Surveying for Marine Minerals

by

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Abstract : A survey chart or plan is only as useful as it may be used to accurately locate places, objects of interest etc. Land survey plans can be prepared accurately and can be used as a guide to the user.

There are many types of surveys. Aerial surveys enable a pictorial map of a vast area in a small time. Underground surveying is used in mining. All the plans prepared from each application must have one basic quality-accuracy and reliability so that a user of these maps or charts may not waste time in locating features shown in the map.

The first step to assessing marine minerals is to accurately survey the geology of the submarine terrain and record the results on a survey chart. The inherent inaccuracies in offshore hydrography are many.

What constitutes a hydrographic seismic survey? Instrumentation demands familiarity with sophistication in electronics, personnel require specialised training, surveying costs a lot of money.

We may not in our lifetime either fully measure or benefit from our efforts to assess marine minerals but we can and must set in motion a plan for posterity so that mankind may use their mineral resources more wisely than they have done of the resources on land.

Surveying is a word very common no doubt to everyone present here and perhaps conjures in your minds the picture of a surveyor standing behind a theodolite with survey labourers walking around the countryside carrying red and white poles dragging behind them a steel chain. Yes indeed, surveying on land very basically and in the good old fashioned way will be carried out in this manner. Such a survey can produce a map showing, as accurately as it has been surveyed, the relative positions of the different objects within the survey area. It will for instance be possible to use such a plan to describe any given location by indicating where the point sort is in relation to street corners, buildings and other significant landmarks.

Surveying however is carried out from the air, underground as in mining surveys and from the surface of a body of a water be it on land or sea. An aerial survey will enable a large area to be photographically recorded in a fraction of the time required to cover the same area by conventional land survey techniques.

Surveying in mines is a specialized application of the principles of surveying in the mapping of mines. All land based survey techniques are very much controllable and well understood by the survey fraternity unlike in the case of surveying from the surface of a body of water.

You will appreciate the need to have an accurate survey chart so that at the ridiculous end of the scale you may not end up building your house on someone else's land or plan a city too large to be accommodated on the ground available for it. If you are to be able to search for minerals on land the detected sonar reflectors from a survey will need to be accurately mapped to be of practical use to a geologist planning the harnessing of mineral resources.

A hydrographic survey poses many problems with respect to the accuracy with which data may be gathered, processed and presented on charts. Today's technology and techniques have overcome the greater majority of the sources of error in off-shore surveying and mapping. As on land the first step to assessing submarine mineral resources is the surveying of same and the accurate mapping of the results. What therefore are the components to hydrographic and seismic surveying ?

1. Navigation: Navigation is the term used to describe the method by which a survey boat is conned along a selected or given course and the means by which the position of that boat is fixed at frequent periodic intervals such as say every 100 metres to every 1 minute. This aspect of the survey is less of a problem when the survey is carried out within site of land. However if Sri Lanka's Exclusive Economic Zone is to be explored for submarine mineral resources then the survey boat will be many hundreds of miles from the nearest point of land. How can we in these circumstances hope to know where exactly the survey boat has been either in relation to Sri Lanka or any other geographical location. Positioning off-shore has become a specialized art and 1 of 3 navigation methods or a combination of these is commonly used to position survey vessels off-shore. The first of these is the micro-wave ranging system which has a maximum range of about 100 km off-shore. Radio navigation systems allow the survey boat to be accurately fixed at 400-300 miles off-shore. Beyond this limit, although other systems exist, the practical system to use would be the satellite navigators. In certain, if not all parts of the world, coverage exists from the radio navigation system known as the Omega Chain, which is more a tool for general navigation than a tool for survey. The micro wave system offers you an accuracy of fix better than +/- 5 metres at maximum range, the radio navigation system dropping down to an accuracy of + 50 metres at maximum range and the satellite systems to around +/- 100 metres and steadily deteriorating with time on a constantly moving ship which suggests a need to calibrate a satellite system against another navigation system at frequent intervals.

A boat off-shore can be fixed by 2 ranges but will provide no accuracy of fix unless its position is tested by a third ray. Hence in practice a minimum of 3 shore controlled stations are used to fix a position offshore. It is commonly found that to the inescapable imperfections of any one or all the transmitting control

stations, atmospherics etc., a triangle of error results which has to be resolved for the most probable position by a least squares solution of the spread and workout the standard deviation for that fix and print out this value. The standard deviation enables a surveyor to decide whether his survey is being carried out within the parametres of the specified positioning accuracies for the survey.

