



UNDERSTAND OPTIMISE PROTECT

Offshore Seismic Monitoring Solutions for Carbon Storage

JAMES LINDSEY
GLOBAL SALES MANAGER



1985

ESTABLISHED

50,000+

INSTRUMENTS SUPPLIED
WORLDWIDE

30+

REGIONAL
DISTRIBUTORS

1000+

OCEAN SYSTEMS



**SURFACE
DOWNHOLE
OCEAN**

ISO9001:2015

CERTIFIED

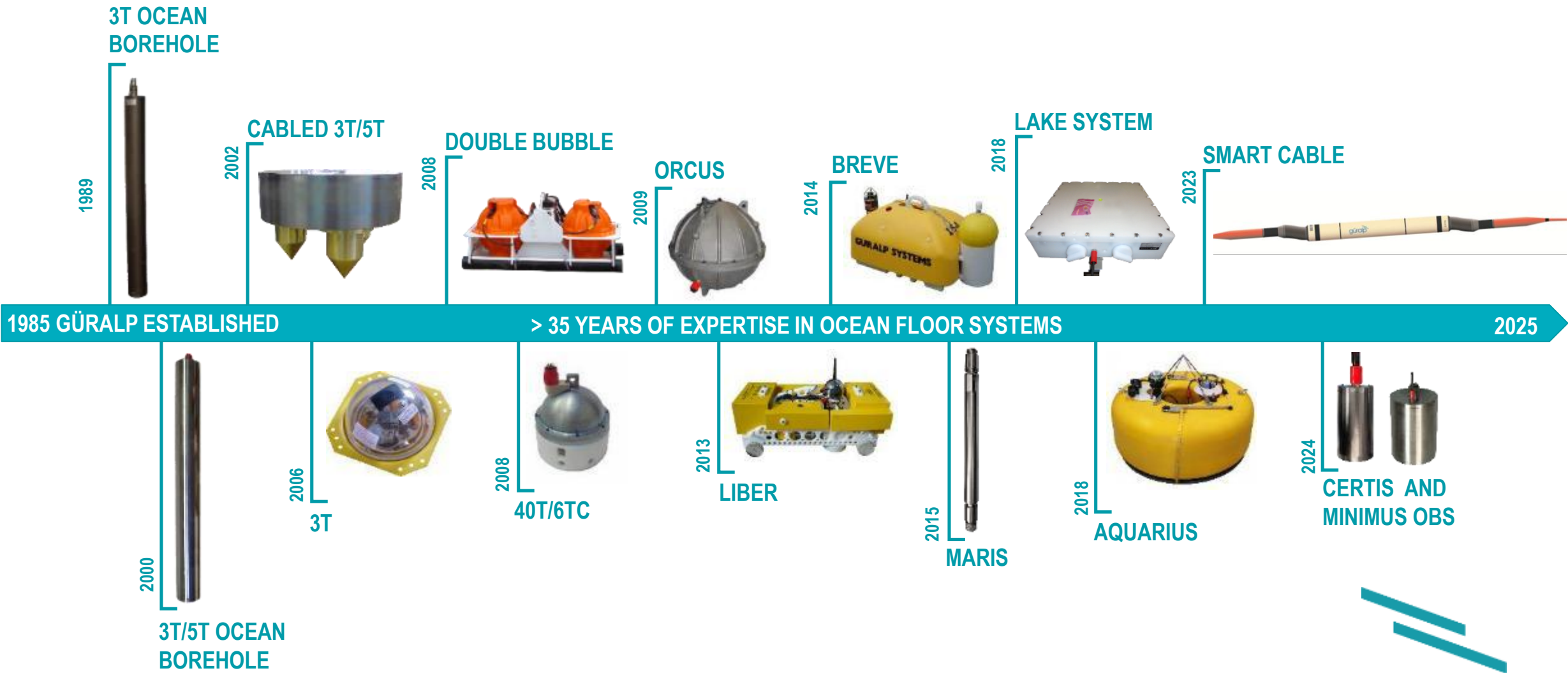
**NEXT GENERATION
Bespoke Engineering**

100+

COUNTRIES SUPPLIED



PRODUCT TIMELINE – OCEAN BOTTOM SYSTEMS

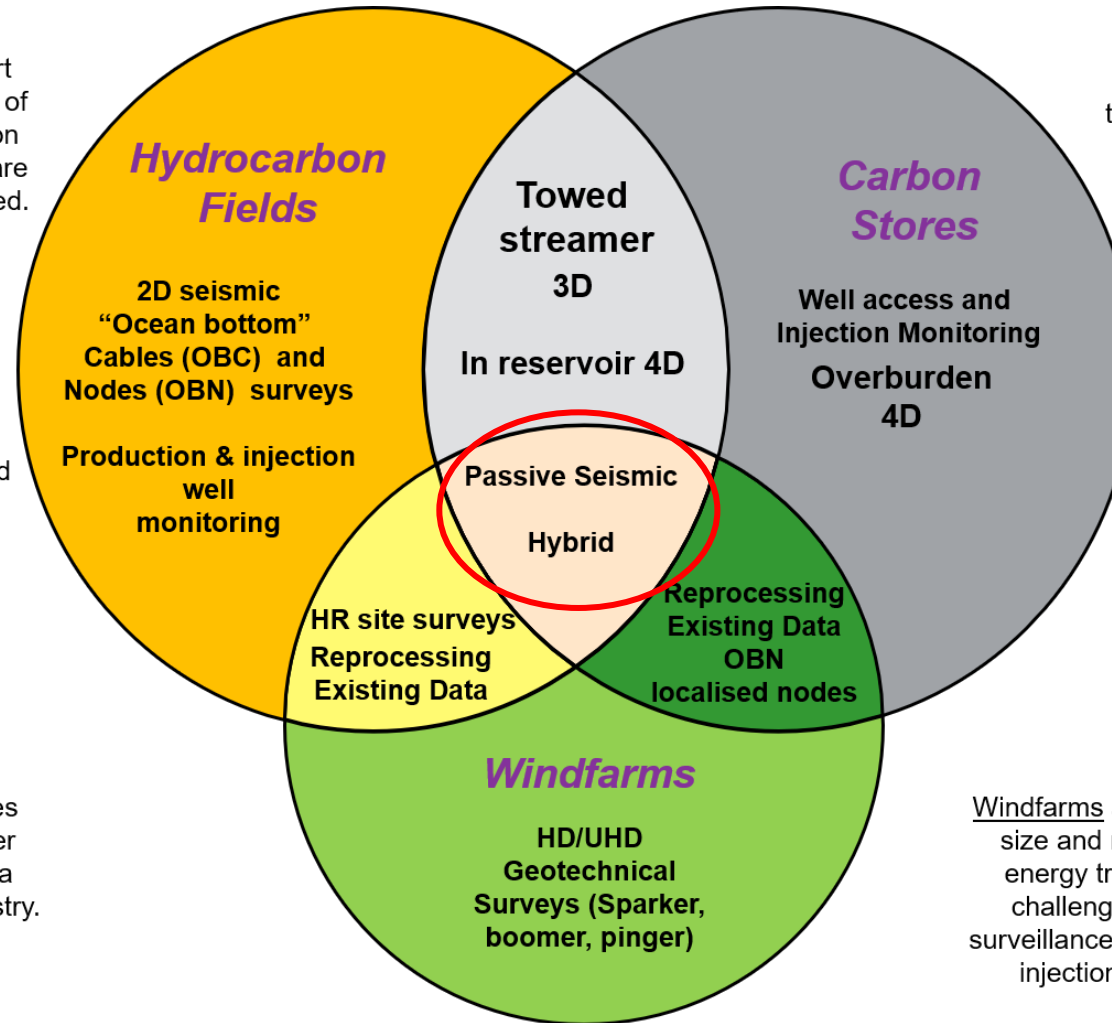


OFFSHORE MONITORING STRATEGIES

Deep Imaging Geophysics
The O&G industry has helped support and drive the development of an array of highly sophisticated seismic acquisition and processing technologies. These are overwhelmingly seismic reflection based.

One subsurface
Separate organisations (energy company, geophysical acquisition and research institutes) are beginning to utilise new full wave algorithms to understand the overlap.

Shallow Imaging Geophysics
Siting offshore wind turbines, like installing O&G and CS facilities, relies upon very much shallower and higher resolutions, typically undertaken by a separate geophysical acquisition industry.



Carbon Stores
There are many similarities between traditional O&G deep seismic imaging and that being re-employed for CS sites, with greater focus on the overburden rock structure above the injection reservoirs.

Carbon Stores
In the long term, carbon stores are expected to move towards targeted monitoring around specific risk areas (e.g. legacy wells & critical faults). This could include minimal 2D, HR only, in well active seismic, in well or seabed passive reservoir monitoring.

Windfarms are expected to increase in size and number with the evolving energy transition. One of the key challenges will be in maintaining surveillance of the subsurface and CO₂ injection in areas of colocation.

Force-Feedback instrumentation provide lower self-noise performance, allowing for the full energy spectrum of natural and induced seismic events to be monitored, even at global distances and with small magnitudes.

