360VR EXPEDITION GUIDE: DIVING IN A SUBMARINE

About your 360VR Expedition

During this expedition, you will learn what it takes to dive in a submersible. You will join the Nekton Mission crew as they undertake deep ocean research around the seamounts of Bermuda.

The Nekton team used two submersibles, Triton 1000/2s, which transported scientists down to depths of 1,000 feet. Each submersible has a life support system which can last up to 96 hours, although the team normally spent three to five hours underwater on each dive.

You will learn about some of the science and technology involved in exploring the deep, and get ready to 'Dive! Dive! Dive!'.

How to view this 360VR Expedition

This 360VR Expedition can be viewed at **https://encounteredu.com/discover/images/diving-in-a-submarine** or via the Google Expeditions app **http://edu.google.com/expeditions/**, search for 'Diving in a submarine'. For more guidance on using either 360VR or Google Expeditions, please see the Subject Updates: **How to: Quick start to 360VR in the classroom, How to: 4 ways to use 360VR in the classroom,** and **How to: Use Google Expeditions.**

This Expedition Guide provides detailed information about each of the 360˚ photos, known as panoramas, included in this expedition. Each 360˚ photo will have the following information to help you guide your students on the expedition:

- Description – to be used to introduce each panorama.
- Point of interest overview – points of interest is the term given to specific details on a panorama. These are numbered on an overview photo.
- Point of interest descriptions – a description of each point of interest allows the teacher to guide students around the panorama.
- Class discussion questions – a differentiated list of questions for class discussion is included at the end of each panorama section.

Panorama 1 Submersible interior

We start our expedition safely on deck, to take you through some of the controls, features and safety features of the submersible. Operating in the deep ocean is fraught with danger. The pressure mounts as you dive down and you will be completely reliant on the life support systems provided by the submersible, so listen carefully.

Point of interest 1: Joystick

The joystick is used to control the movement of the submersible backwards and forwards and left and right. A smaller thumb control mounted on top of the joystick is used to translate (slide sideways) and to maneuver up and down.

Point of interest 2: Manual cutaway

This is an emergency system used to cut manual drop equipment on the submersible. For example, if one of the battery compartments becomes flooded, you can drop 105kg weight to maintain neutral buoyancy (floating at the same depth). You can also manually cutaway the hydraulic arm if it becomes entangled.

Point of interest 3: Communications

Communications between the submersible and the surface vessel is essential both for operations and for safety. The submersible pilot wears this headset for the acoustic underwater telephone to speak to the surface officer who works from the bridge of the research vessel.

Point of interest 4: Dials, scrubbers and ballast

Along the middle are three sets of important features and controls. At the top, the dials give readings for oxygen, depth and high pressure air, in the center panel are electrical controls including for air scrubbing system which removes carbon dioxide and between the seats are the ballast controls used for ascent and descent.

Point of interest 5: Hydraulic arm controls

A separate control system is used to control the hydraulic arm to collect samples underwater. You can also see a water bottle to make sure the crew stay hydrated, and 96 hour of life support equipment and rations are stored behind the seats.

Questions

Beginner

Question: Can you list some of the features inside the submersible?
Answer: Students should be able to list: joystick, thumb control, dials, life support system (scrubbers), ballast controls, manual cutaway and hydraulic arm controls.

Intermediate

Question: Why does the submersible need scrubbers?
Answer: During the dive, the crew breathe and release carbon dioxide into this enclosed space through respiration. If these levels rise too high, the crew may lose consciousness. Scrubbers use a chemical to remove the carbon dioxide from the air.

Advanced

Question: Can you think of how the ballast system might work?
Answer: The ballast system alters the density of the submersible. Increasing the volume of air in the tanks, decreases the density of the submersible causing it to ascend. Flooding the ballast tanks with water increases the density of the submersible causing it to descend.

