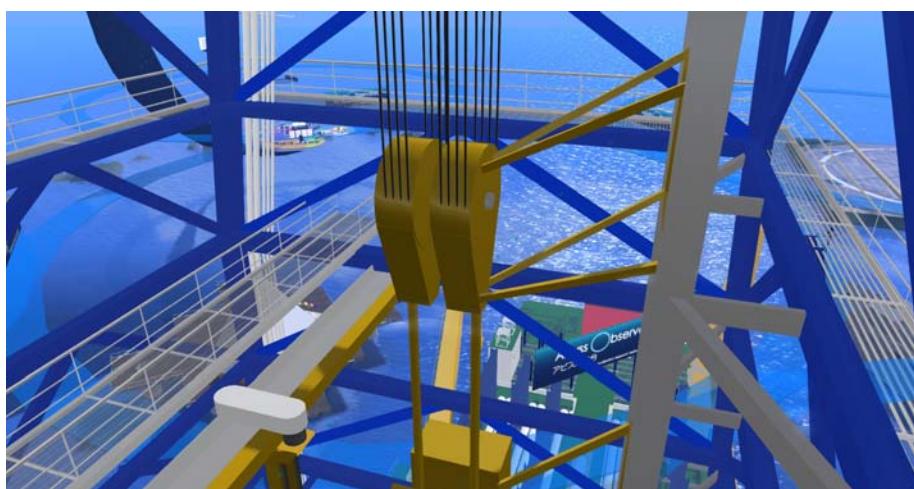
[07:53] Delia: fascinating

[07:53] Arianne: just a plan lol

Yan: Here, at first, 4 drill pipes are connected in advance, so, 36 m drill pipes are stored inside of Derrick like here. Total 250 Drill Stands for 9 km Drill pipes. This is "Pipe Racking System", a kind of robot arm handling Drill Pipes. This is "Hydraulic Roughneck" for connecting drill pipes.

Yan: All machines are operated from "Drillers House", called "Dog House", but inside of this house looks like pilot seat of Spaceship in a Science Fiction Movie.

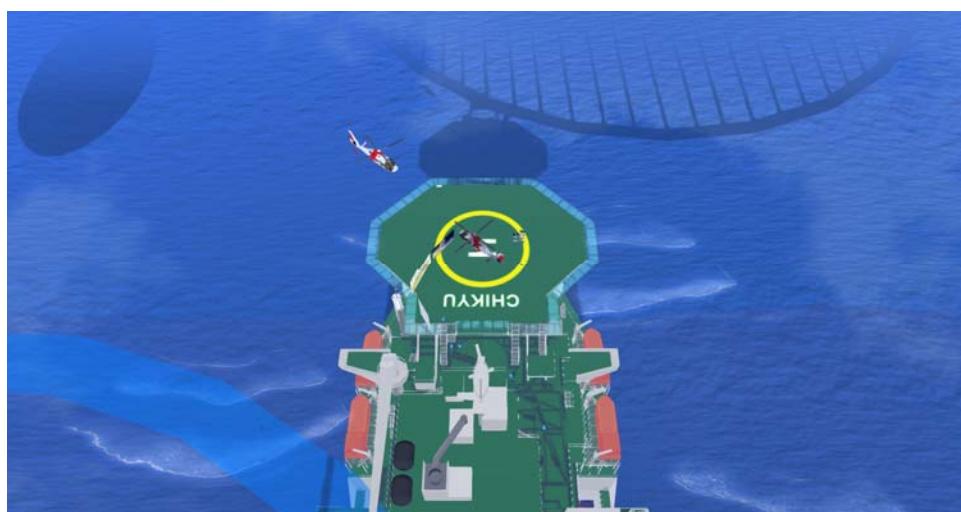
Yan: Then, please fly up along this Drill Pipes or TP by this panel



Yan: This is "Top Drive" or "Power Swivel" rotates drill pipes and above of Top Drive is "Travelling Block" which can hang 900 tons.

Yan: Then go out of Derrick and go to Top of Derrick or TP by this panel.

Yan: Here is Top of Derrick. 100 m from sea surface. Can you look down? Please keep pushing Ctrl and Alt key and Mouse Drag.