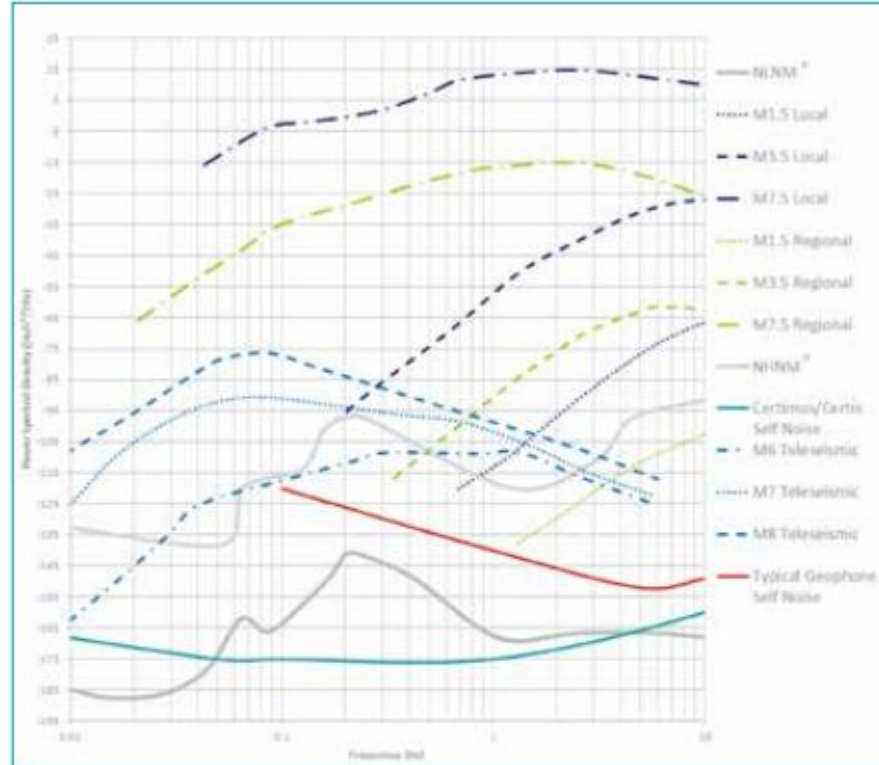


DIAGRAM 1 COMPARISON OF SELF-NOISE OF TYPICAL GEOPHONE VS GÜRALP CERTIS/CERTIMUS BROADBAND SENSOR

* New Low Noise Model/New High Noise Model; Peterson, 1993, USGS

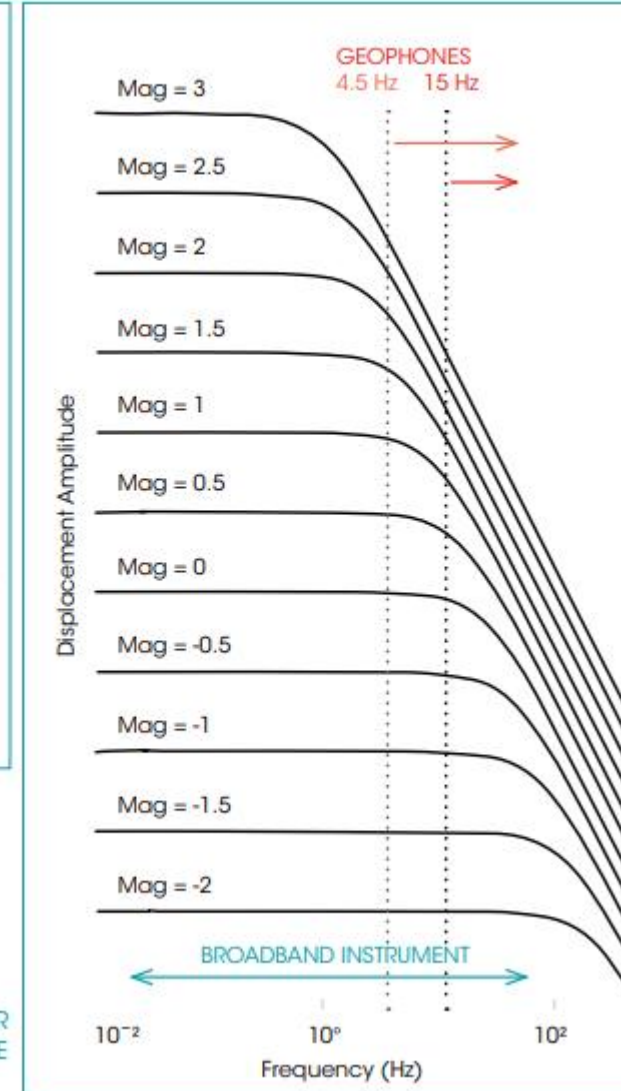
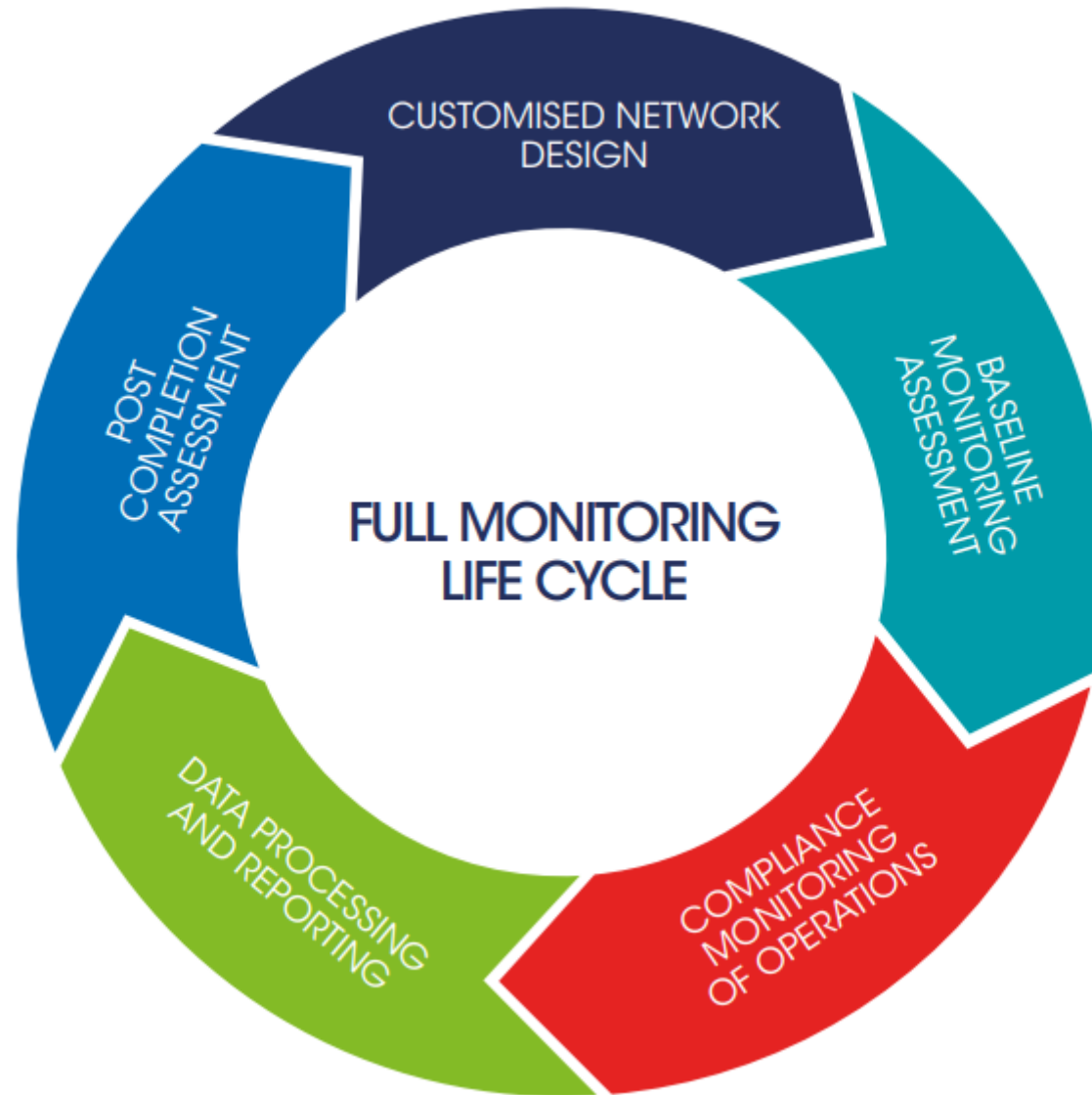


