CASE STUDY – SEISMOLOGY

Ocean bottom seismology

'Wiring the Abyss' with Güralp ocean bottom seismometers

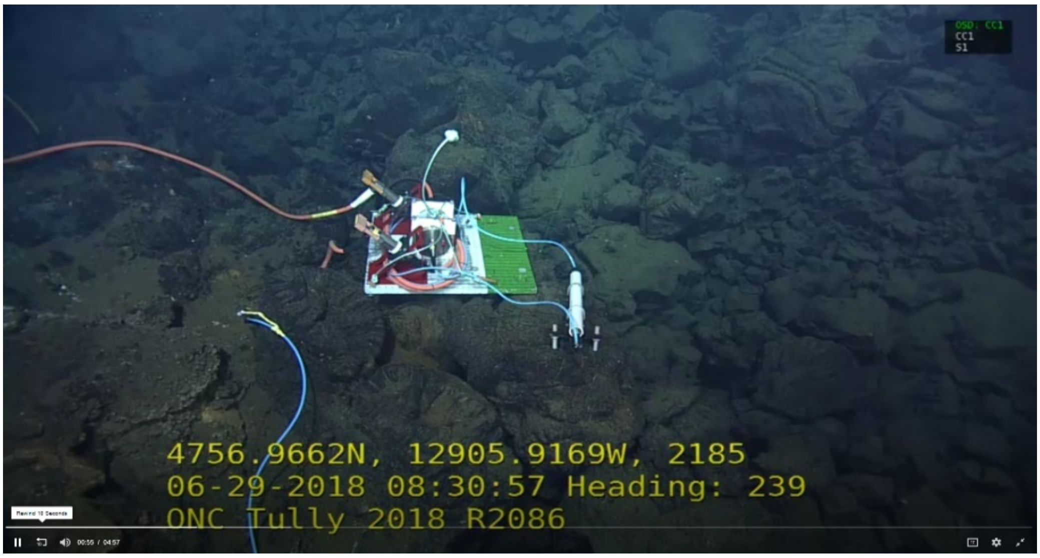

Figure 1: Installed and connected Maris OBS and interface unit (Image courtesy of Ocean Networks Canada.)

Summary

Ocean Networks Canada (ONC), a University of Victoria initiative, successfully deployed a string of three cabled Güralp Maris ocean bottom seismometers (OBS) as part of their 2018 'Wiring the Abyss' expedition aboard the Canadian Coast Guard Ship 'John P. Tully'.

The deployment was carried out on one of the annual expeditions to maintain ONC's NEPTUNE cabled seafloor observatory, in the Northeast Pacific Ocean offshore Vancouver Island. The backbone of the observatory is a more than 800 km cable loop that provides power and real-time internet connectivity to instruments on the continental slope, abyssal plain, and reaches all the way out on the Endeavour Segment of the Juan de Fuca Ridge.

The Güralp OBS were deployed on the Juan de Fuca Ridge, a divergent boundary between the Pacific and Juan de Fuca tectonic plates. The instruments were positioned at a depth of approximately 2200 m adjacent to hydrothermal vents that have formed along the ridge, and were lifted into place using the Canadian Scientific Submersible Facility's remotely operated vehicle for ocean science—ROPOS.

Endeavour

The water depths at Endeavour reach 2200 to 2400 m. The Juan de Fuca Ridge is a medium rate spreading centre forming the divergent boundary between the Pacific and the Juan de Fuca

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tectonic plates. At this divergent plate boundary, the mantle rises up as magma, emerging through the rifts as lava, further crystallising as new rock on the ocean floor.

The monitoring of seismic activity along these ridges is important in developing scientific understanding of large scale plate tectonics and seismic activity. Hydrothermal vents form along these mid-ocean ridges and create their own unique ecological communities. At these great depths, many of the species found here are endemic to their surroundings, separated from the surface waters, and therefore are of great scientific interest.

Through Güralp technology, a global community of scientists working with ONC infrastructure are able to gain a better understanding of seismic activity in this unique location.