Yan: Can you see wave pattern move from bow to stern? We are in Kuroshio current, more than 2 m/sec.

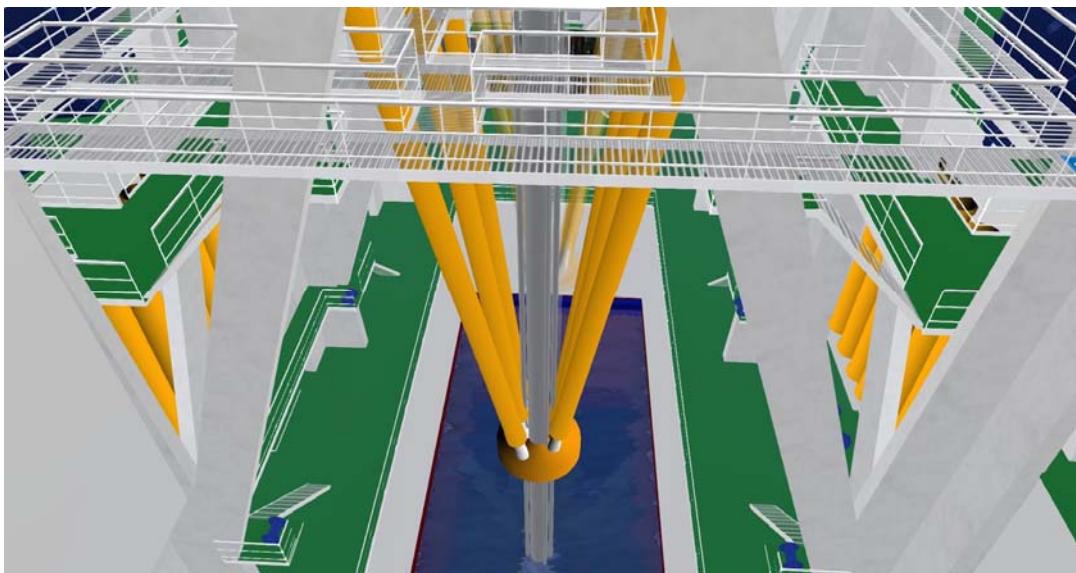
[08:01] Delia: yes

Yan: please come here. Let's go to under the Drill Floor.

(Moon pool area)

Yan: Let's go to under the Drill Floor. Very complicate dungeon. Please follow me carefully

Yan: Look down, there are Riser pipe, "Riser Tensioner" and "Moon Pool".



[08:06] Dae: Excellent build

[08:07] Mike: Yes, the amount of work it took to create this is staggering!

Yan: Riser Pipes are connecting with Well Head of ocean floor. On the other hand, "Chikyu" is rolling, pitching and heaving. So complicated force will affect to Riser pipes. Riser tensioner will absorbed such a forces.

[08:08] Delia: amazing in virtual space and mind boggling what they do in the real world

[08:08] Kao: yes!

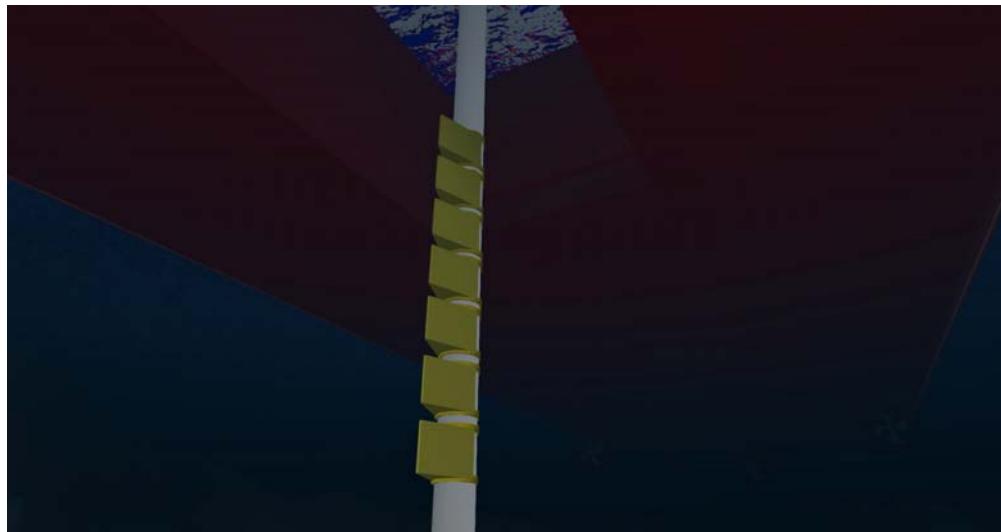
Yan: Another case, when the riser pipes is disconnected from well head in emergency, tension is vanished suddenly and due to reaction, riser pipes will rise up and destroy Drill floor. It is said "Riser Recoiling". Riser tensioner also absorbed Riser Recoiling.