DIAGRAM 2 INSTRUMENT RESPONSE COMPARISON FOR GÜRALP BROADBAND INSTRUMENT AND GEOPHONE

Vargas G. et al, 2012





AUTONOMOUS OBS

RESPONSE: FLAT RESPONSE 120 SECONDS – 100 Hz
USER SELECTABLE LONG PERIOD CORNER FROM 1
SECOND TO 120 SECONDS

LOW PROFILE DESIGN
MINIMISES NOISE FROM THE SEA-FLOOR

ACOUSTIC TELEMETRY
TRANSMIT DATA FROM THE SEAFLOOR
TO THE SURFACE WITHOUT CABLES

EARTHQUAKE / TSUNAMI EARLY WARNING
OPTION FOR TRIGGERED DATA TO BE SENT
TO A RECEIVER AT THE SURFACE FOR
ALERT APPLICATIONS (UP TO 9000 BPS)

ABSOLUTE PRESSURE GAUGE AND HYDROPHONE
OPTION TO UPGRADE TO AN ULTRA-LOW FREQUENCY
HYDROPHONE AND INCORPORATE ADDITIONAL HIGH
PERFORMANCE ABSOLUTE PRESSURE GAUGE



FREE-FALL DEPLOYMENT TO 6000 M
FULLY OPERATIONAL AT +/- 90 DEGREES

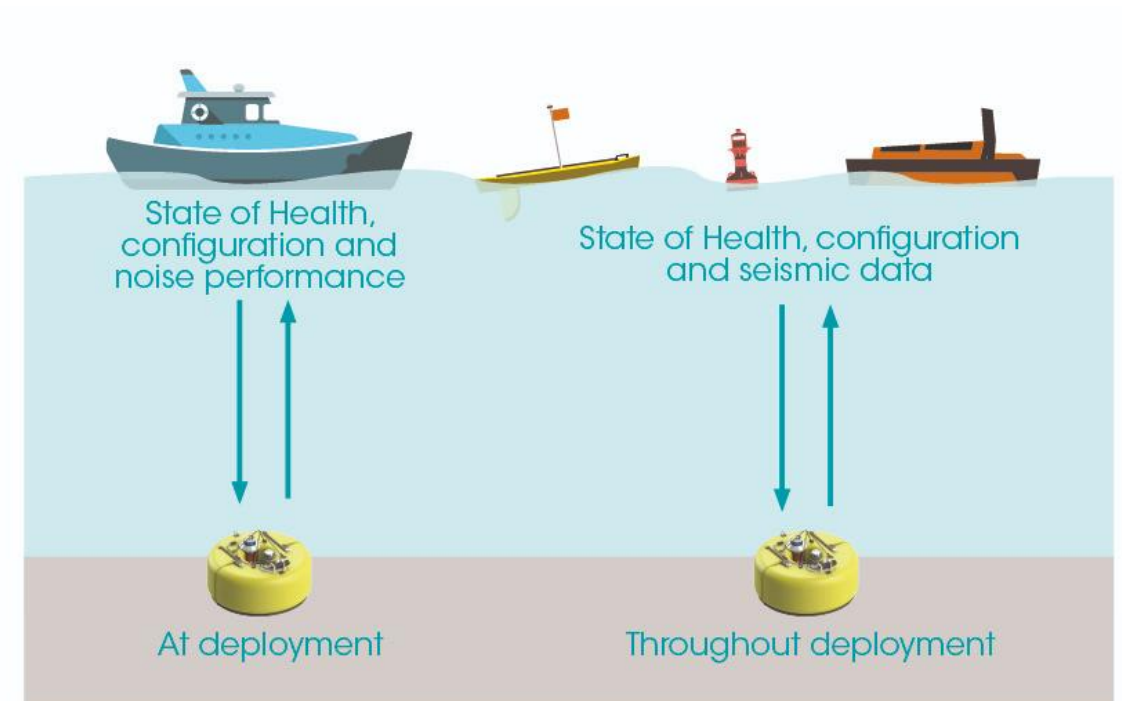
DEPLOYMENTS UP TO 18 MONTHS
LITHIUM BATTERIES, FAST RECHARGE
1 HR PER 1 MONTH DEPLOYMENT

EASY AND PRECISE DEPLOYMENT
INTEGRATED LOCATION AND RANGING
SOFTWARE FOR PRECISE LOCATION ON
THE SEABED, GPS-A AND USBL COMPATIBLE

COMPREHENSIVE RECOVERY SYSTEM
BURN-WIRE SYSTEM RELEASES BALLAST AND
SYNTACTIC FOAM RAISES INSTRUMENT TO THE
SURFACE WHERE IT IS LOCATED USING
SATELLITE TRACKING



- During Installation
 - Obtain state-of-health information, configure the instrument, receive limited seismic data to analyse noise performance
- During Deployment
 - Continuous data is recorded internally
 - Event timestamps are recorded in a table
 - Event table transmitted upon request
 - Seismic data downloaded using event table or by specifying a time window
- Transmission to a vessel, buoy or wave-glider