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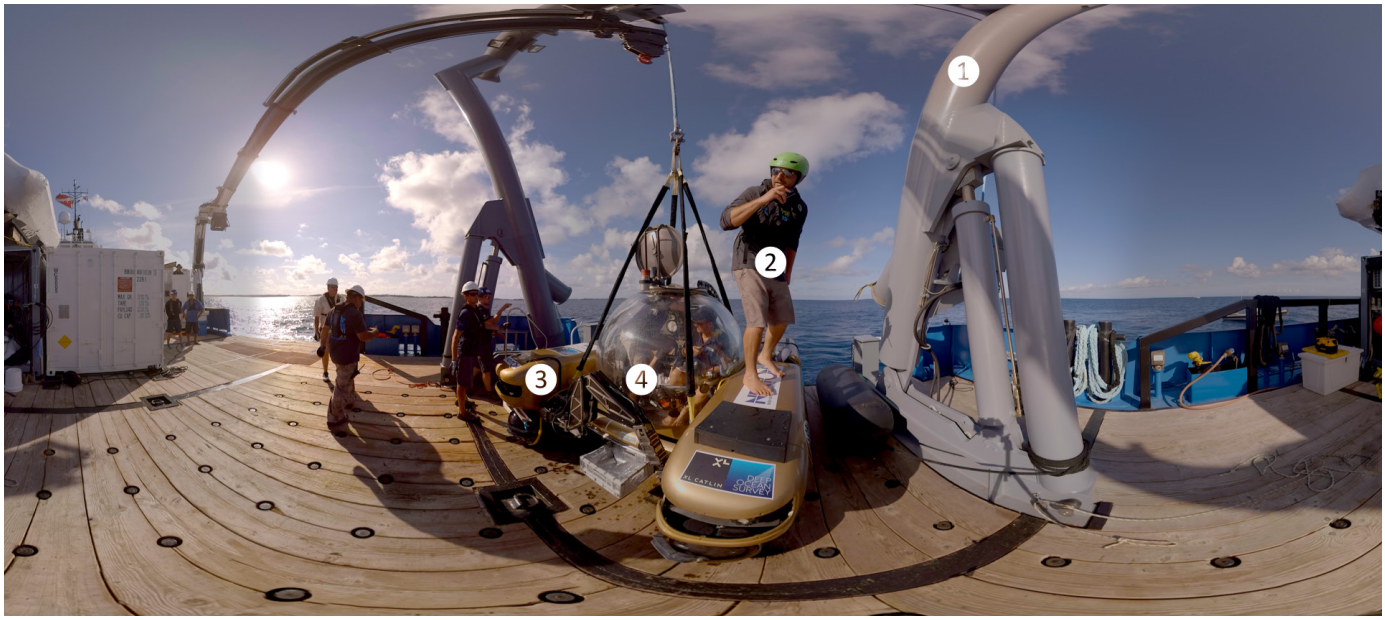

Panorama 2 Submersible launch

The submersible crew is made up of a pilot and a scientist. The scientist isn't just a passenger, as if something happens to the pilot, they will have to navigate the submersible safely back to the surface. Now you have learned about some of the main features inside, we will take you through some of the exterior features and how to get the submersible into the water.

Point of interest 1: A-frame crane

This research vessel, the Baseline Explorer, is especially equipped for submersible operations. This A-frame crane mounted on the rear (stern) of the ship can lift 15 tons and lifts the submersible from the back deck into the water.

Point of interest 2: Teamwork

Launching the submersible is not a fully automatic process, but relying on a team to get you safely into the water. Kenny is the 'swimmer', one of the launch team, who is responsible for detaching the crane straps once the submersible is in the water.

Point of interest 3: Battery and ballast

Along each side of submersible are the main ballast tanks, which control the ascent and descent of the submersible. Beneath these are large batteries supplying the power to the submersible for navigation, control, life support and science equipment.

Point of interest 4: Pressure hull

These clear pressure hulls are made from acrylic, a type of plastic. Their transparent and spherical design mean that the crew have a 360-degree view when they are underwater, allowing for better observation of the underwater environment.

Questions

Beginner

Question: How is the submersible launched from the back deck?
Answer: The submersible is launched using the A-frame crane.

Intermediate

Question: Why do you think one of the launch team is called the 'swimmer'?
Answer: The swimmer stands on the submersible as it is being launched and detaches the crane straps. Once this is done, they need to get back to the surface vessel before the submersible dives, which can often involve a swim.

