



## The *Bonhomme Richard* Series

### Lesson 1

# Surveying the Ocean



### LESSON OBJECTIVES

- Introduce ocean surveying technologies such as side-scan sonar, multi-beam and magnetometer technology
- Compare the similarities and differences in survey technologies

### NATIONAL SCIENCE EDUCATION STANDARDS

#### **Content Standard A: Science as Inquiry**

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

#### **Content Standard E: Science and Technology**

Abilities of technological design

Understandings about science and technology

#### **Content Standard G: History of Nature of Science**

Science as a human endeavor

History of science

### OCEAN LITERACY PRINCIPLES

**Principle #7:** The ocean is largely unexplored.

### BACKGROUND

On September 23, 1779 one of the most fierce and famous battles of the Revolutionary War took place off the coast of Flamborough Head, England between the sailing ships *Bonhomme Richard* and H.M.S. *Serapis*. The *Bonhomme Richard* was captained by John Paul Jones, who is considered by some people to be the father of the United States Navy. The battle between the two ships took place at point-blank range and lasted almost three and a half hours. John Paul Jones emerged from the battle victorious and captured *Serapis* as his prize. Thirty-six hours after taking command of *Serapis*, he watched his beloved *Bonhomme Richard* sink into the North Sea. It was during this battle that John Paul Jones' legendary words, "I have not yet begun to fight!" were recorded in American history. The Ocean Technology Foundation and its team of partners are searching for the remains of the *Bonhomme Richard*. (For more information on the battle and the search, please visit [www.bonhommerichard.org](http://www.bonhommerichard.org))

### WARM-UP

Ask students to think of ways in which scientists study the oceans, and list their answers on the board. Ask them to list any technologies they think scientists would use to map the seafloor, or to look for shipwrecks. Answers might include remotely operated vehicles (tethered underwater

cameras), diving, submersibles, or sonar. Ask how these technologies might be useful in undersea research, and particularly to locate shipwrecks like the *Bonhomme Richard*. (Have students visit the Ocean Technology Foundation's website at [www.bonhomme-richard.org](http://www.bonhomme-richard.org) if they are not familiar with the search for this famous ship.) Tell students that this lesson will explore two technologies used in underwater surveying: sonar and magnetometry.

Both of these technologies are being used in the search for the *Bonhomme Richard*. The remains of the ship are difficult to find because there was no record of the location of the sinking, and the ship was made of wood, which by now would probably have decomposed in the salt water. However, searchers expect to find approximately 200 tons of iron ballast, such as cannons, cannonballs, and other iron used for weight in the bottom of the ship. This is where a magnetometer comes in handy!

## SONAR

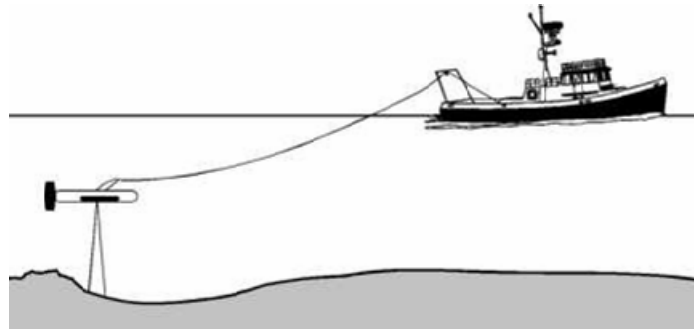
Sonar (SOund Navigation and Ranging) is a technology used by marine scientists, archeologists, military personnel and others to create a picture of the ocean bottom. Sonar is used to search for objects in the water because water is an excellent conductor of sound. The speed of sound in water is an easily calculated and predictable value. Sound traveling through water tends to attenuate (diminish) less than light or radar waves. There are two types of sonar: active and passive sonar. Passive sonar is only able to receive signals, but active sonar is able to both generate and receive signals. Sonar was first used by the military to locate enemy submarines in World Wars I and II. The invention of the computer made sonar much easier to use. It was only in the 1970's that sonar technology was declassified and made available to the science community.

