

# SeaQuest

3-Axis Gradiometer



The needle in a haystack finder

SeaQuest is the ultimate magnetic target detection platform. It gives you more information, and helps you see just what you want to see.

# Features

## The Overhauser Effect

Marine Magnetics' SeaQuest gradiometer measures the ambient magnetic field using a specialized branch of nuclear Magnetic Resonance technology, applied specifically to hydrogen nuclei.

## Highest Absolute Accuracy



SeaQuest has the best absolute accuracy of any marine gradiometer: 0.1nT.

## High Sensitivity

SeaQuest sensors deliver high-resolution output with a noise level of 0.01nT; counter sensitivity is 0.001nT.

## Worldwide Operation With No Restrictions



SeaQuest is entirely omnidirectional, meaning you never have to orient your sensor because it is already optimized to work around the world. As a result, regardless of where you are in the world and no matter what the magnetic field strength is, your SeaQuest sensors will continue to provide a strong signal and accurate data.

## Maintenance-Free Sensors, No Realignment and No Consumable Parts

SeaQuest Overhauser sensors are entirely maintenance free and most importantly, SeaQuest's specifications do not degrade over time. As a result, SeaQuest sensors, unlike optically pumped sensors, never have to be realigned or recalibrated in order to meet the manufacturer's specifications at the time of shipping.

# Stability and Durability



Accidents happen. SeaQuest's hard-anodized aluminum frame is ready for them, providing strength and rigidity while keeping weight down. Most of the frame is covered with an ultra-tough and flexible composite that forms the surface area of the wings protects the frame from impact.

All cables are contained within the pressurized sub-housings, or within the hollow free-flooded wings. This, coupled with its sleek, swept design minimizes the ability to snag foreign objects and debris. The entire structure is designed to deflect impact rather than absorb it.

The bottom-wing ballast weight keeps SeaQuest's center of gravity lower than the towing axis, keeping pitching and rolling motion to a minimum. The large surface area of the wings ensures that the platform will tow straight and smooth, even in high sea states. All this comes together to produce the highest quality data possible in a towed marine gradiometer.



## SeaQuest 4 Sensor Gradiometer with Floats and GPS Integration

The four-sensor SeaQUEST provides horizontal, vertical, and longitudinal gradient measurements. A floatation sub-assembly keeps the gradiometer within metres of the water surface. An on-board GPS receiver enables the system to append a position to each measurement.

## On-Board Sensors

In addition to our Overhauser sensors, accuracy is further improved by the integrated tilt sensor. The sensor continuously monitors the tiniest platform movements caused by rough seas, telling the operator exactly how 'horizontal' and 'vertical' the gradient measurements are. The echosounder/altimeter measures bathymetry with 0.1m precision, which provides a precise reference for the vertical gradient measurement, and allows continuous compensation for magnetic variation caused by igneous bedrock.

## Floats

This makes deployment and retrieval very easy, as the vessel can be stopped and the tow body can be brought in by hand, with very little resistance.

The floats can be adjusted to sit more forward or aft on SeaQuest, presetting its natural pitch in the water. When the floats are forward, SeaQuest will remain at the surface at any speed. In aft positions, the SeaQuest wings act as a depressor, causing it to descend to a fixed depth at a fixed speed.

The floats are air-filled, and equipped with pressure relief valves. If the floats are damaged and leak under pressure, the valves will allow any internal pressure to dissipate slowly as SeaQuest is brought to the surface.

## On-Board GPS



SeaQuest's floatation assembly can be equipped with a GPS mast. With the system configured to tow up to 1.5m below the surface, SeaQuest will position its gradiometer data with the onboard GPS, providing unmatched positioning accuracy. The GPS antenna is engineered for marine use, and is fully waterproof and submersible.

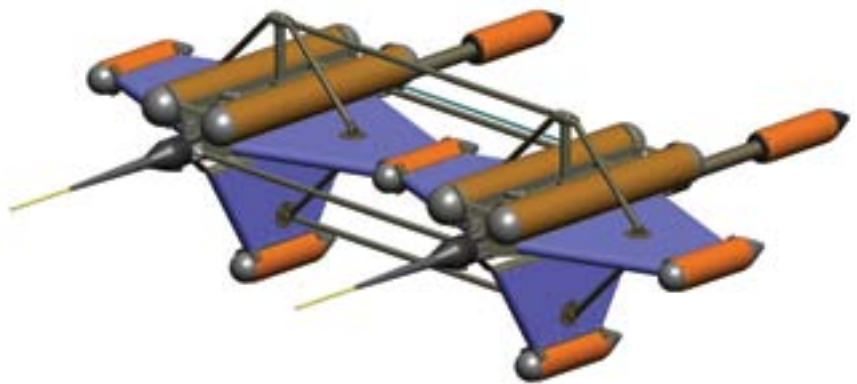
## SeaQuest is Ideal For



- UXO and mine detection
- Cable and pipeline tracking
- Environmental survey
- Archaeology

*I have been using a complete 2-unit SeaQuest array and have found the magnetic data delivered to be excellent, with less than one nano-tesla of variability in the total gradient (analytic signal).*

Richard Funk, Geophysicist



### SeaQuest 7 Sensor Array with Floats

The SeaQuest Array combines seven sensors to provide two sets of horizontal, vertical and longitudinal gradients.