Advanced

Question: How do the exterior features of the submersible aid underwater exploration and science?
Answer: The ballast tanks control the descent to and ascent from the deep ocean. The batteries provide power for control and science equipment as well as life support. The clear pressure hull affords a 360-degree of the subsea world.

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Panorama 3 Diving deeper

Before the submersible is allowed to dive, the pilot goes through a number of checks with the surface officer via radio. "Hatch is secure," followed by "Life support systems are running." The pilot then confirms, "Safety briefing complete." The last statement before descent is, "Requesting permission to open vents and dive." The surface officer will then reaffirm the checks and then say to the pilot, "You are cleared to dive, dive, dive."

Point of interest 1: Synchronize watches

Watches are synchronized with the surface officer to increase the accuracy of establishing the location of the submersible during its underwater journey.

Point of interest 2: Sharing the experience

Head of Content for the expedition, Will West, descended with Triton pilot, Patrick Lahey. Will recorded the submersible dive in 360° to help create this expedition.

Point of interest 3: An all-round view

The clear, spherical pressure hull means you can even see the seafloor beneath your feet. Pilot and passenger don't wear shoes so as not to mark or damage the acrylic.

Point of interest 4: Hatch is secure

The hatch is secured tight. If the atmosphere in the pressure hull is contaminated and the pilot and passenger have to use an emergency regulator, additional pressure will build up internally in the pressure hull. The pilot sometimes then has to release the hatch lock near the surface during ascent, holding on tight, carefully release air pressure just for a second. This is known as 'burping'.

Questions

Beginner

Question: How would you feel before you went on your first dive?
Answer: Open question to prompt students to reflect on the experience rather than just the technology.

Intermediate

Question: In pairs, can students repeat the conversation between the pilot and surface officer before a dive.
Answer: Use the quotes in the panorama description to practice as a class.

Advanced

Question: When and why might you 'burp' a submersible?
Answer: If the atmosphere in the pressure hull has been contaminated by an internal fire or a failure of the oxygen or carbon dioxide system.

Panorama 4 Surface vessel operations

The strict difference between a submersible and a submarine is that a submersible requires the support of a surface vessel, while a submarine can operate autonomously. The surface vessel provides a place for the submersible to be recharged and checked. During the dive, you will be working with a surface officer who directs the dive, maintains safety oversight and liaises with the ship's captain to make sure that the surface vessel stays close to (but not on top of!) the submersible. This also makes recovery easier.

Point of interest 1: Surface Officer

Shane Zigler is the Surface Officer for the submersibles. He defines the dive goals and itinerary, briefs the submersible pilots, goes through safety checks and tells them when it is time to 'Dive! Dive! Dive!'.

Point of interest 2: Location equipment

The surface vessel uses an acoustic device to send 'pings' through the water to locate the submersible. This is tracked on a screen on the bridge. These 'pings' will only reflect off the submersible, if the ship is relatively close.

Point of interest 3: Communications system

This is a special 'radio' system using ultrasonic through water communications and allows the surface officer to communicate with the submersible throughout the dive.

Point of interest 4: Ship's captain

Larry Bennett, the ship's captain can't just take a rest while the submersible is underwater, but needs to navigate the ship to stay close to aid tracking, communications and to make the recovery process easier.