### Side Scan Sonar

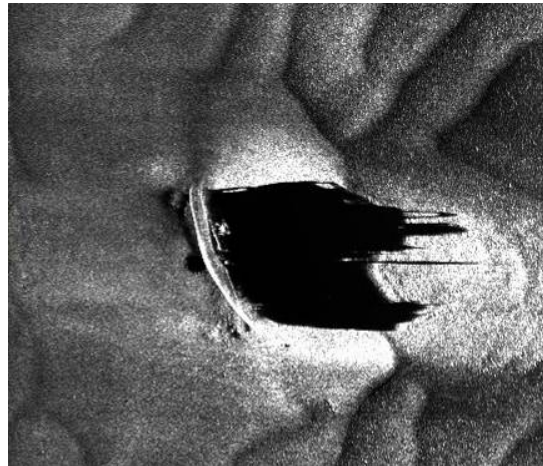
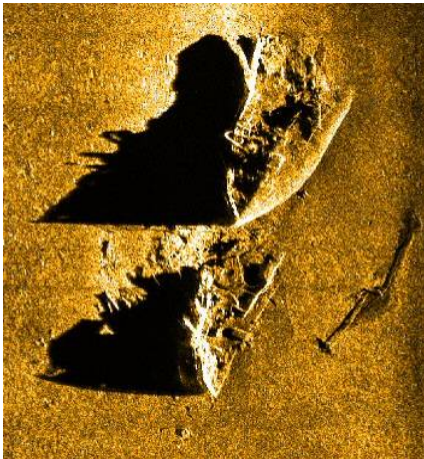
Side scan sonar is used to map the ocean floor and to find and identify objects underwater. It has three main components: a towfish, transmission cable and computer. The towfish, so named because it resembles a long, thin fish, is equipped with a transducer made up of a hydrophone and a projector. A transducer converts energy from one form to another for the purpose of measurement. The projector converts an electrical signal to an underwater sound wave. The hydrophone does the opposite and converts the sound wave to an electrical signal. The towfish is tethered to the ship by a long transmission cable which is connected to the computer onboard the ship. The towfish is towed behind the ship close to the ocean floor (see image below). The sonar beam is transmitted in the shape of a fan under the towfish and to the sides. A sound wave is produced by the transducer. The sound wave travels to the seafloor, bounces off the seafloor or the object, and returns to the transducer inside the towfish. The range, or distance to the bottom, is determined by how long the towfish waits before transmitting the next pulse of sound.



A side scan sonar towfish and related equipment.



The side-scan sonar continuously records the return echo from the seafloor, creating a picture consisting of light and dark areas. The dark areas are objects that are hard or protrude from the bottom, which reflect more energy. Lighter areas are soft mud or sand, and they reflect less energy. Side scan sonar produces a shadow, just like a flashlight does when illuminating an object, except that sonar uses acoustic, or sound impulses, instead of light.



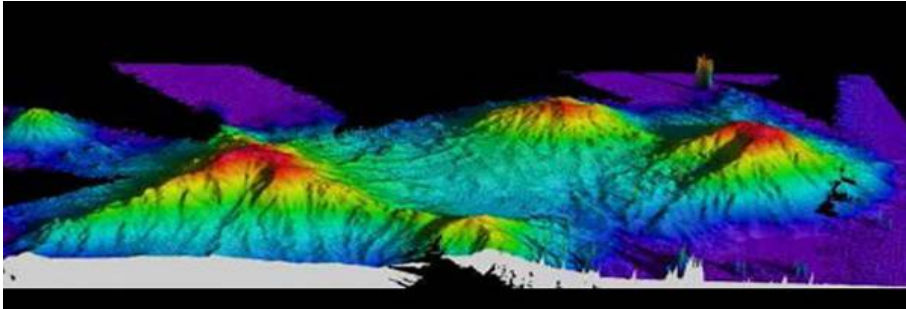
**Side scan sonar images of shipwrecks in the North Sea. Note how the shadows, or darkest areas, can show a different perspective of the wreck.** Images: Ocean Technology Foundation

The process of surveying with side scan sonar is similar to mowing a lawn. The ship travels back and forth in long straight lines, overlapping the lanes on the return trip to make sure that the entire area is covered.