## Mapping Marine Ferrous Targets Using the SeaQuest Gradiometer System

The figures on the right show the results of a target survey conducted by the United States Naval Undersea Warfare Center (NUWC) - Keyport, WA. The images show the striking contrast between conventional magnetometer (total field) data and the high resolution gradient data obtainable with SeaQuest.

FIGURE 1 shows the total magnetic field data collected by the top sensor of the SeaQuest platform. This image represents data that would be obtainable by a conventional total field survey and is presented for comparison purposes. The total field image is dominated by north-south trending curvilinear anomalies, which are likely related to magnetic susceptibility variations in the bedrock. This strong background magnetic response makes it difficult to quickly identify anomalies associated with ferrous objects. Presenting the total field grid with a 'stretched' colour-scale allows identification of at least four potential ferrous targets in the western half of the survey site.

In contrast, the total gradient map (FIGURE 2) allows easy identification of at least 12 (high-confidence) ferro-magnetic objects within the survey block. The wavelengths associated with the geological magnetic effects are effectively suppressed in this image in comparison to the total field image. Targets are defined by simple 'bull's-eye type' positive anomalies, which are centered over the target position. In the western part of the survey block, a low amplitude NNW-trending linear anomaly is present. This anomaly corresponds to a known pipeline marked on the marine charts of the area. It is worth noting that the amplitude of the pipeline anomaly is less than 0.5nT/m, and yet it is clearly visible in the total gradient map.

Also of interest is the large anomaly east of the center of the map. Despite its size, the anomaly is obscured by geology in the total field data, yet it shows up prominently in the total gradient data.

It is easy to see that the total gradient (Analytic Signal) directly measured by SeaQuest provides the clearest results, effectively creating an intuitive magnetic 'image' of the sea bottom. While the single-axis gradient results enhance only certain types of anomalies based on their geographic direction, the total gradient is effectively a direction-independent result, enhancing all near-surface anomalies equally, and suppressing deep geology evenly.

Magnetic gradient is commonly used to enhance the signals from small, relatively close sources typical of iron manmade objects, and to suppress the signals from large distant sources associated with geological variation. The total gradient technique goes even further by eliminating the directional dependence of conventional gradiometer methods. This produces an easily interpreted magnetic 'image' of the sea floor, with target positions unambiguously marked by 'bull's-eye' type anomalies. Also, the total gradient anomalies are

expressed with a higher signal-to-background-noise ratio than with conventional techniques, enabling the identification of tiny targets that would otherwise be invisible.

The SeaQuest gradiometer platform enables the acquisition of high-quality total gradient data because of its hydrodynamic stability and the high absolute accuracy of its sensors, producing clean results free from heading errors and offsets. Despite high currents and demanding conditions, SeaQuest provided consistent results that did not require the filtering or level-shifting that are necessary steps, yet large sources of calculation error, for other gradiometer instruments.

For a more comprehensive discussion on the theory of total-field gradiometry see the detailed case study available for download from our website at [www.marinemagnetics.com](http://www.marinemagnetics.com)

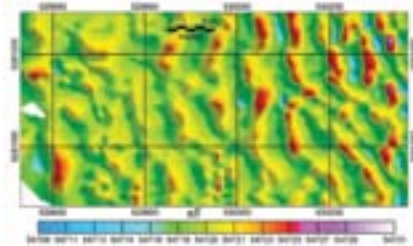


Figure 1: Total magnetic field map of the NUWC survey site. The image is dominated by North-South trending curvilinear anomalies related to buried geology. Only a few ferro-magnetic targets are identifiable. The Eastern part of the survey block is dominated by geological noise.

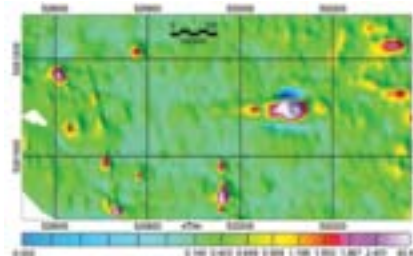


Figure 2: Total Magnetic Gradient (analytic signal) map of the NUWC survey site. The deep geological signal is eliminated, and extremely small targets can be easily resolved, including a faint linear feature in the west that was invisible in the total field data. The linear feature corresponds to a known pipeline.