(Undersea)

Yan: Then, fly mode and dive into the Moon Pool or TP by this panel. Go down along the riser pipe

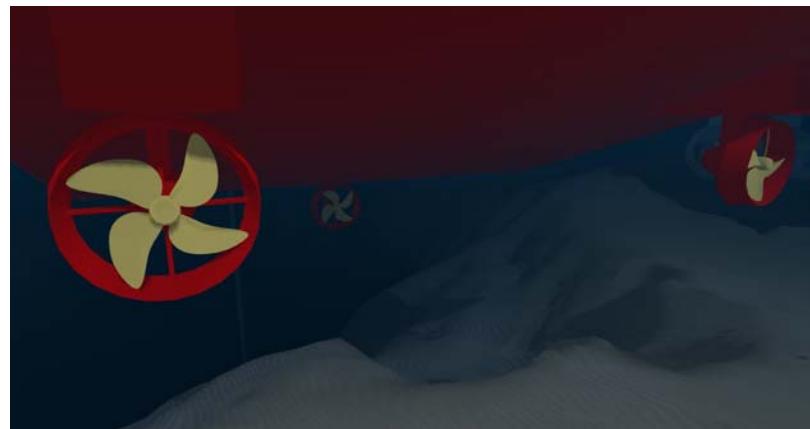
[08:10] Arianne: do not go far, or you will fall :XD

Yan: These are Fairing to reduce resistance of Kuroshio current.



[08:11] Mike: ☺

Yan: Please look at the bottom of bow and stern of this ship. There are total 6 azimuth thrusters at the bow and the stern to keep position.



Yan: Go down or TP by this panel.

Yan: This is "Blowout Preventer", BOP on the "Well Head".



Yan: If Drill Pipe penetrates oil or gas reserver, usually pressure inside of drill hole is controlled, but once fails well control, oil or gas like Hydrocarbon or Hydrogen Sulfide ascend through Riser pipes and is released on the Moon Pool area and Drill Floor directory. Then, this BOP cuts off the drill pipe and shuts off the well.

Yan: BOP is consisted "Lower Marine Riser Package", upper part, and "Lower BOP Stack", lower part.

Yan: In other case, if "Chikyu" lost Dynamic Positioning Capability due to severe storm or engine trouble, then "Emergency Disconnect" is executed, then at first, Lower BOP stack cuts off the Drill pipe and shuts off the well, then next, "Lower Marine Riser Package" is disconnected from "Lower BOP Stack."



### (Closing)

Yan: That's all of today's tour. Thank you. Do you have any question or comment?

[08:18] Arianne: Thanks everyone for coming

[08:18] Delia: Thank you, Yan. This was very interesting and informative

[08:18] Mike: Your English is very good. I have enjoyed your tour of this facility deeply!

[08:18] Kao: I'm glad I finally made it for part of this!

[08:18] Dae: Thank you Yan. Your English was fine

[08:19] Dae: I found this website on the Japanese effort to drill into the mantle

[08:19] Dae: <https://www.cnn.com/2017/04/07/asia/japan-drill-mantle/index.html>

[08:19] Dae: When is the ship going to try to hit the mantle?

(Yan's comment: Maybe 5 years or 10 years future depend on getting new fund.)

[08:19] Kao: oh thank you

[08:20] Dae: 5 years?

[08:20] Arianne: Thank you Dae .

