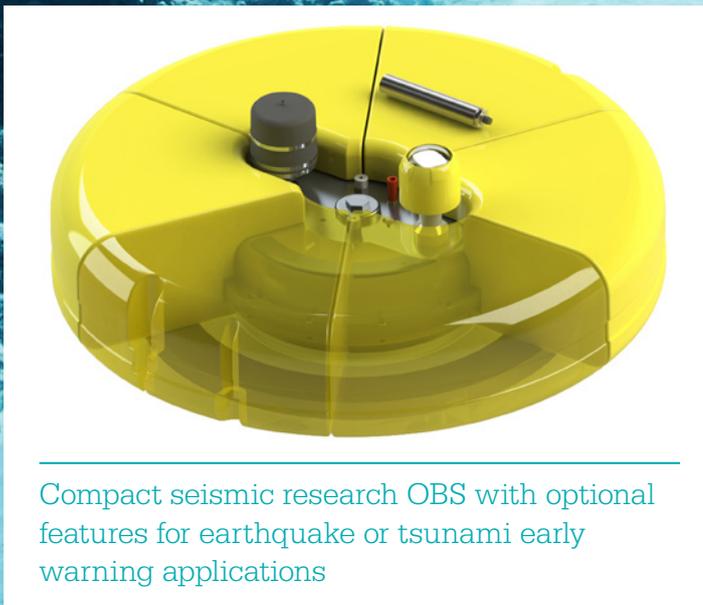


# AQUARIUS

OCEAN BOTTOM SEISMOMETER WITH ACOUSTIC TELEMETRY



Compact seismic research OBS with optional features for earthquake or tsunami early warning applications

## KEY FEATURES

- > Digital feedback triaxial broadband seismometer, operational at any angle, with a flat response between 120s and 100Hz
- > Research option - receive State of Health parameters and noise performance data direct from the seabed following deployment for confident seismic recording projects lasting up to 18 months
- > Research and alert option - receive triggered (STA/LTA) event notifications to the surface in near real time with options to receive more detailed data, selected by time frame or by event, for further analysis
- > Bi-directional communication and controls between the underwater system and the surface unit

# Güralp Aquarius OBS

This revolutionary ocean bottom seismometer (OBS) uses acoustic telemetry capability to deliver near real-time seismic data from the ocean floor to the surface without cables.

The new Güralp Aquarius OBS is a stand-alone free fall OBS with acoustic data telemetry for deployments at depths of up to 6000m for up to 18 months duration.

## AQUARIUS OPTIONS

### AQUARIUS

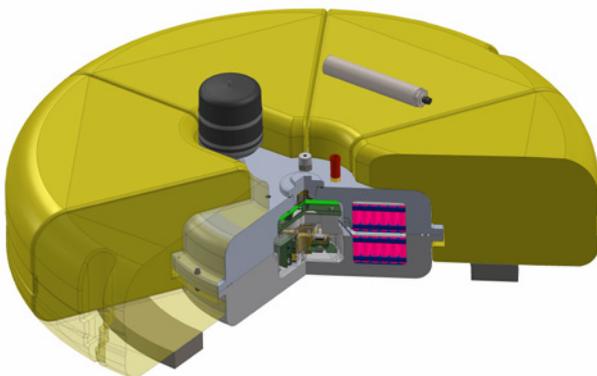
#### Seismic Research

- > When data transfer is needed only at the installation and at the recovery of the OBS
- > The OBS is equipped with an omnidirectional transducer
- > Battery is sized to record seismic data for 18 months
- > Data transfer of State of Health parameters and noise performance data from the seabed following installation ensures confident commencement of seismic recording
- > The acoustic link activates the burn-wire for release to the surface and an on-board satellite tracking system guides recovery

