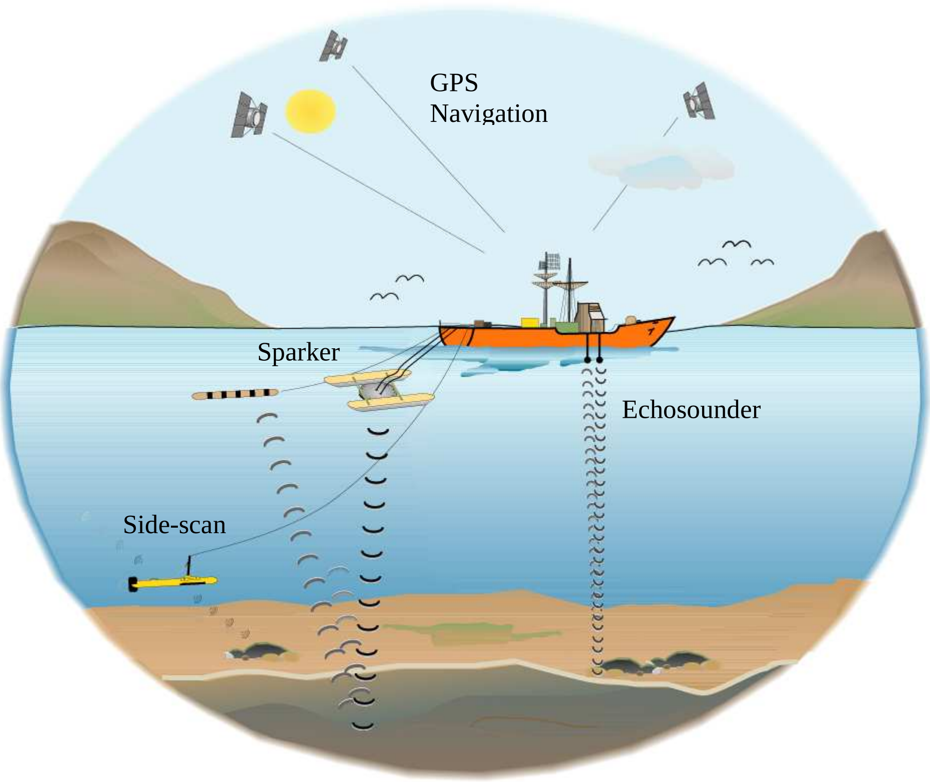
Marta protocol on marine shallow geophysical methods



Principal illustration of marine shallow geophysical methods.

High frequency reflection seismic measurements at sea are based on the frequent transmitting of sound pulses while the survey vessel is sailing. By recording the sound energy reflected by the seabed and underlying strata, the depth of the seabed and sub-bottom strata can be determined.

The high frequency echo sounder used for depth measurements is hull mounted, while different kinds of acoustic equipments are towed behind the ship.

The Marta database includes data going back to the late 1970'ies and represents the general development from analogue data recorded on tape and paper prints until the early 1990'ies, when the computer technology gradually resulted in today's digital formats such as XTF side scan- and SEG-Y shallow seismic data.

Positioning has undergone a similar revolution from Decca positioning to present day global positioning system (GPS).

Shallow seismic data

An *echo sounder* transmits high frequency sound waves in the range of 10-200 kHz. Almost all energy in this range is reflected by the seabed, which enables a precise measurement of the water depth with an accuracy of a few centimetres.

Multibeam echo sounder sonar's are highly sophisticated instruments used for hydrographic surveys in areas requiring total bottom coverage. The multibeam sonar system has a single transducer, or pair of transducers, that continually transmit numerous sonar beams in a swath or fan-shaped signal pattern. This makes the systems ideal for mapping large areas rapidly, with essentially 100 percent bottom coverage. Multibeam signal backscatter information can be used to generate side scan data for imaging bottom features and targets in a wide variety of water depths. The coverage area of these systems is a function of water depth and number and pattern of beams. Most systems provide coverage ranging from two to approximately seven times the water depth. The number of beams also varies with the manufacturer and ranges from 30 to more than 240; however, the outer beams on each side of the swath are subject to more errors and may not be useful. Because of the increased density of soundings with multibeam systems, it is possible, with proper calibration and adjustments, to detect and resolve smaller objects on the bottom relative to single beam systems. Transducer frequencies normally range from 200 to 455 kHz.