(Yan's comment: Current drilling will reach seismogenic fault within this year (2019).)

[08:20] Dae: Oh end of this year

[08:20] Kao: How deep are you now?

(Yan's comment: Drilling is repeatedly including tests and failures. Now, Chikyu is drilling at 2500 m

depth ocean floor. Target is 5200m from ocean floor. Chikyu exceeded 3058m from ocean floor which is world record of science drilling on last December.)

- [08:20] Dae: This is very exciting
- [08:21] Dae: But if you hit the mantle there are gem stones and other valuable materials down there.
- [08:21] Arianne: We don't need "Government Shutdown" :XD
- [08:21] Kao: I may have missed this earlier, **How fast does the digging go?**
- (Yan's comment: It depends on stratum. In normal condition, 300m/day for shallow sediment and 70m/day for deep sediment, but abnormal condition will occur frequently.)
- [08:22] Kao: **What is the biggest problem you face?**
- (Yan's comment: When there are many fault of stratum is too fragile, drilling is repeated. Once is test for drilling plan. Some time, drill hall was collapsed and drill pipes are stuck, then disconnect and abandon drill pipes, change drilling plan and change drilling site and drill again.)
- [08:23] Kao: **Did you say many folds on the ocean floor?**
- (Yan's comment: not "folds" but "faults")
- [08:23] Arianne: broken and fixing it
- [08:24] Dae: I have to log off but this has been very interesting thanks again Yan
- [08:24] Dae: great work here
- [08:25] Dae: I would love to talk to you more about OS when you have time, but bye for now
- [08:25] Arianne: I'd like to ask you, I'll take pic for Chantal , please line up around Yan.
- [08:26] Arianne: Michael , plz come closer

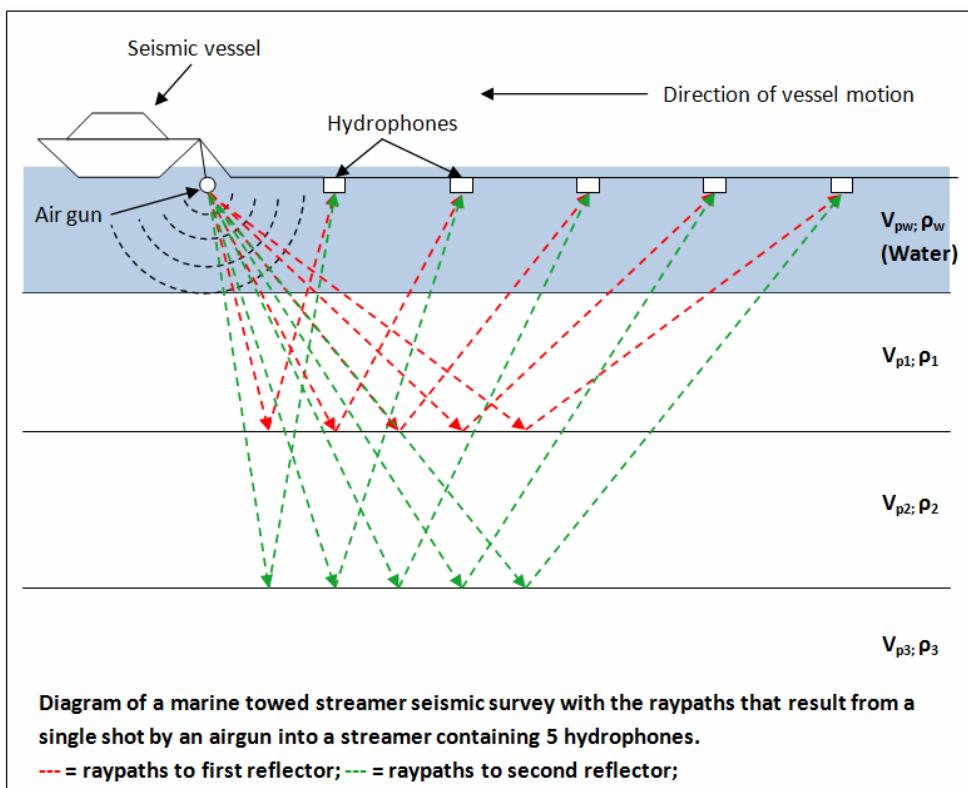


- [08:26] Delia: Thank you, Arianne, for doing the logistics today
- [08:26] Arianne: Thank you all
- [08:26] thief: you are welcome
- [08:27] Mike: ☺

