

Aquarius BBOBS instrument pool, Canada

Canada's National Facility for Seismological Investigations (NFSI), 2023 research projects



Figure 1. Güralp Aquarius OBS on route to Vancouver Island. Photo courtesy of Katie Bosman

Background

Situated in Canada and based at Dalhousie University, The National Facility of Seismological Investigations ("NFSI") is supported by a partnership of ten universities from across Canada. The NFSI operates a pool of 120 Güralp Aquarius broadband ocean bottom seismometers (BBOBS) systems. These state-of-the-art BBOBS are available for innovative research investigations across the world's oceans, inland seas, and lakes. Based at Dalhousie University, the NFSI laboratory provides instrumentation and data preprocessing services worldwide and maintains a repository of ocean-based seismic data.

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"We selected Güralp for this ambitious project because of their long history with designing and manufacturing free-fall OBS systems. There is inherently more risk associate with offshore instrumentation so Guralp's experience has been valuable during the design, testing, supply and operation of the 120 BBOBS systems. The newly created BBOBS pool opens up great opportunities for the Canadian offshore seismology community and beyond so we are very excited to see what science comes from our future projects."

Mladen Nedimović, Project Director, NFSI

Monitoring and understanding faults are important for providing earthquake warning and mitigating seismic hazard and risk to an area.

In 2023 the NFSI undertook a busy year deploying 56 broadband BBOBS across three research projects in three oceans. Aquarius OBS were deployed within the St Lawrence seaway over the Lawrence seismic zone; off the north end of Vancouver Island over the Revere-Dellwood Fault; and over the Hikurangi Locked Zone, New Zealand's largest fault and subduction zone.

Project requirements

The research projects require instrumentation that can be deployed for a few months up to a year and at depths of up to 6000 metres. For maximum flexibility, the compact BBOS can be winched onto vessels for transportation to the desired location, before being deployed in a freefall manner without the use of ROV. As a pool of autonomous offshore sensors, it is essential that the return rate of the instruments is high.



Figure 2. Deck crew of R/V Tangaroa deploying Aquarius offshore New Zealand. Photo courtesy of Katie Bosman

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Güralp Solution

The Aquarius broadband ocean bottom seismometer

The Aquarius results from more than thirty years' experience in developing offshore seismic monitoring solutions. Unique in the market, is Aquarius' capability to deliver near real-time State-of-Health (SOH) and seismic data from the ocean floor to the surface using acoustic telemetry. The advanced triaxial broadband sensors housed in the Aquarius are fully operational at +/- 90 degrees, ideal for freefall deployments on to the sea floor, up to depths of 6000 m. Aquarius has a flat response between 120 s and 100 Hz and a customisable long-period corner allowing it to be tailored to the environment. The circular, compact design of the Aquarius is low profile to minimise noise from current flow.



Figure 3. Aquarius

With the development of wave glider, buoy and UAV technology, there are a growing number of data collection methodologies that are compatible with Aquarius that aim to resolve complex ocean research challenges.



Figure 4. John Thibodeau checking electrical connections on the Aquarius prior to deployment. Photo courtesy of Katie Bosman



Figure 5. Acoustic communication through the deck unit to an underwater instrument. Photo courtesy of John Thibodeau.

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2023 Deployments

Lower St Lawrence Seaway Deployment

The Lawrence Seismic Zone (LSZ) is a region within eastern Canada that is seismically active. Along the St. Lawrence Valley there is thought to be a zone of weakness between two re-activating old faults and analysis has shown that most of the earthquakes within the LSZ occur beneath the St. Lawrence River, however few faults are mapped within the region.

Between September 26th and 29th, eight Aquarius were deployed in the St. Lawrence River estuary by NFSI. Dalhousie University jointly deployed 48 nodal land stations along the north and south shores of the river during mid-September to mid-October 2024. The planned recovery is due to take place during the Spring of 2024.



Figure 6. Instrument locations for the Lower St Lawrence Seaway project. The blue triangles are Aquarius. The green triangles are land nodal stations.

PACSAFE Deployment

Later in the year NFSI partnered with PACSAFE, an NSERC Alliance project, deploying 28 Aquarius over the end of Vancouver Island, this formed leg one of a five-year project which will study earthquake hazards along Canada's west coast. Initially aiming for the Queen Charlotte Fault, PACSAFE had to change locations due to incoming major storm forecasts. Regardless of this the crew and science team were able to successfully deploy the Aquarius, which are scheduled for recovery during the Summer of 2024.