Shallow seismic equipment transmits sound waves in the range of 0.5-10 kHz. But also within this range a distinction can be made between high and low-frequency sound sources. Therefore, often several sound sources are used, and systems traditionally used are the "*pinger* "(3.5 kHz), and the "*boomer* " (0.6-2 kHz). More recently, sound sources were developed with a wave spectrum of a broader frequency range (" *chirp* " signals). These systems are characterised by both a relatively deep sub-bottom penetration and a high resolution, which is achieved through processing of the return signals. These shallow seismic sound waves penetrate the seabed and reach sub-bottom depths of 10 to 50 m, and have a resolution of 10 to 50 cm. High frequency multitip *„sparker"* (a center frequency of 800-1200 Hz) is likewise an instrument type that has been developed recently giving a better penetration than the traditional Boomer systems.

In addition to the vertical seismic sections, the "*side scan sonar*" is used, which is also an acoustic equipment, but which transmits a swath of high frequency (100 or 500 kHz) sound waves in 2 beams perpendicular to the ship's course. These sound waves are reflected by the seabed and produce a "sonograph" of the seafloor. In this c. 200 m wide area covered by the side scan sonar swath differences in acoustic back-scatter intensity reveal various hardness of the seabed sediments, stones, morphological features as sand waves, and objects such as shipwrecks.

The result of all these seismic investigations is an acoustic impression of the seabed sediments and sediment strata below down to a depth of 50 m below the seafloor. This acoustic imagery can be interpreted and various known types of deposition can thus be recognised. Sound waves relatively easily penetrate in fine grained sediments as mud, silt, and clay. In contrast, penetration depth is very limited in sand, gravel and glacial till. Gas, which frequently occurs in seabed sediments, imposes a particular acoustic problem. The gas can develop, for instance, through decomposition of organic matter found in mud. When mud deposits have reached a thickness in excess of c. 2 m, in most cases so much gas has formed, that it absorbs the acoustic energy. Consequently, no information is available from the underlying sedimentary strata.

Magnetic data

Magnetic surveys record spatial variation in the Earth's magnetic field. A magnetometer is an instrument used to measure the value of the Earth's total magnetic field at a particular location. Many objects including man-made items and geologic structures perturb or distort the Earth's magnetic field due to properties of the material from which they are made. The measurement of the distortion or bending of the background field is used to identify the physical characteristics of objects or structures. For example, a marine search team could use a magnetometer to locate a sunken ship, since shipwrecks produce magnetic "signatures" that appear as "anomalies" or noticeable deviations from the usual background intensity of the Earth's magnetic field.

The typical end result of a survey is to produce a map that shows the GPS locations (track plot) and the shape of the anomaly on a contour map. From this the user can often determine the shape and location of the source body even if the "signal" is very small. The unit of measurement used to express the intensity of the earth's magnetic field is the gamma (1 gamma [γ] equals 10-5 gauss or 10-9 Tesla or 1 nanoTesla, nT). Depending upon where the field is measured, the intensity can range from 20,000 to 70,000 gammas (nT).

Magnetometers can be hand-carried, vehicle mounted, fixed as base stations, or operated aboard aircraft, marine vessels, or even spacecraft. Data collected from magnetometers can be used to describe characteristics of the geologic structure of specific areas of the Earth and thereby locate and characterize mineral and petroleum deposits. Magnetometers can also provide valuable assistance in locating buried pipelines, electrical cables, cultural artefacts, unexploded ordnance, buried waste containers or archaeological sites. In some cases the magnetometer is the only device that will detect a given type of target at the range required. In addition, nonmagnetic items are “invisible” allowing the magnetometer to see through water, sand or other nonmagnetic materials to the source of the anomalous field distortion.

The basic rule of thumb is that one ton of iron gives a one gamma anomaly at one hundred feet distance.

Navigation

Navigation is very important in the marine mapping in order to get an accurate position of the collected geophysical data.

The Marta Database includes marine geophysical data from the time period about 1980 to present time and a historical development of navigation systems can be observed from low precision Radio navigation (Decca) through local high precision systems (Syledis, Loran) to global satellite positioning systems (GPS) and with additional reference stations in differential GPS and Real Time Kinematic (RTK) GPS.