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MARIS OBS

RESPONSE: FLAT RESPONSE 120 SECONDS – 200 Hz
LONG PERIOD CORNER UP TO 120 SECONDS WITH
STATE OF THE ART BROADBAND SENSOR

OMNIDIRECTIONAL OPERATION

SENSOR HAS $\pm 90^\circ$ TILT TOLERANCE ALLOW FOR
MULTIPLE DEPLOYMENT ORIENTATIONS

EARTHQUAKE / TSUNAMI EARLY WARNING

DATA DELIVERED IN REALTIME VIA
ETHERNET OR FIBRE CONNECTION

DEPLOYMENT IN SERIES

UP TO 8 SENSORS CAN BE DEPLOYED IN SERIES TO
ALLOW FOR EASILY DEPLOYED LOCAL ARRAYS



HIGH PRESSURE CASING RATED TO 4000 M
CORROSION PROOF DESIGN

PERMANENT DEPLOYMENT

INSTRUMENT DESIGNED TO OPERATE
FOR 10+ YEARS

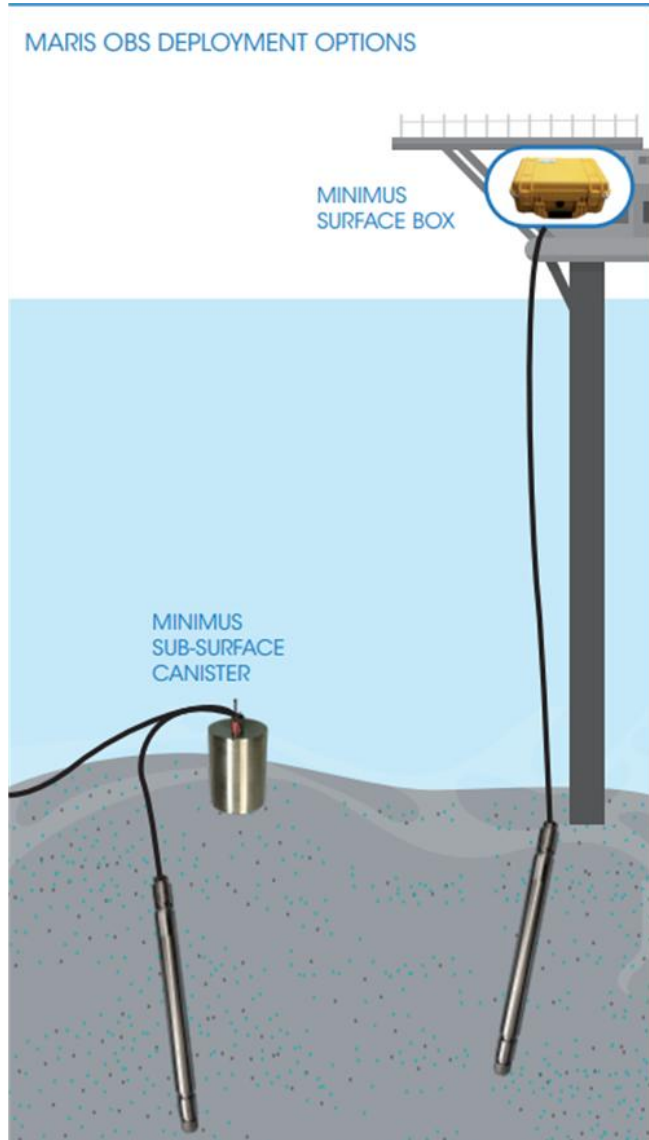
PROVEN DESIGN

DESIGN BASED ON 30+ YEARS OF OBS
MANUFACTURING EXPERIENCE

ROV FRIENDLY

SLIM CASING AND CONNECTORS DESIGNED TO
ALLOW FOR EASY MANIPULATION WITH ROV
AND WETMATABLE CONNECTOR





- > Option of seafloor or topside data acquisition
- > Minimus interface unit digitises data at site with real-time streaming over ethernet
- > Deployment and cable installation via Remotely Operated Vehicle (ROV) or winch
- > Option to install as stand-alone site or strung together to form a daisy chain array on the seafloor



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SMART

> The Problem

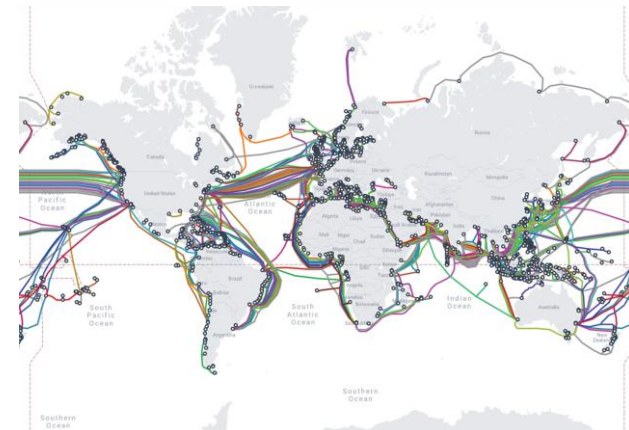
- > Long term data from the Ocean is essential for resilience against ocean hazards
- > Current sparse spatial distribution of permanent real-time monitoring systems
- > High capital and maintenance costs associated with such systems

> The SMART Solution

- > Integration of environmental sensors into transoceanic telecom cables
- > Sensors to piggy-back on power and comms infrastructure
- > Seismic, temperature and pressure sensors

> Potential for global adoption

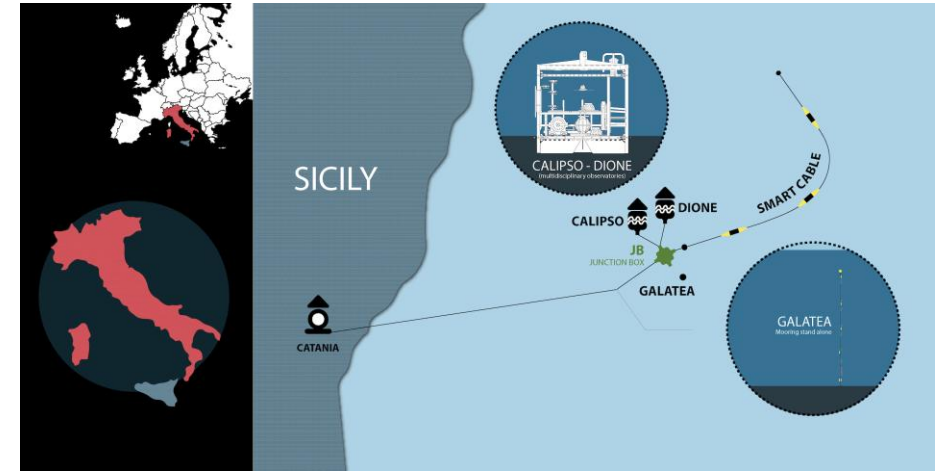
- > Over 1 million kilometres of operational subsea cable today
- > In 2024, ~140,000km of new subsea telecom cable was deployed
- > Cable operators interested in the SOH benefits from the sensors