### AQUARIUS+

#### Seismic Research and Alert

- > A near-real time seismic underwater observatory
- > Aquarius+ is equipped with a directional transducer
- > The battery is sized to transfer 10-15 MB of data per month for a deployment lasting 12 months. With optional methods of data retrieval as follows:
  - > The data logger automatically detects seismic events using a STA/LTA trigger. A compressed list of triggered events is rapidly sent to the surface by the acoustic link with minimum power requirement. The operator can then select which detailed event data is required for energy efficient transmission.
  - > Alternatively, the operator can stream portions of seismic data from a time window selected using the Güralp software available on the surface
- > Bi-directional communication with the underwater system allows interaction with the datalogger when the OBS is installed on the seabed, making it possible to change recording parameters and to check fundamental settings during the experiment (i.e. State of Charge of the battery pack).
- > The acoustic link activates the burn-wire for release to the surface and an on-board satellite tracking system guides recovery



The Aquarius system is equipped with a digital feedback tri-axial broadband seismometer, operational at any angle, with a flat response between 120s and 100Hz. A three-axis magnetometer and a MEMS accelerometer record the seismometer's 3D position on the seabed for data rotation during post-processing. The low profile and compact design is optimized to minimise the noise generated by the current flow.

An additional sensor can be fitted within the Aquarius canister such as a hydrophone or a high precision pressure sensor; or alternatively an external Absolute Pressure Gauge can be connected. The system is equipped with rechargeable lithium-ion batteries for fast and easy re-deployments (less than 12 hours needed to re-charge a flat system).

Data are stored locally in a dual redundant 256 GB Micro-SD card and can be downloaded using a Gigabit Ethernet link available on one of the top lid connectors. Once connected to the Ethernet of the Gralp deck unit provided with the system, the OBS is powered through Power Over Ethernet (PoE) for data retrieval and system configuration. This allows for separate and concurrent charging of the batteries via a dedicated connector to an external charger, so that the system can be re-deployed as rapidly as possible.

Up to 9000 bps transmission is possible between the surface and the Aquarius(+) on the seafloor using the direct acoustic communication.

## Key features

Compact OBS equipped with an acoustic modem

Digital feedback tri-axial broadband seismometer, operational at any angle, with a flat response between 120s and 100Hz

A three-axis magnetometer and a MEMS accelerometer record the seismometer's 3D position on the seabed

Transmission of State of Health parameters and noise performance data from the seabed following installation (Aquarius/Aquarius+)

Up to 9000 bps transmission of data between seabed and surface using acoustic communication (Aquarius+)

Aquarius+ automatically transmits compressed list of events detected using STA/LTA triggers, with option to request full data transmission for selected events

Dual redundant 256 GB Micro-SD card

Gigabit Ethernet retrieval of data once recovered, with OBS powered using Power over Ethernet (PoE) to allow battery re-charge to commence simultaneously

Acoustic burn-wire release mechanism with satellite tracking system to guide recoveries, with location alerts sent via email, SMS and/or webpage

## Easy and precise deployment

A key consideration in the design of the Aquarius OBS was to minimise transportation and installation costs. Aquarius is the most compact OBS equipped with an acoustic modem available in the market. It can be deployed from smaller vessels and once on the seabed, can be accurately located using a compatible USBL system installed on board the installation vessel.

## The recovery system

The acoustic link in the Aquarius is also used to activate the burn-wire system and release the ballast for recovery of the instrument. The syntactic foam around the aluminium pressure canister provides the lifting force to bring the instrument back to the surface.

A satellite tracking system hosted in a glass sphere tracks the instrument on the sea surface, following deliberate release but also in the unlikely event of accidental release. Messages from the tracking system can be automatically sent by e-mail, text messages (to both satellite or standard mobile phones) or on a web platform. For night recoveries, a strobe LED light is installed in the same glass sphere.

