

# SURFICIAL AND SUBSURFICIAL GEOLOGICAL EXPLORATION OF THE OCEANS: INSTRUMENTS AND APPLICATIONS

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The understanding of surficial geology of the seabed is critical for various reasons. It has application in resources exploration, designing offshore constructions, delineating offshore submarine pipeline route, development of ports and harbours etc. There are many aspects of seabed and substrate developed in response to complex environment prevailing like geomorphological features and sediment characteristics. High resolution marine geological and geophysical surveys are required in understanding the same.

While geological methods are direct i.e. to collect the seabed samples or photographs, the geophysical methods are indirect, involving remote sensing from a survey vessel using techniques which measure and record parameters related to changes in the physical properties of materials. The possible applications and objectives in brief, which can be achieved with the help of such surveys are given below for example. It may be noted that actual objective may vary as per requirement.

## APPLICATIONS

1. In Research and Development Projects: to obtain basic data and correlate with other disciplines of geology and oceanography.
2. In Offshore Engineering Projects : to obtain the requisite data for the purpose of planning and designing of structure.

Projects	Requirement
a. Offshore Oil and Gas Industry	1.Submarine Pipeline route survey 2.Drilling location 3.Post-lay checkup of pipelines 4.Relocation of drill-well
b. Development of Ports and Harbours	- Navigational channel route survey
c. Effluent disposal system	- Submarine pipeline route survey
d. Special purpose survey-	For Marine Archaeology, Navy, Search surveys

## OBJECTIVES

1. Preparation of Bathymetric charts
2. Identification of geomorphologic features such as even, uneven, rugged topography, exposed and buried channel, escarpments, ridges, valley, periodic bedform, lithological contact planes.
3. of sediment facies variation maps, isopach maps of sediment thickness, stratigraphic sequences.
4. Understanding of depositional environment, sedimentological regime, rate of sediment deposition, sediment transport.

The various techniques that can be employed and equipment which can be deployed for the purpose of preparation of surficial geological map of the oceans are listed in Table 1. However, it must be added here that though the basic principles may remain same for shallow areas i.e. say continental shelf and deeper areas, the specifications of equipment may be entirely different for the two.

For the quicker, economic and reliable collection of the seabed data, usually, the acoustic equipment are deployed first and after preliminary interpretation, various control points are selected for launching of appropriate sampling tool as per expected sediment type.

The acoustic methods, also known as seismic methods, are preferred generally as analysis of field data can yield an unambiguous interpretation of underlying geological structure. The different instruments are available for different purposes like mapping of oil traps at deeper depths (av. 2-3 or more km below the seabed) or buried channel or pipeline at shallow depth.

The seismic method records the time elapsed between generation of sound wave which propagates at characteristic velocity in different medium and its arrival back at surface which helps in determining the depth to a reflecting interface. Sound waves operating at different frequencies are used to achieve the required penetration. Though many parameters of the sound waves in use play critical role, in general, lower the frequency, the deeper the penetration but lower the resolution and vice versa. Echosounder, sub-bottom profiler and side scan sonar all basically work on above principle.

Echosounders with dual frequency transducers i.e. in the range of 30 kHz and 210 kHz enable optimum penetration and resolution. Echogram mainly provide the depth to the seabed and also the geomorphology of the area is revealed by them. Echosounder basically comprise of a recorder with power supply and transducers. The portable variety has provision for fixing and transducers in different survey vessels. The recorder gives the command for sending out the sound pulse and records it on arrival on a graph which indicates the depth time considering the velocity of sound in water as 1500 m/s. Applying correction for the sound velocity in particular area, the

accurate depth can be worked out. The recorder has provision to select different ranges and phases to enable expansion or compression of data as also to eliminate a certain part of water column. The geomorphic features which can be identified without any unambiguity, beside even, uneven and rugged topography include periodic bedform, open channels and buried channels, escarpments, terraces, ridges, valley, etc.

The subbottom profiling system provide cross section of the seabed which enables vertical and spatial variation of sediment strata. The different variation of the systems are dependent on sound source accordingly the system may be sparker, boomer or pinger for shallow water and airgun for deeper water. In sparker, sound is generated by discharge of electricity through water, in boomer by electromagnetic induction of boomer plate while in pinger ceramic transducers are used for the purpose. In former two the receiver is hydrophone while in pinger the same transducers also receive the reflected sound signals. The signals are filtered and processed before recording.

Side scan sonar provides the plan view of the seafloor and records lithological and topographical variations in the form of the tonal difference. The system comprises of a tow fish having a set of transducers on either sides and a dual channel recorder. The method essentially records variations in the back-scatter of transmitted energy which depends on surface roughness of the seabed and the excessive impedance of the surface material. It is possible to obtain the orientation of the seabed features, such as crestlines of ripples and dunes ridges and outline of exposed rock sands-clay boundary formations from sonographs. The microprocessorised system automatically corrects for speed and height distortions. The exact distance between tow fish and reference station of positioning system is required to correct positional lag.

Locations for sampling stations are selected after the preliminary processing of the data collected using echosounder, side scan sonar and subbottom profiler. Soil samples confirm and improve the lithology.

The integrated analysis of the data collected provide the necessary informations for preparation of surficial geological map which in turn may help in understanding the geological environment present and its implications on the problem at hand.

#### SUGGESTED READINGS

1. Sea surveying - ed. A.E. Ingham, 1975, Part I & II - John Wiley & Sons, London.
2. Offshore Site Investigations - ed. D.A. Ardus, 1980. Graham & Trotman, London.
3. Advances in underwater Technology and Offshore - engineering vol. 3 Offshore Site Investigations - 1985. Graham and Trotman Ltd.

TABLE 1

1. SAMPLING EQUIPMENT	<ol style="list-style-type: none"> <li>1. Grab</li> <li>2. Boomerang grab/core</li> <li>3. Core ... Gravity/Piston</li> <li>4. Dredge</li> <li>5. Vibrocorer</li> <li>6. Rock core drill</li> <li>7. Autolift drill</li> <li>8. Drilling rig</li> </ol>
2. PHOTOGRAPHY	<ol style="list-style-type: none"> <li>1. Sterio Camera</li> <li>2. Camera Sledge</li> <li>3. T.V. Camera</li> <li>4. Boomerang camera</li> </ol>
3. SUBMERSIBLE	<ol style="list-style-type: none"> <li>1. Tethered vehicle</li> <li>2. Untetherd vehicle</li> <li>3. Manned submersible</li> <li>4. Unmanned submersible</li> </ol>
4. ACOUSTIC EQUIPMENTS	<ol style="list-style-type: none"> <li>1. Echosounder</li> <li>2. Side scan sonar</li> <li>3. Subbottom profiling</li> </ol>
5. ADVANCED ACOUSTIC EQUIPMENT	<ol style="list-style-type: none"> <li>1. Seabeam</li> <li>2. Gloria</li> <li>3. Deep Tow</li> </ol>