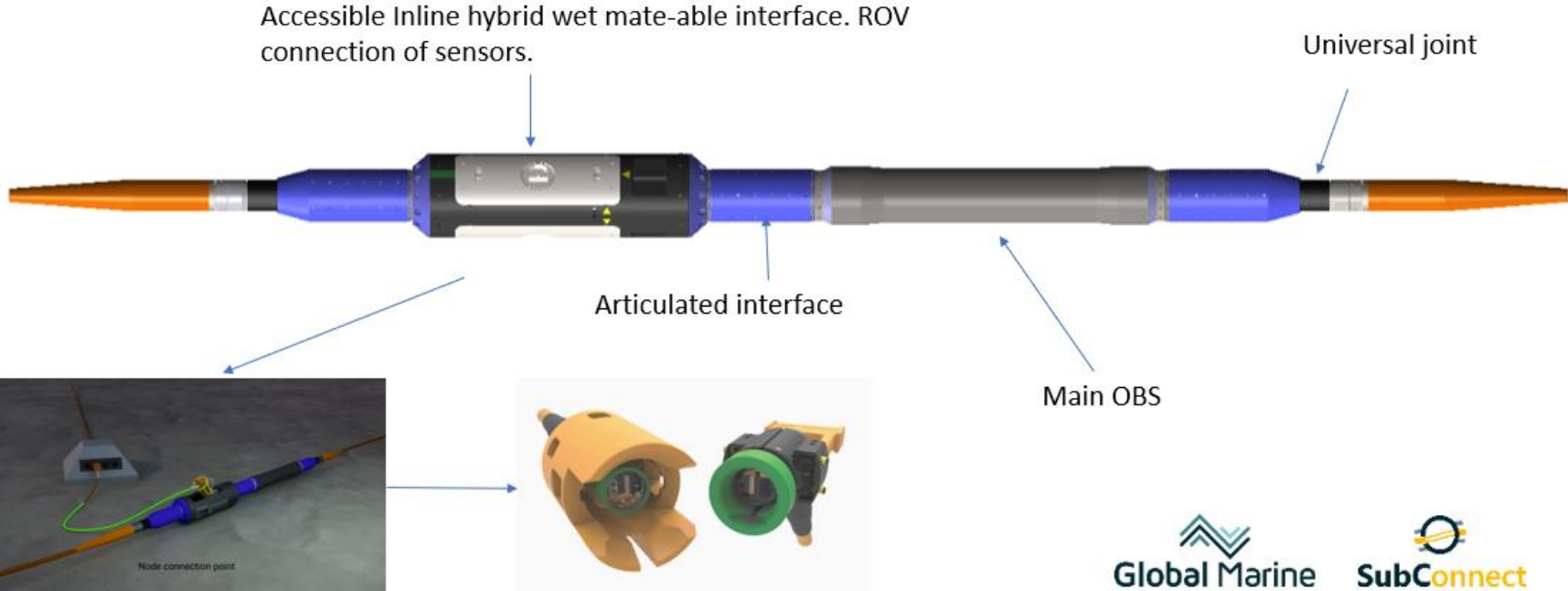
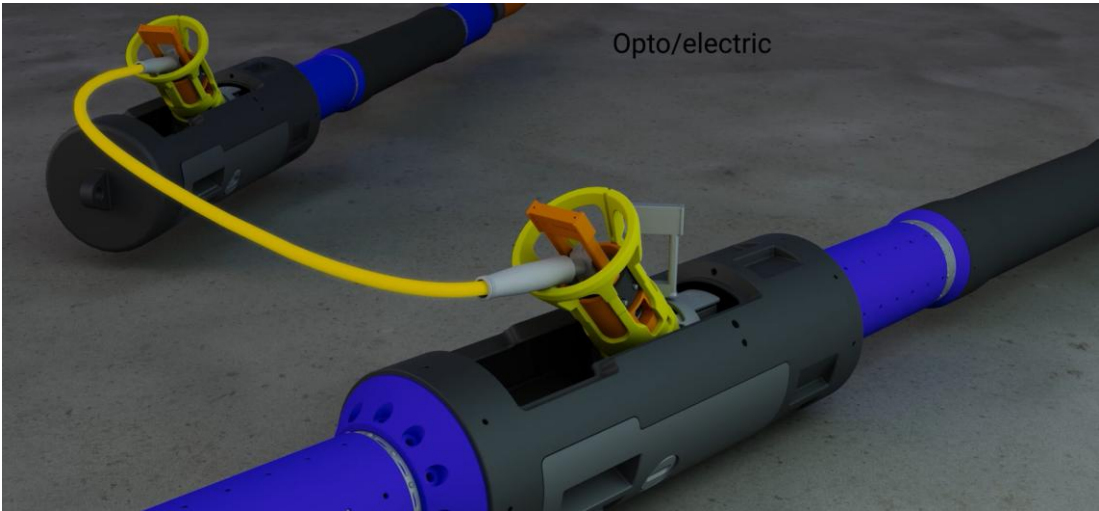
INGV INSEA WET DEMONSTRATOR PROJECT

