

Side Scan Sonar (SSS) surveying

Side scan sonar was developed in the 1960s for use as a wreck location tool. Since then its use has become standard throughout the marine surveying industry, from mapping of large tectonic seabed features to archaeological inter-tidal surveys.

Principles of operation

Side Scan Sonar operates by emitting a narrow beam of high frequency acoustic energy in a plane orthogonal to both the direction of ship travel and the sea surface, then recording the acoustic returns from the sea bed. Typically the acoustic transceivers are mounted in a streamlined housing (*towfish*), that is towed behind the survey vessel.

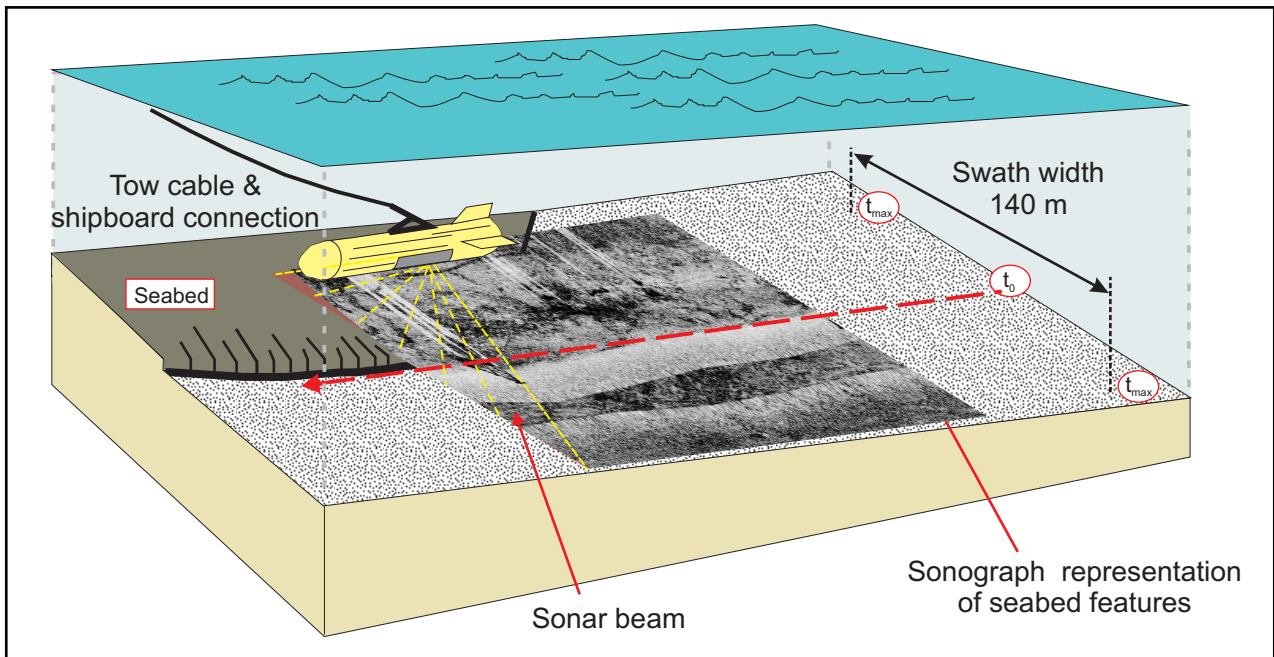


Figure 1: Cartoon representation of typical side scan sonar survey scenario, demonstrating the relationship between seabed features and sonograph data.

Side Scan Sonar systems employed for site surveys utilise high frequency acoustic pulses in the range 100-600 kHz, which result in strong reflection from seabed features and rapid attenuation of any energy transmitted into the seabed. Any reflections detected are therefore due to features located either on or above the seabed. System resolution is divided into range (track-perpendicular) and transverse (track-parallel) components. Range resolution is a function of pulse frequency content, whilst transverse resolution is defined by beam width, determined by transceiver geometry and pulse content. Modern systems may employ either simple pulses or swept frequency ('Chirp') signals, which offer improved resolution at the expense of repetition rates.

The altitude of the towfish is governed by the effective range of the system and the local topography. Low relief terrains favour lower towing altitudes, detecting more subtle seabed variations. Increasing towfish altitude reduces survey efficiency, as slower repetition rates will be required to maintain the swath width.

Processing and Interpretation

Side scan sonographs provide scaled plans of seabed features after the geometric effect of diagonal beam paths has been removed, a process known as slant range correction. The advent of digital acquisition and accurate positioning systems in the late 1990s made image processing, real-time data mosaicing and pattern recognition possible. An example 500 kHz sonograph is presented in Figure 2.