Another important piece of data is the exact location of the ship and the towfish while the data is being collected. If this information isn't accurate, it will be very difficult to relocate a specific object on the sea floor if scientists think it deserves a closer look. This location data is recorded with a Global Positioning System so it can be easily input into the computer when the data is processed. The data from side-scan sonar can be viewed "live" while being collected or may be viewed afterwards in different formats. At the end of the survey, all the separate swaths are pieced together like a puzzle to form a comprehensive map, called a mosaic.

## Multi-Beam Sonar

Multi-beam sonar is another type of sonar which sends out multiple beams of sound energy, instead of the single beam in a side scan sonar. A multi-beam sonar is a small unit attached to the hull of a ship, instead of being towed behind the ship. Multi-beam sonar is also able to provide bathymetry (depth) data, which is expressed in colors, allowing a three-dimensional picture of the ocean floor. Multibeam sonar measures and records the time elapsed between the emission of the signal from the transducer to the seafloor or object, and back again, whereas the side scan sonar measures the strength of the returning acoustic beam.



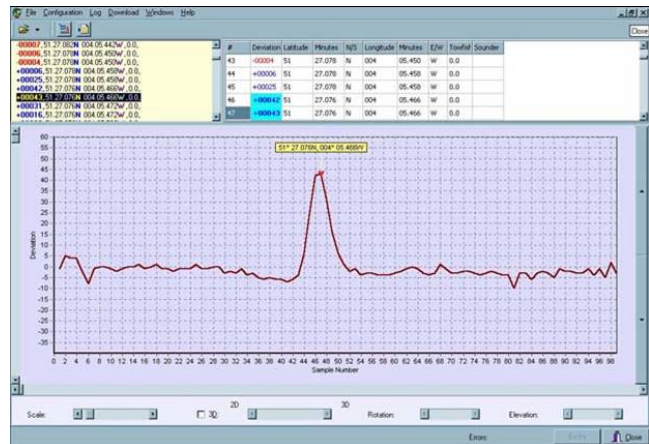
**Example of a Multi-Beam Sonar Image.** This is an image of a seamount, or underwater mountain, off the coast of New England. The colors represent different depths. Image credit: NOAA.

## Magnetometer

The earth has a natural magnetic field, which varies depending on the materials in the earth's crust. A magnetometer is one of the technologies used in both land-based and marine archeology to locate buried metallic objects. For underwater purposes, it is towed behind a ship (similar to how a side scan sonar is towed), where it is connected by a tether. Through its tether, it transmits data back to the research vessel, where the information is displayed as a graph on a computer. The magnetometer detects anomalies (irregularities) in the earth's magnetic field, which might indicate metal associated with a shipwreck. Note the peak on the graph below, which indicates a magnetic anomaly.



**A magnetometer and its tether on the deck of a survey vessel.** Image: OTF



**An example of data generated by a magnetometer.**  
Note the peak indicating a magnetic anomaly.

## ACTIVITIES

1) Make a Simple Magnetometer

[http://www.windows.ucar.edu/tour/link=/teacher\\_resources/magnetometer\\_edu.html](http://www.windows.ucar.edu/tour/link=/teacher_resources/magnetometer_edu.html)

2) Side Scan Sonar Lesson -- NOAA Office of Ocean Exploration

<http://www.oceanexplorer.noaa.gov/explorations/03portland/background/edu/media/portlandping.pdf>

3) Browse the internet for information on side scan sonar. Summarize and give examples of three uses for this technology, besides looking for shipwrecks. How are side scan and multi-beam sonars different?

4) Career Focus: A Hydrographic Survey Technician is an example of someone who would use the technologies mentioned in this lesson. Visit [www.oceancareers.com](http://www.oceancareers.com) and click on Careers. In your own words, summarize the duties, job requirements and education needed for this job. Determine the average annual salary for a Technician who has extensive experience.

## ADDITIONAL RESOURCES

Ocean Technology Foundation's Search for the *Bonhomme Richard*

<http://www.bonhommerichard.org>

Woods Hole Oceanographic Institute – Technology Pages

<http://www.whoi.edu/instruments/viewInstrument.do?id=14847>

Side Scan Sonar Technology – NOAA's Gulf of Mexico Marine Debris Project

<http://gulfofmexico.marinedebris.noaa.gov/side-scan-sonar-technology>

## ACKNOWLEDGMENTS

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