2. Sonar: Now that we are able to fix our position off-shore it is pertinent to discuss our sonar tools which in the case of a bathematric survey include an echo sounder, side scan sonar and sub-bottom profiler and in the case of a seismic survey a magnetometer and seismic profiler in addition. All of these operate on the same principle which is the emission of a sound wave and the receipt of its returned signal after bouncing off the sea floor or sub-surface reflector. Sub-bottom profilers are capable of a penetration usually up to 10 metres and is commonly deployed when harbour works have to be undertaken and sub surface geology becomes critical to plan construction and dredging etc. Penetration achieved is usually depth and soil type dependent. Seismic profilers can offer a penetration of the submarine sea bed to well over 6-7 km once, again depth and soil type dependant. The power sources for the different applications are understandably different and is the all important part of a profiling system. Once the seismic records are produced a marine geophysicist geologist will analyse the records at times by probing the sea bed in an area surveyed to obtain a signature of an analogue trace to actual samples of soils. The interpretation of seismic records is a specialization essential to have any benefit from a data gathering exercise which can be very costly.

Having had this brief introduction to sonar (sound navigation and ranging) devices the one remaining key component to make it all happen and to correlate sonar data with navigation data a central ship-board computer is used. In the film you are about to view these different attributes in hydrographic surveying for submarine mineral which will be highlighted.

3. Central Computer: The Central Computer is commonly of the make Hewlett Packard. There are many different models which could be used each with a different capacity of data storage, processing and handling.

A Central Computer is set up and programmed to take in navigation signals, sonar signals, signals from a Gyro Compass, radio tidal meter etc and process all of these inputs to output a latitude and longitude (or an easting and a northing or both), a depth reduced to tides and plot a survey chart using these outputs which will become a reliable survey chart of the area investigated.

The Central Computer will offer real time, on-line, aids to navigate the survey vessel by indicating on either or both a plotter (on which the survey lines to be run are preplotted) and on a CRT screen (on which the currently surveyed line can be shown) the position of the survey vessel which in turn enables the coxswain of the vessel to steer a straight/true desired survey course. The mathematics in the

Computer enables a least squares solution for each fix, and to print out all available information such as line numbers, fix numbers, raw navigation ranges, computed fix co-ordinates, standard deviation of each fix, layback for towed fish, heading of the vessel etc.

In order to put it all into perspective may I indicate the typical costs for data gathering off-shore. A bathematric survey spread ie. survey vessel, navigation system, sonar system, computer, seismic profiler etc. fully manned requiring a total team of about 15 persons can cost about £ 7 to 10 thousands per day which in rupee terms gives a budgetary figure of say Rs. 200,000 per day. The addition of a deep seismic profiler can virtually double this cost. Dedicated seismic vessels engaging in deep digital seismic operations can cost as much as £ 30 to 40 thousand per day which can bring our rupee equivalent to the million rupee mark per day. It will be obvious that there is very little to be gained by going to survey off-shore without all of the appropriate survey tools since the most important objective from any survey is the repeatability of a survey so that with a minimum of error and or ambiguity a 2nd survey vessel will be able to relocate any important findings from the first survey. If on acccount of poor navigation one is obliged tosearch for previous finds of minerals of value in an area which is literally a wet desert with no sign posts, roadways or any visible aids to locate one's self it may be days of very expensive fruitless search which Sri Lanka certainly will never be able to afford.

To plan and assess mineral resources we need a reliable survey chart. To prepare a survey chart we must first carry out a seismic survey using a hydrographic survey platform. To achieve all of this we need expertise, equipment and operating funds. While the latter is perhaps the hardest to come by we in Sri Lanka may now be able to claim some degree of competence in the techniques, instrumentation and the execution of data gathering.

When we are able to produce reliable charts and information we will be ready to look closer into the other specialisations which are even less known in the world - the mining of the oceans.

The oceans may hold the key to the future survival of mankind after man has used up the resources of our land. Let us hope that we who can plan will be wiser with our planning for the use of our marine mineral and biological resources than we have been in the use of our land resources.