There are two main aspects to Side Scan Sonar interpretation: detection of vertical offsets and recognition of textural differences. Vertical offsets are identified by discrete strong reflections (seabed has stepped upward) and shadow zones (seabed has dropped down); combinations of these effects facilitate identification of troughs (e.g. dredge marks, scour, channels) and ridges (sand bars, man-made features). Objects such as mines, buoys, and wrecks also give rise to distinctive, characteristic images. Changes in seabed material grain size and composition result in differing acoustic backscatter patterns; modern sonar processing systems are equipped with pattern recognition algorithms capable of suggesting sediment types for a given area of any sonogram.

Applications

- Shipwreck location and salvage.
- Archaeological mapping.
- Pre- and post-dredging sediment distribution mapping.
- Identification of seabed type for sub-sea diamond mining.
- Pipeline and cable route surveys.
- Site survey for drilling rigs, road constructions, bridges *etc.*
- Mapping seamounts, ocean ridges and other major tectonic features.
- Mine hunting.
- Identifying seabed plant colonisation.

There are many other applications of this diverse technique. Below are two examples of side scan sonar data.

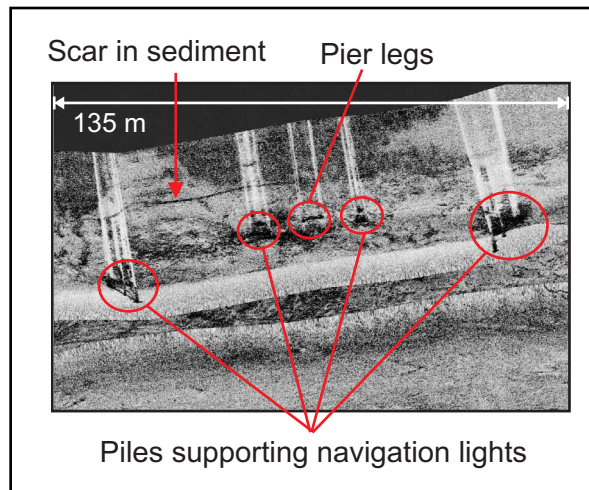


Figure 2: 500 kHz sonogram of shallow shoreline features in Woolwich Reach, London, collected using GeoAcoustics™ side scan sonar.

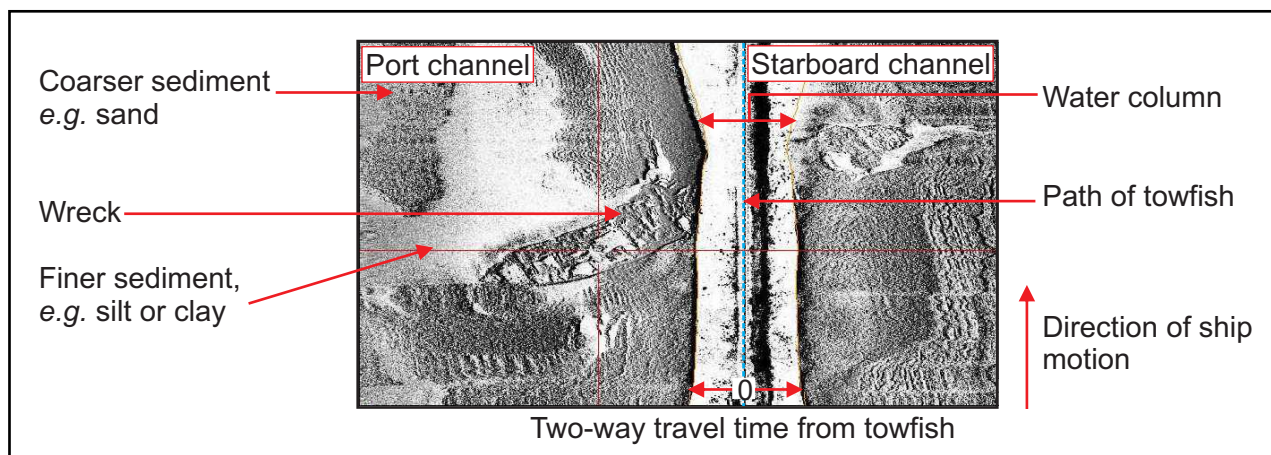


Figure 3: 500 kHz sonogram of wreck site, showing seabed texture variations. Data have not been slant-range corrected. Image courtesy of GeoAcoustics Ltd.