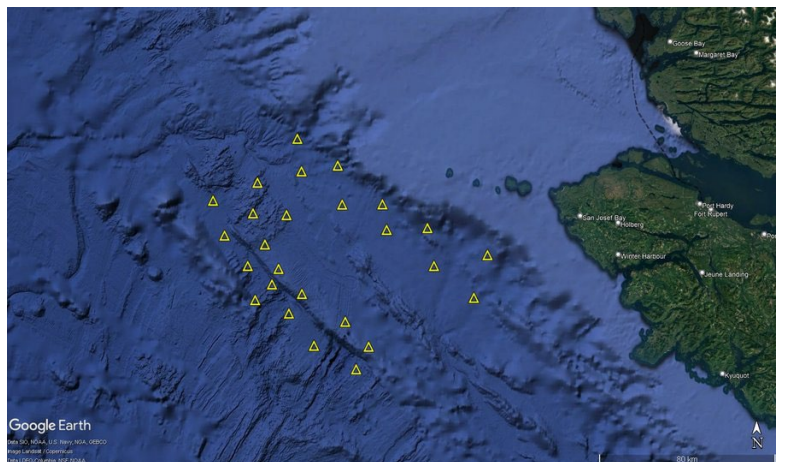


Figure 7. Yellow triangles denote the locations of Aquarius deployed for PACSAFE Leg 1.

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ELVES Deployment

Less than a month later, the NFSI team travelled to New Zealand to deploy instrumentation for the ELVES (Earthquakes and Locking Investigation of Subduction) project, a collaboration between Canadian and New Zealand researchers. Project scientists aim to investigate whether the Hikurangi 'locked' zone is producing any small-scale earthquake activity and use these signals to paint a clearer picture of the structure and potential for the subduction zone to cause major earthquakes. NFSI shipped 20 Aquarius directly from the UK to Wellington, air-freighting the accessory equipment. The NFSI and ELVES team were able to successfully deploy the 20 Aquarius over a 5-day period to depths of up to 3 km, they will be recovered in January 2025.

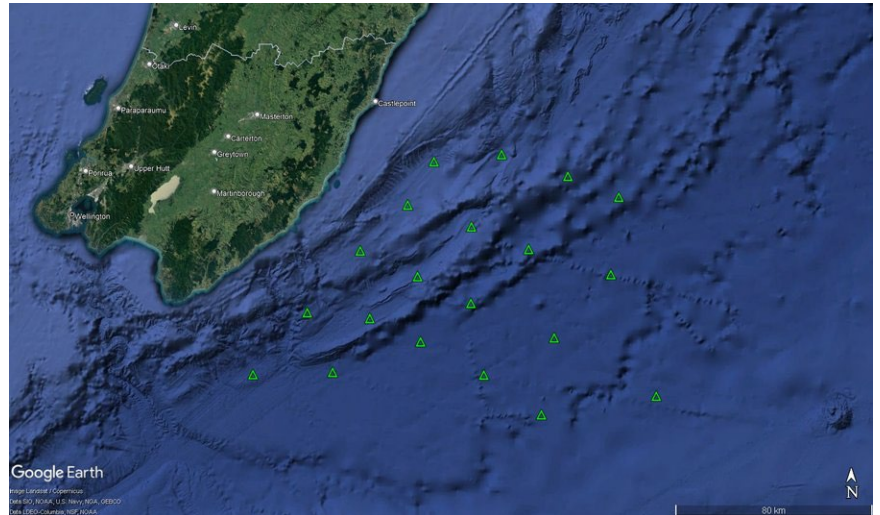


Figure 8. Green triangles show the deployed locations of Aquarius for the ELVES I project.

Outcome

The 56 Aquarius deployed in 2023 by NFSI are gaining insight into ocean bottom seismology across Canada and New Zealand, already recording Mw 3+ earthquakes shortly after deployment.

Data from the 56 Aquarius will form the basis for increased understanding of seismic risk in each of the deployment locations. As pool instruments, following their recovery, these instruments will then be available for redeployment on further research projects.

Through their Marine Seismology Workshops, the NFSI have developed institutional communities (primarily students and post-docs) on various topics surrounding Aquarius OBS including, marine seismology, hands-on data analysis, field demonstration and recovery.