Güralp Solution

Güralp supplied a string of three cabled Maris ocean bottom seismometers and one autonomous Maris seismometer to ONC. The autonomous Maris seismometer has recorded seismic activity over the period of 15 months and was retrieved in September 2019.

The string has acceleration response and is sampled at 500 samples per second. The aim of the array is to detect very small, very local events that are related to the hydrothermal activity of the Main Endeavour Vent Field. The instrument spacing is 70-100m.

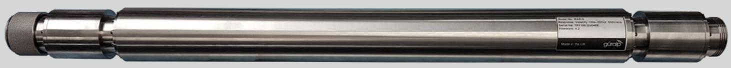

Figure 2 Guralp Maris ocean bottom seismometer

One of the benefits of the Güralp Maris instrument for this type of deployment is the unique capability of the sensor to operate at any angle. This functionality allows for greater flexibility when installing the instruments in environments where precise alignment and levelling are difficult without gimbals. The internal magnetometer and MEMS accelerometer are working together to automatically compensate for tilt and horizontal orientation to deliver high-quality waveforms. The string includes the Minimus digitiser, housed in a separate vessel, which enables data exchange over Ethernet from the seismometers direct to the cabling network.

In addition, there is a 'regional' array, which includes a Güralp 1T broad band seismometer that measures regional background seismicity. Further details about the 5 station regional array can be found at https://www.oceannetworks.ca/observatories/pacific/endeavour.

Deployment

The deployment of the Maris string took place on the 29th June, 2018, and was streamed live via the ONC website. The video of the deployment can be found at: https://data.oceannetworks.ca/SeaTube?resourceTypeId=1000&resourceId=1001&diveId=2551&time=2018-06-27T12:10:10.000Z.

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Güralp engineers watched the installation live and provide advice to the scientific team on board the expedition vessel and to ONC staff onshore led by staff scientist, Dr. Martin Heesemann. Having direct communication with the ONC's team on-board the ship, allowed them to provide advice about the placement of the sensors, and, given the rocky and uneven terrain of the deployment site, to witness the value of the capability of Maris to work at any angle on the seafloor first hand. The process of placing, connecting, and testing the whole system took around five hours to complete.

Dr Martin Heesemann, senior staff scientist for the project, commented:

"Güralp has been providing cabled Ocean Bottom Seismometers and expertise to ONC since initial instrument deployments for the NEPTUNE observatory in 2009. In addition to the Maris instruments we use 1T broadband seismometer that are buried in sediments at all, but our shallowest, instrumented sites. In shallow waters, ambient noise is just too overpowering to make an installation worthwhile. Installations at Barkley Upper Slope and Clayoquot Slope cover the Cascadia Subduction Zone that is capable of generating magnitude 9 mega-thrust earthquakes".

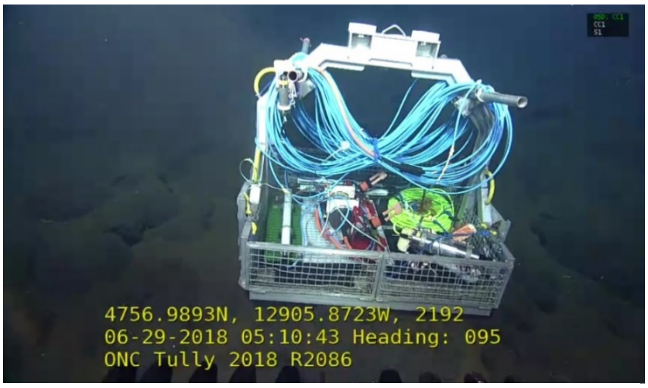

Figure 3. ROPOS toolbox containing Maris OBS, interface unit and cabling
(Image courtesy of Ocean Networks Canada)

Figure 4. Güralp Maris Seismometer being placed in position at 2200m depth
(Image courtesy of Ocean Networks Canada)

Outcomes

The system is fully operational with real time information recorded by the string cabled seismometer being sent to IRIS (Network code NV). Via the ONC website, daily recordings can be viewed, over a very broad frequency range (flat response of 120s -200Hz). The seismic signals in this range can include microseisms, which are natural background noise including signals from storm waves and long wavelength sea swell.