- > 1st successful wet demonstrator project
- > 3 instrumented repeaters
 - > Broadband seismometer (dry)
 - > FBA accelerometer (dry)
 - > Pressure sensor (wet)
 - > Temperature sensor (wet)
- > Installed in December 2023 and performing as expected for broadband velocity, acceleration and temperature, proving reliable implementation
- > Pressure sensors have gone offline, investigations continue into cause
- > Data available at:

https://www.moist.it/sites/western_ionian_sea/2/INSEASC



IN-LINE SCIENCE NODE WITH WETMATE CAPABILITY



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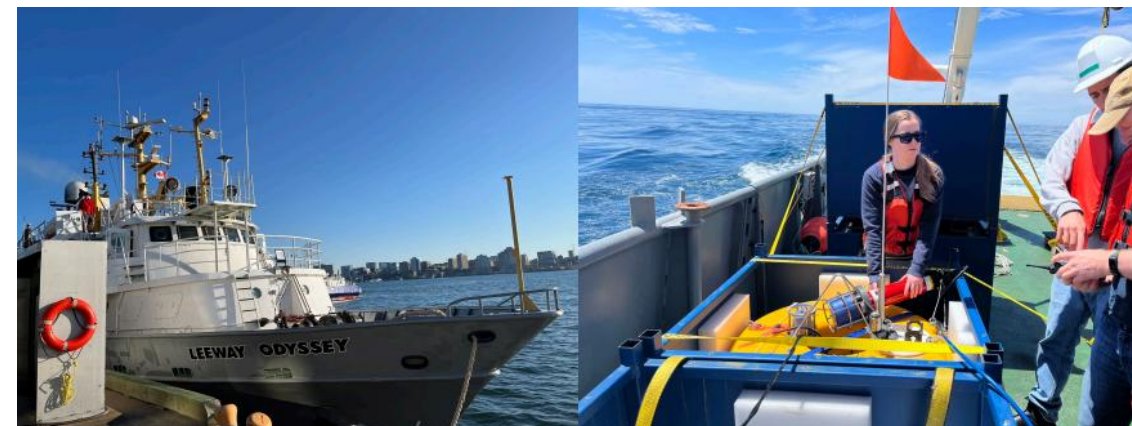


CASE STUDIES

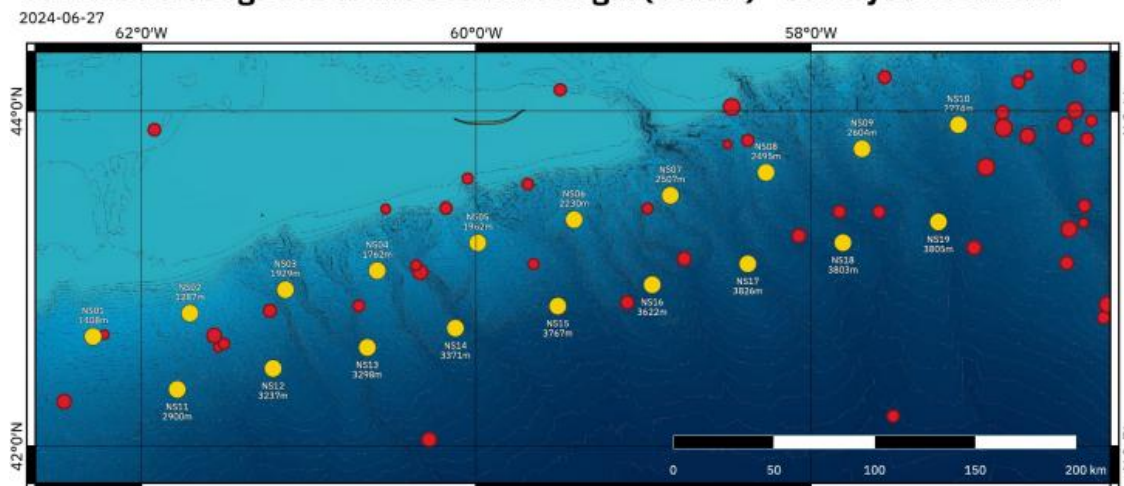
- > 120 free-fall, Aquarius broad-band ocean bottom seismometer (“BBOBS”) systems and associated topside equipment to form the instrument pool of (“NFSI”) based at Dalhousie University in Halifax.
- > The world’s largest pool of commercial BBOBS systems
- > Over 250 successful deployments (100/year)
- > Setup of in-country service centre for long-term support



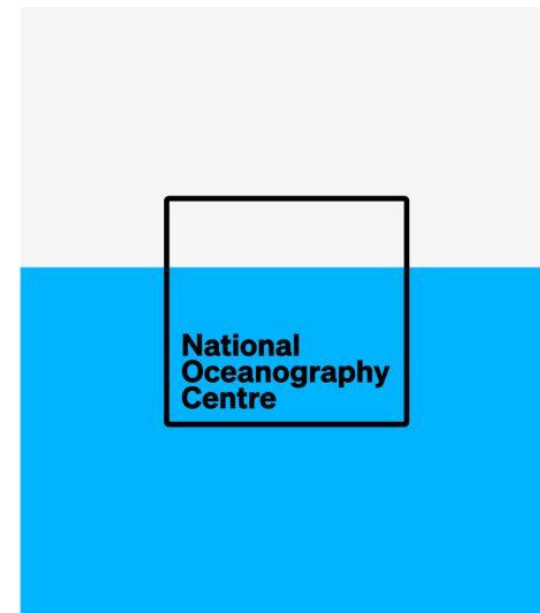
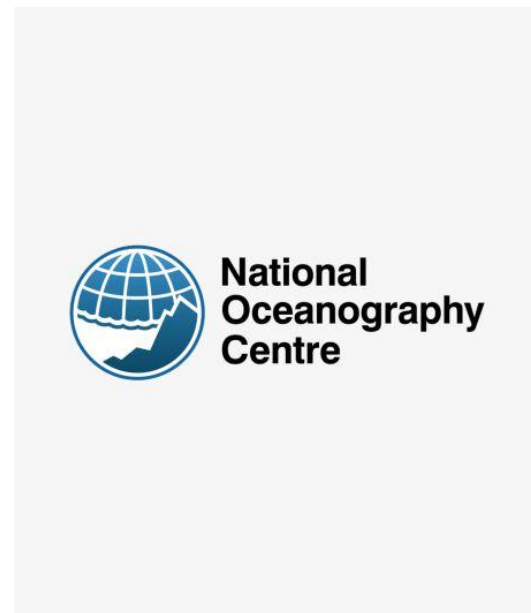
- > SeISM: Seismic Evaluation of the Scotian Margin for Long-term Carbon Storage
- > PIs: M. Zhang (Dalhousie), M. Nedimović (Dalhousie)
- > June 2024 - May 2025
- > Need to evaluate seismic risks and tectonic structures that can impact long-term storage
- > 19 OBS deployed

