Wiring the Abyss

Introduction

Ocean Networks Canada (ONC) is a not-for-profit research facility that operates and maintains cabled observatories to monitor the ocean and inform decision making from a community, governmental and industrial perspective. The observatories support a diverse array of instruments deployed on the seafloor that continuously collect data on multiple oceanographic parameters such as salinity, dissolved oxygen, temperature, turbidity, and current speed and direction, among many others. The data collected are transmitted to UVic's archives through fiber optic cable and are freely available to students, researchers and teachers through the data portal (www.data.oceannetworks.ca).

ONC has two large observatories, VENUS and NEPTUNE, that cover a number of different strategic ecosystems. VENUS is located in the Salish sea and has instruments in Saanich Inlet and the Strait of Georgia. Saanich Inlet has been continuously monitored since 2006. NEPTUNE's operation started in 2009 and is located off the West Coast of Vancouver Island and extends 250 km offshore, from the coast across the continental shelf and into the deep sea. There are five nodes that are analogues to power bars to which multiple instruments are connected. The nodes are connected to 840 km of cable and positioned at key sites that include coastal ecosystems, submarine canyons, abyssal plains and mid-ocean ridges, and across two tectonic plates: the North America and Juan de Fuca plates (Figure 1). Like Saanich Inlet, each node is equipped with a unique array of sensors to monitor critical biological, chemical and physical oceanographic processes.

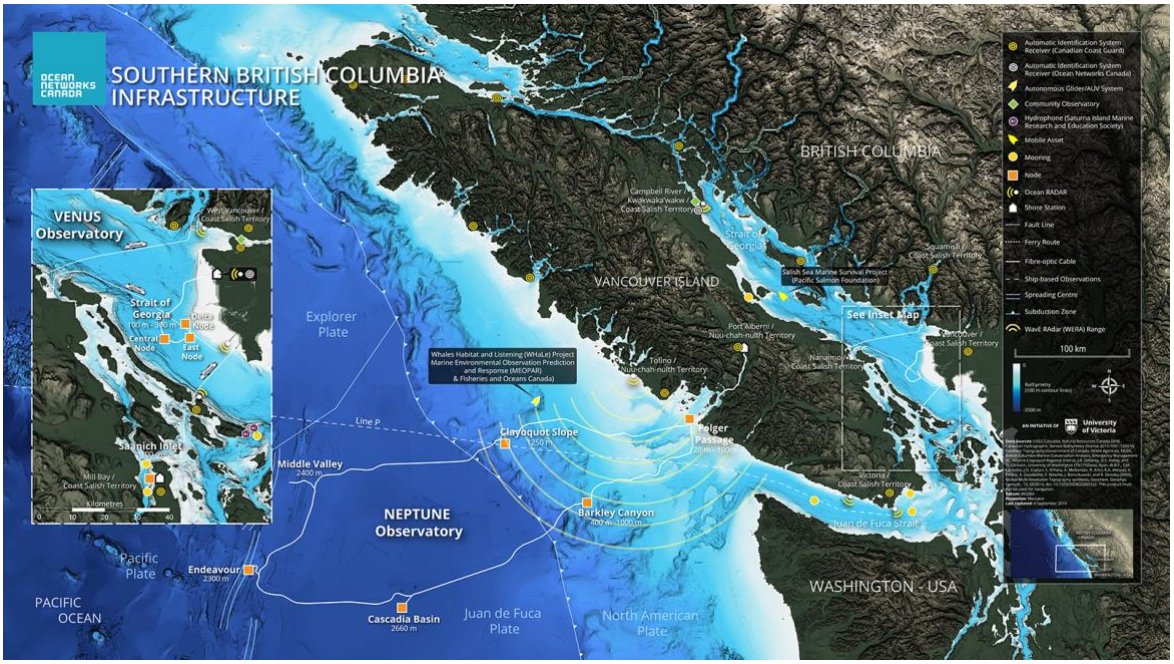

Figure 1. Map of the VENUS and NEPTUNE observatories in the North East Pacific of Canada.

Although cabled observatories provide high-resolution, long time-series data and have substantially contributed to better understanding the deep sea, such infrastructure requires a considerable amount of maintenance over time in order to guarantee high data quality. For example, CTDs and hydrophones must be calibrated periodically following the manufacturer's recommendations. As a result, ONC conducts maintenance cruises, known as Wiring the Abyss, to VENUS and NEPTUNE twice a year, typically in the spring and fall.

Initial instrument deployment and subsequent maintenance operations are done with Remotely Operated Vehicles (ROVs) given the depth at which the instruments are located on the seafloor. An ROV is tethered to the ship and piloted by three experts on board the vessel. Typically, an ROV has two arms to conduct different tasks such as grabbing things and connecting and disconnecting instruments. ROVs are equipped with different sensors which collect oceanographic parameters during the dive, a GPS device that continuously records spatial location, and multiple cameras used for both piloting and to record the dive. These cameras are equally important when transects are carried out to collect data for scientific research.