Questions

Beginner

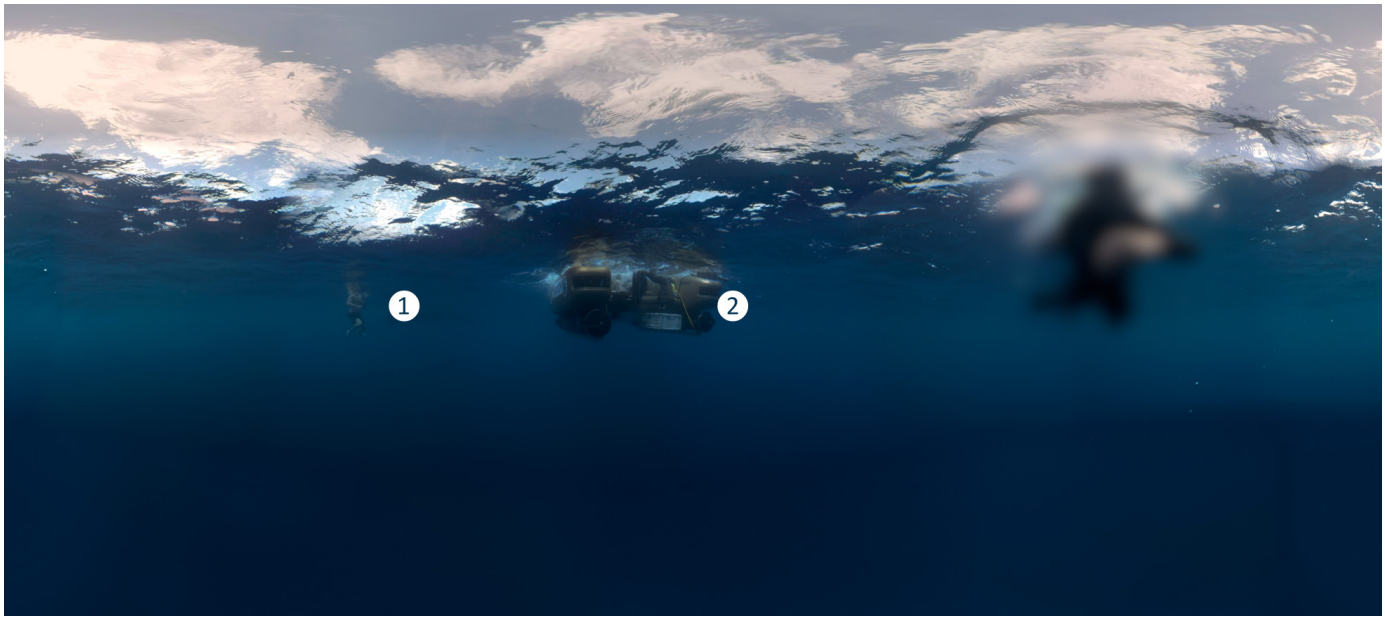
Question: How does the surface vessel support the submersible?
Answer: The surface vessel provides a place for recharging and repairing the submersible between dives and during the dive provides safety supervision, tracking and coordination.

Intermediate

Question: What is the difference between a submarine and a submersible?
Answer: The strict difference between a submersible and a submarine is that a submersible requires the support of a surface vessel, while a submarine can operate autonomously.

Advanced

Question: Why does the surface vessel need to stay relatively close to the submersible?
Answer: The location and communications system have a limited range of about 650 meters (just over 2,000 feet). In addition, the surface vessel needs to be close to the submersible when it ascends to aid recovery.



Panorama 5 Ready to dive

This is the view of the submersible just before it is about to dive. With the submersible off the back deck you can see some of the features more clearly. It is already possible to see how the light decreases with depth and by the time you reach your survey site at depths down to 1,000 feet you will need lights to see the underwater environment.

Point of interest 1: Swimmer

You can see Kenny, the swimmer, in the water. He has made sure that the crane straps have been detached from the submersible, so you are ready to dive.

Point of interest 2: Battery pods

It's possible to see the battery pods that supply power to the submersible systems more clearly. Without this power, there would be no control, no life support and no real ability to conduct science.

Questions

Beginner

Question: Are you ready to dive?
Answer: Check in with your students and ask them to explain why. This can be used to check student learning before the last panorama showing the deep ocean environment.

Intermediate

Question: What systems need power?
Answer: The batteries provide power to a variety of systems including the vents for the ballast tanks, the thrusters for navigating, life support systems and science equipment.

Advanced

Question: Why does it get darker, the deeper you go?
Answer: Water absorbs light, starting with the red end of the spectrum. This is why the deep is blue, then turning to black.