- [08:24] Kao: Is it very loud to be on the ship while the drilling is happening?
- [08:27] Kao: Is it loud when they drill?
- [08:27] Kao: I teach 10 year olds and we study this, they will ask if it is loud when you dig
- [08:28] Arianne: やかましのかつて
- [08:28] Kao: Noisy. Bad for your ears
- [08:28] Delia: Loud on the ship and loud for the marine animals in the water near the drill?
- [08:29] Arianne: They must use ear plug I think ;XD

(Yan's comment: For human, engine room of usual ship is harmfully noisy, but it is insulated for outside. I thing drilling noise is not loud than ship engine.

For marine animal, drilling noise is not problem. But "seismic survey" using air gun and long streamer cable (hydrophones) for determination of under sea bottom structure is noisy. Once, US coast guard prohibit seismic survey in the US coast, because of doubt of harmful for whales and dolphins. But when we start seismic survey, dolphins are coming near the ship. Now US coast guard doesn't prohibit seismic survey in the US coast.)



- [08:29] Mike: ☺
- [08:30] Arianne: They have lots of curiosity
- [08:31] thief: Thanks all
- [08:31] Delia: The US Navy is again using depth charges in the ocean and those extreme noises are very harmful to whales and dolphins. This is not like that though.
- (Yan's comment: I think active sonar of submarine may be harmful for whale's ear. I heard fishermen claimed fishes are going away for a while after seismic survey.)
- [08:32] Arianne: Drilling is not noisier than the tapping I believe.

- [08:31] Kao: This may sound funny but again...10 year olds
- [08:31] Kao: When you dig, where do you put the stuff that you dug?
- [08:32] Kao: Do you put it back in the ocean to the side of where you are digging?  
 (Yan's comment: All cuttings are recovered on ship, processed and shipping to land dumping site by supply boat. Mud is processed on board and re-circulated repeatedly)
- [08:32] Kao: They take it all back to the land did you say?  
 (Yan's comment: When stratum/ sediments are so fragile, cuttings are also valuable sample. So scientists inspect even cuttings)
- [08:33] Mike: Interesting! Like the Ice cores from Greenland and Antarctica
- [08:33] Kao: To study it?  
 (Yan's comment: Yes)
- [08:34] Mike: exciting material to study... not easy to obtain, so worth close examination
- [08:34] Arianne: yes it is
- [08:34] Mike: ☺
- [08:35] Arianne: Maybe sampling will be done .
- [08:34] Kao: Is it more like chunks of rock or is it more like sand?
- [08:35] Kao: Are the pieces more like big rocks or are they more like sand?  
 (Yan's comment: Cuttings are not large rock but small stone and sand.)
- [08:36] Kao: wow
- [08:36] Kao: This is amazing
- [08:36] Mike: This has been a wonderful tour this morning! Thank you for your time. I had a bit of lag now and then, but i think it went very well. Amazing work on this sim! I have to go, but thank you much!
- [08:37] Arianne: Thanks everyone
- [08:37] Kao: thank you so much
- [08:37] Kao: I think this is right:
- [08:37] Mike: ☺♥
- [08:37] Kao: ありがとう
- [08:37] Arianne: Glad to help you by assisted Yan
- [08:37] Kao: Arigatou
- [08:37] Kao: どうもありがとうございます  
 Doumo arigatou
- [08:38] Arianne: Yay!!!!!!!!!!!!!!
- [08:38] Mike: <Yes, Arianne, I appreciated your guidance!>
- [08:38] Delia: I will come back and explore here more. I haven't been in OpenSim for a few years
- [08:38] Arianne: You all are welcome always. my pleasure
- [08:38] Kao: I'm new to it, that is why I was so late, I was lost!
- [08:38] Mike: ☺

[08:39] Arianne: No one can be accustomed with these OS rather than SL. ;XD