## Applications

### Aquarius

- > Local and regional seismic research
- > Energy exploration
- > Noise surveys
- > Aftershock monitoring

### Aquarius+

- > Local and regional seismic research
- > Earthquake/Tsunami Early Warning
- > Temporary or permanent seismic monitoring via acoustic link connection with buoys or rigs

## SPECIFICATIONS

<b>BROADBAND SEISMOMETER</b>		<b>DATA STORAGE</b>	
Technology	Force-feedback (force-balance) sensor Velocity or acceleration responses available	Data recording formats	miniSEED (metadata stored in dataless SEED format)
Configuration / Topology	Triaxial orthogonal (ZNE)	Flash memory and storage	256 GB field-swappable microSD card flash storage (dual-redundant).
Velocity output band (within -3 dB crossing points)	120 seconds to 100 Hz standard	Direct data download	Via Gigabit Ethernet connection
Output sensitivity	Nominal velocity response: 2000 V/ms <sup>1</sup> Nominal acceleration response: 200 V/ms <sup>2</sup> Other options available	<b>CLOCK AND CALIBRATION</b>	
Self noise below NLNM (New Low Noise Model; Peterson, 1993, USGS)	-165dB re (m/s <sup>2</sup> )/Hz @ 10s	Typical drift per day	VCXO clock: <1 ms (fully correctable during post-processing) Atomic clock option available.
Tilt tolerance	±180°	Timing synchronisation sources	PTP on Ethernet link through Güralp surface deck unit
<b>MEMS ACCELEROMETER</b>		Calibration signal generator	Sine, step or broadband noise, all with adjustable amplitude and frequency
Frequency bandwidth	DC to 100 Hz (0.01 s)	<b>POWER</b>	
Linear acceleration noise density	150 µg / √ Hz	Battery life:	
Clip level	2 g	Aquarius+	12 months
<b>PRESSURE GAUGE</b>		Aquarius	18 months
Resolution	1mm variation in 1000m of water	Battery recharge time	1 hour per month deployment (approx.)
<b>HYDROPHONE (OPTIONAL ALTERNATIVE TO PRESSURE GAUGE)</b>		<b>RECOVERY RELEASE</b>	
STANDARD VERSION		Release mechanism	Acoustically-operated burnwire release or timed release option
Frequency response	2 Hz to 30 kHz	Recovery location tools	Satellite tracking system Strobe light
Sensitivity	Max -162 dB re: 1 V/µPa (562V/Bar); Min -240 dB re: 1V/µPa (0.1 V/Bar)	<b>PHYSICAL / ENVIRONMENTAL</b>	
ULTRA-LOW FREQUENCY VERSION (OPTIONAL UPGRADE)		Operating temperature range	-20 to +75° C
Frequency response	100 s (0.01 Hz) to 8 kHz	Pressure vessel casing material	Aluminium with corrosion-resistant treatment and anodic protection
Dynamic range	-194 dB (1 V/µPa)	Operational depth	6,000 m maximum
<b>ABSOLUTE PRESSURE GAUGE (OPTIONAL ADDITION TO HYDROPHONE OR PRESSURE GAUGE)</b>		Buoyancy	Syntactic foam buoyancy (glass micro-spheres) for extended life and durability
Accuracy	<0.01% full-scale	<b>ACCESSORIES</b>	
Calibrated temperature	-2 to +40° C	Deck control unit	Acoustic command module and OBS communications unit for instrument control/ configuration and clock synchronisation
Hysteresis	≤± 0.01% Full Scale	Battery charger	Suitable for on-deck charging
<b>ADDITIONAL CHANNELS &amp; STATE-OF-HEALTH</b>			
Environmental channels	3 component digital compass Temperature sensor Humidity sensor Supply voltage		
<b>24-BIT DIGITISER</b>			
Primary digitisation channels	Four at 24 bits		
ADC converter type	Delta-sigma		
Output format	32-bit		
Dynamic Range	>136.5 dB at 100 samples per second		
Output sample rates available	1 sample per hour up to 1000 samples per second for primary channels, user-selectable Up to 500 samples per second for environmental channels		
Decimation filters	±2, ±3, ±4, ±5 (Causal / Acausal)		
Trigger modes	STA/LTA, level		

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