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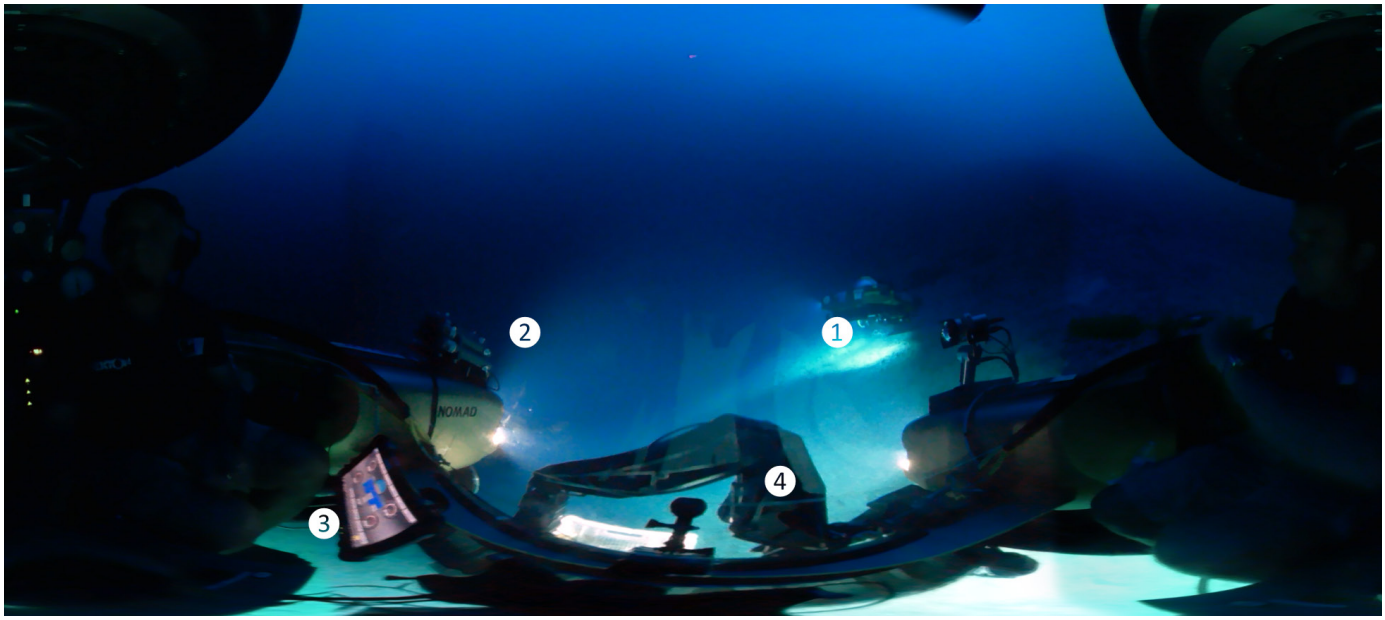

Panorama 6 The deep sea environment

Congratulations and welcome to the deep! This is the view from Nomad. The internal lights are turned off, so that it is easier to see through the pressure hull. The second submersible, Nemo, is conducting a video survey of the seafloor. Through using this submersible technology, scientists are able to study this unexplored habitat.

Point of interest 1: Seamount slope

The white slope of the seamount is visible in the submersible's lights. During the dives, the team discovered an unknown deep sea algal forest and possibly some new species.

Point of interest 2: Science sampling equipment

Special equipment is used to collect water samples and to record the temperature and salinity of the ocean. On the opposite pontoon is a high resolution 4K video camera for recording specific sites or creatures.

Point of interest 3: Control screen

The control screen or GUI shows a variety of readouts: oxygen levels, carbon dioxide levels, depth and altitude (height from the seabed) and also a sonar screen showing what's in front of the submersible. The GUI is also used to control the external lights and air conditioning.

Point of interest 4: Hydraulic arm

The hydraulic arm is used to collect samples from the seafloor. These might include coral, algae and rhodoliths (a specific type of red rock-like algae). These are transported back to the surface for further analysis.

Questions

Beginner

Question: Why are the lights turned off inside the submersible?
Answer: The lights are turned off to make it easier to see out and observe the deep sea environment.

Intermediate

Question: How do the scientists study the underwater world?
Answer: The submersible has equipment to collect water samples, record salinity and temperature, take physical samples and record high resolution video.

Advanced

Question: Why is it important for the GUI to show oxygen and carbon dioxide levels?
Answer: The oxygen and carbon dioxide levels inside the submersible are essential for the survival of the crew and need to be closely monitored.