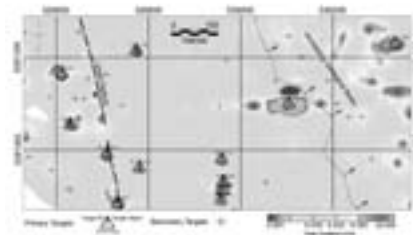
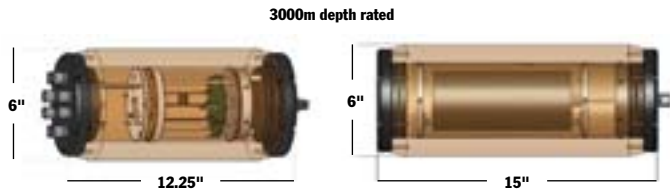


Figure 3: Interpretation of data products overlaid on grayscale total gradient map. Primary target depth estimates (see triangle symbols) obtained from Euler Deconvolution of the measured gradients. Total gradient grid values of the target position provide an estimate of the relative target.

# A Gradiometer Solution for AUV & ROV Installations



SeaQuest 6 sensor gradiometer with 2 electronics modules

## Electronics module

In Pressurized Housing

**RATING LENGTH DIAMETER**

300m	12.7"	0.5
1000m	12.75"	0.5
3000m	12.25"	0.6
6000m	12.25"	0.65

## Sensor

In Pressurized Housing

**RATING LENGTH DIAMETER**

300m	15.5"	0.5
1000m	15.5"	0.5
3000m	15.0"	0.6
6000m	15.0"	0.65

## It's expandable

Each SeaQuest is comprised of a single electronics module that can drive up to 4 sensors. Add as many SeaQuests as you need.

## Auto synchronization - it just works

Multiple SeaQuests are always synchronized to each other via a sync line hardwired to each additional electronics module. Synchronization of SeaQuests is entirely seamless. You can even synchronize by sending communications from the host directly to the gradiometer.

## The only gradiometer that delivers an expandable sensor array without compromise

- Worldwide operation, no dead zones
- No heading error
- Best absolute accuracy on the market 0.1nT
- 0.01nT sensitivity; 0.001nT counter sensitivity
- Ultra low power requirement
- Sensors do not degrade with time and never need calibration to meet our specs at time of shipping

## Features

- Isolated inputs/outputs/RS232 no ground loops
- Auxiliary sensors include: 3D compass, tilt sensor, leak detector in E/M, pressure sensor, altimeter
- Sensor distance from another sensor: no restrictions, ie sensors can even touch
- Sensor distance from electronics module: 0.25m (10 inches) to 30m (98 feet)
- Entirely non magnetic construction. All aluminum and fiberglass
- Depth ratings available 300m, 1000m, 3000m, 6000m



# Why SeaQuest?

## You get more information

SeaQuest measures the gradient in all three axes simultaneously, so no matter how your heading changes no information is lost. Horizontal gradiometers, on the other hand, are limited by the fact that they can only measure the gradient in one axis (direction) at a time. When surveying with a one axis gradiometer and your heading changes by even a few degrees you are no longer measuring the same gradient.

# Features at Glance

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- Entirely non magnetic construction. All aluminum and fiberglass
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# See what you want to see

SeaQuest suppresses geology and enhances small nearby targets, enabling you to see more of what you want to see, while suppressing what you don't want to see. Single-axis gradiometers and arrays enhance targets and geological features within the direction of their axis. Since SeaQuest measures the complete 3-dimensional gradient, it enhances signals from small targets uniformly, regardless of their geometry or position in space.

# Specifications

Worldwide operation	No restrictions or dead zones
Highest absolute accuracy	0.1nT
High sensitivity	0.01nT
Resolution	0.001nT
Power consumption	2W standby, +1W persensor, +2W per altimeter
Maintenance free sensors	No realignment and no consumable parts
No heading error	Eliminates the need to level your data
No drift	A complete lack of 1/f noise providing a totally flat noise spectrum
No temperature dependence	Data accuracy does not change through a temperature range of -40C to +60C
Altimeter	0-100m range, 0.1m step
Heading	3-axis magnetoresistive compass, 0.1 degree step
Tilt sensor	Two-axis, 0.1 degree step
Pressure sensor	300m range, 0.1m step (others optional)

**Marine Magnetics** 

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