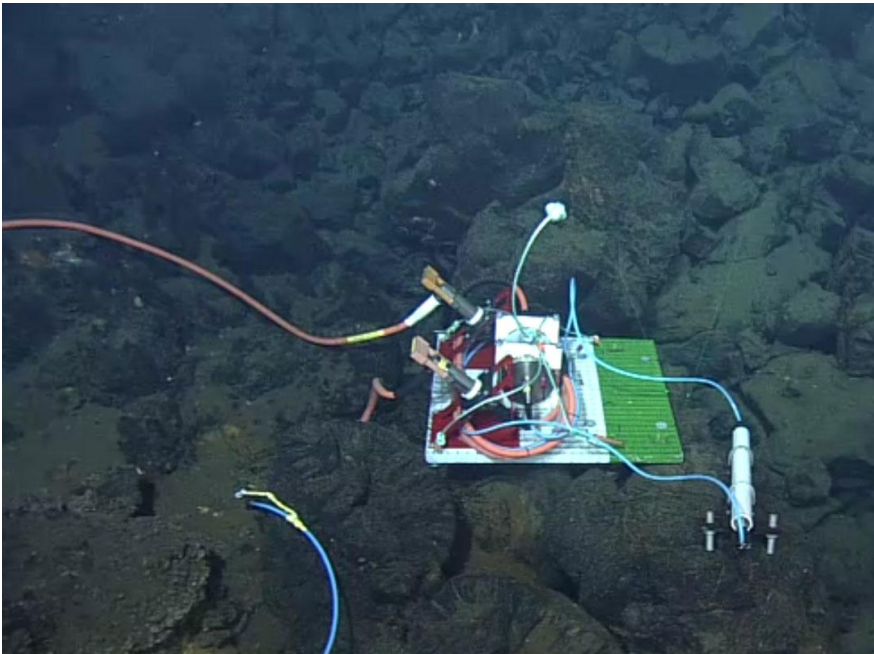
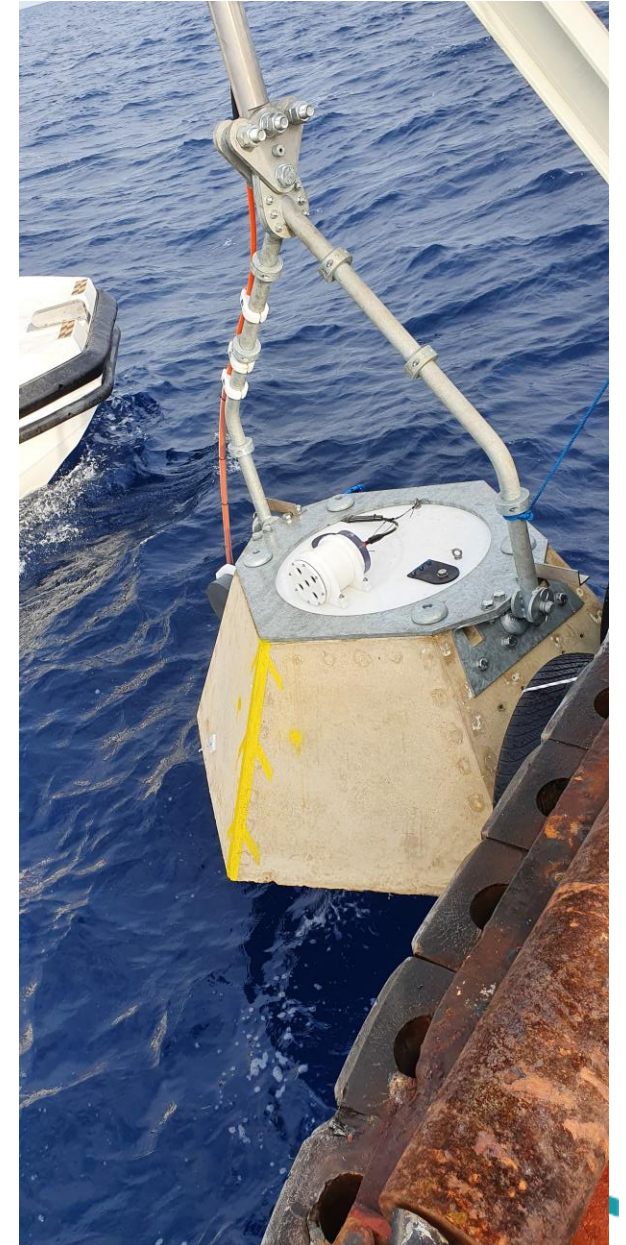


Seismic Investigation of the Scotian Margin (SeISM) - Surveyed Locations



- > 6 Aquarius OBS Units
- > 5-year supply contract
- > Longer term development of autonomous ocean bottom sensing technology
- > Initial deployment in the North Atlantic as part of the Full Ocean Fiber project - calibrate Distributed Optical Fibre Sensing (DOFS) along the subsea cable crossing from Shetland to the Faroe Islands.





	Aquarius Autonomous OBS	Maris Cabled OBS	SMART Cable
Data channels	Broadband seismic, hydrophone and pressure	Broadband seismic	Broadband Seismic, acceleration, temperature and pressure. Optional gateway to support external instrument clusters
Realtime or offline	Offline (online triggered data available via acoustics)	Realtime	Realtime
Installation costs (Relative)	Low	High	Medium
Maintenance costs (Relative)	High	Low	Low-Medium
Notes	Smaller commercial vessels (e.g. dive support vessels) can be used to reduce vessel costs	Seafloor interface unit can support other auxiliary instruments	In-line system deployable using industry CLVs. ROV required for external sensor packages



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