For the purpose of this lab you will work with ROV footage of one specific site, Main Endeavour from a maintenance cruise in 2017. This site is an **oceanic ridge** located at the edge of the Juan de Fuca plate and the Pacific plate at 2300m below sea level. Such plates are spreading at a rate of 6cm/year which in geological time is considered to be a fast spreading ridge.

The main objectives for this lab are:

- Identify critical geological features found at the Juan de Fuca segment of the Endeavour spreading ocean ridge.
- Recognize some scientific methods used to study deep sea environments.

Part 1: Before the Dive

Based on what you know about spreading ridges (to learn more about spreading ridges in general and the Endeavour segment spreading ridge click here):

- Describe what geological features you are likely to find at an oceanic ridge. Based on such features, what processes do you think are happening at this site?

- Imagine you are the Principal Investigator (PI) for this dive. Based on the available tools (e.g., cameras, ROV sensors, ROV GPS, etc.) explain what kind of geological research questions can you answer? What kind of data do you think you can collect to answer the questions mentioned above?

Part 2: ROV Dive 1

Now you will look at footage from ROV Hercules collected during a maintenance dive conducted in June 17, 2017. While this was a very long (~25 hours) dive there are many interesting geological characteristics that you will be able to identify.

- To access the dive, go to https://data.oceannetworks.ca/SeaTube
- On the left panel you will see a tree of many different cruises. Search for **ONC maintanence 2017 - 06 Nautilus (Jun 2017)** and click the (+) sign to expand the tree.
- Scroll down to dive **H1581- 2017 – Jun - 17 12:40:00 - Endeavour - West Ridge/Main Endeavour Field** and click on it. The dive should start.
- Below the video panel you will find the dive log entries. These are annotations made during the dive to facilitate future searches for maintenance and research purposes. Each comment has a time and date associated with it. Use the search bar to search for different key words of sea bottom characteristics you think you can find at this site. The search bar is on the right of the annotation panel. When you have entered a search term, click “Find”. The video will start where the first match is found.
- After conducting your own searches, scroll down the annotations and click on annotations you find interesting. As above, the video will start at the particular time stamp where the annotation was made.
- Finally, scroll down and find the following time stamps and complete the table by describing what you observe.

Time stamp	Characteristics
June 18 – 00:02:19 (for 2 minutes)	
June 18 – 00:33:30 (for 3 minutes)	
June 18 – 00:56:00 (for 2 minutes)	
June 18 – 1:11:00 (for 2 minutes)	
June 18 – 2:52:16 (for 2 minutes)	
June 18 – 3:54:13 (for 2 minutes)	
June 18 – 6:15:19 (for 3 minutes)	
June 18 – 6:26:30 (for 2 minutes)	
June 18 – 10:37:30 (for 2 minutes)	

Part 3: ROV Dive 2

For the last part of this lab you will watch a 21-minute video clip of an ROV dive from the same location, Endeavour. As you watch the clip try to identify the following features:

- Lava pillows
- Fractures
- Hydrothermal vents (white and black effluents)
- Tube worms

Fill out the table below, including time-stamps where you observe each of these features, and what characteristics of each feature helped you identify them.

Feature	Time stamp(s)	Identifying Characteristics
Lava Pillows		
Fractures		
Hydrothermal Vents (white effluent)		
Hydrothermal Vents (black effluent)		
Tube worms		

After completing the table answer the following questions

- Briefly explain how hydrothermal vents work and why are they commonly found in spreading ridges.

- Throughout the lab you observed two different types of hydrothermal effluents. Describe the characteristics of the observed effluents and explain the differences between them in terms of temperature and chemistry.

Part 4: Endeavour Node Instrumentation
For this part of the lab you will explore some of the instrumentation that is stationed at the Endeavour Field.

- Visit: https://www.oceannetworks.ca/observatories/pacific/endeavour to see a map of the ONC installations at Endeavour.
- Scroll down to the bottom of the page and open up the Marine Protected Area Hydrothermal Vents Map. Zoom in to the Main Endeavour Field.
- Click on the double arrow at the upper left corner of the map. This will give you access to various map layers that you can enable. For example you can see where individual sponges have been documented, or look at the ROV tracks for a particular year. If you click on an individual icon—e.g., a sediment sample—information about that sample will come up, and often a link to a relevant dive clip on SeaTube.
- Data from the instruments can also be viewed by returning to the Oceans 2.0 site https://data.oceannetworks.ca/.
- Navigate again by clicking on the (+) signs to access Pacific, Northeast Pacific Ocean, then Endeavour. From here you can investigate the data collected with the various sensors, displayed graphically for the past day or month (choose tab at top of main window).

- Using either platform, find three different kinds of instruments that provide geological information. For each of your chosen instruments, briefly describe the kind of data it collects and how that data might be used (i.e. why is it useful to collect?).

- What did you find interesting or surprising about exploring a spreading centre via cabled observatory and ROV?