# Bathymetry~ The Decade Ahead

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## Abstract

The status of bathymetric mapping of Australia's continental shelf is briefly examined – past, present and future. Some emerging trends – mainly as a result of new technology – which will affect bathymetric surveyors and cartographers of the future are discussed.

## What exactly is Bathymetry?

**Bathymetry** is the determination of ocean depths – the general configuration of the sea-floor as determined by profile analysis of depth data[1].

A **bathymetric map** is a topographic map of the bed of a body of water. It is the end product from a number of activities including, in broad terms, ultrasonic soundings, positioning techniques and tidal observations. The combined talents of surveyors and cartographers process this mass of data into a bathymetric map.

An interesting difference between bathymetry and hydrography was given by Camille Mageau[2]. He said that bathymetric maps represented the actual shape of the ocean bed as closely as possible while the hydrographic chart alerted the mariner to the dangers of surface navigation, particularly within coastal waters. On hydrographic charts, the shallowest depths recorded on echograms were emphasised to stress navigational hazards. Bathymetric maps, however, were based on the totality of the data recorded and they sought to interpret these values based on an understanding of geological processes which moulded the topography of the ocean. Mageau likened a bathymetric map to a scientific paper – the scientific data and its interpretation being presented pictorially rather than by the written word.

## Who collects Bathymetry?

Most seafarers, knowingly or unknowingly, collect bathymetric data during the course of a voyage. The data only becomes valuable, however, when the positions of the depths recorded at sea are accurately known and are related to a common vertical datum.

The main collectors of bathymetric data in Australia are the Division of National Mapping (Natmap), Department of National Development and Energy; and the Hydrographic Service, Royal Australian Navy. Natmap is responsible for mapping Australia's continental shelf and that of its Territories. At present this work is carried out to a depth of 300 metres, at a scale of 1:250 000. The bathymetric map series, consisting of 287 sheets, is a natural extension of the continental topographic map series of the same scale and the maps provide an accurate base which scientists and offshore resource managers can confidently use for their own projects. The series will be a valuable tool for the exploration, exploitation, conservation and proper management of offshore Australia.

Other contributions to the knowledge of Australia's offshore topography come mainly from the Commonwealth Bureau of Mineral Resources, CSIRO, offshore petroleum exploration companies and State Government departments.

## Why collect Bathymetry?

Captain Calder (Hydrographer, RAN) "The fundamental building block of all oceanography is to know how deep the ocean is."

Senator MacGibbon – "yes, and where it is . . ."[3].

The above is an extract from the 1981 Hansard transcript of evidence on the Senate Standing Committee on Science and the Environment with particular reference to Australian Marine Science.

No one would seriously dispute these statements. Depths are relatively easy to measure. It is more difficult to determine the co-ordinates of the echosounder at the instant of sounding. It is inconceivable to imagine any major engineering, mining, prospecting activity or natural resource management occurring in the marine environment without a basic knowledge of the sea-bed topography. If Australia is to fully utilise the potential wealth of its continental shelf then exploratory programs in search of this wealth must be undertaken. Mapping is the basic first step in this process.

## The decade ahead

To put likely trends in bathymetry into perspective it is really necessary to briefly review the past decade and, to some extent, the one prior to that.

In the 1960s there was no program to systematically map Australia's continental shelf. Marine survey activity was mainly confined to the Hydrographic Service, RAN, for the production of nautical charts; petroleum exploration companies; State

Government departments and, to a lesser extent, private practitioners.

In the early 1970s the Commonwealth Government recognised the need for bathymetric mapping of the continental shelf and Natmap was charged with this responsibility.

The bathymetric mapping program commenced with a contract survey in Queensland waters. Nearly half of the program has since been completed. Assuming no change in present funding and staffing, the program should be completed by 1990-91.

Fortunately, satellite navigation equipment was commercially available from the start of the program. This new technology enabled huge tracts of Australia's outer continental shelf to be surveyed without the need for cumbersome radio navigation chains and their attendant shore camp installations. New technology will play a major role for bathymetry in the 1980s.

## New technology

All large surveying and mapping projects in the next decade will be influenced in some degree by changing technology. They will be influenced by such innovations as:

- The Global Positioning System (GPS) should be available to civilian users by the mid to late 1980s. Although the number of satellites in GPSs configuration has been reduced from twenty-four to eighteen, there will be continuous coverage in the Australian region from the smaller number. The implications of this new system on surveying, charting and mapping are both enormous and exciting – there will be an all weather, day or night, self-contained navigation system from which surveyors can determine their position anywhere in the world. The development of GPS will be particularly relevant to bathymetric surveys in deep water where improvements to existing positioning instrumentation is highly desirable.
- The Weapons Research Establishment's Laser Depth Sounder (WRELADS) currently being developed for the Department of Defence will become routinely operational in the next decade.
- Remote sensing satellites will contribute more in the next decade than in the past – not in the way of providing accurate depths as echo-sounders do now but by pinpointing areas of shoals or deep water that may merit further investigation. The US Defense Mapping Agency Hydrographic/Topographic Centre has produced a satellite image map covering 10 000 square miles near the Bahamas at 1:500 000 scale. The result has been reported as being valuable for reconnaissance and planning[4].
- Digital data acquisition systems at sea will be the rule rather than the exception. Bathymetric data gathering will be computer controlled with minimal interference from on-board operators. Natmap for example, in cooperation with the Bureau of Mineral Resources, has one marine data acquisition system operating already with another in the pipeline.
- The next decade will see telemetering tide gauges become popular in Australia for surveying purposes. At the moment, tidal data is the only data not recorded in real time on the survey vessel during the bathymetric survey. In 1979 the Canadian Hydrographic Service installed the Tidal Acquisition Telemetry System (TATS) to replace three conventional tide gauging stations and the Service intends to install TATS at major Canadian ports on the Atlantic seaboard[5].
- Multibeam sonars, which represent a dramatic advance over the conventional single-beam echosounder, will be used more during the decade ahead. The wide lateral coverage, high resolution and quick data capture will make this equipment useful for marine scientists.

## Other likely developments

### An earth centred datum

As users of satellite navigation equipment increase – and with the advent of GPS – there will be pressure to convert to an earth-centred world datum for mapping purposes. Already it has been recognised by the National Mapping Council of Australia – Resolution 396 of 1980 – that Australia's offshore Territories should be mapped on the WGS72 satellite datum. Bathymetric maps of the Territory of the Coral Seas Islands are presently being mapped on this datum.

The International Association of Geodesy and the International Hydrographic Organisation both support the concept of a world datum for navigation purposes. The importance of an international reference system for national and international boundary lines at sea is also evident.

### Closer links with other professions

Surveyors will become more involved with other professions. This is inevitable because of changing work patterns and the impact of new technology.

Surveyors and cartographers have never been slow to embrace new technology and this trend is unlikely to change. Brocklebank and Gaudreault[6] suggest that there are three technologies which have been major contributors to innovations in the surveing and mapping field – electronic technology, computer technology and space technology. Because of these technical innovations the surveyors' traditional associations with the cartographic, legal, engineering and town planning disciplines are changing. There will always be strong links with these disciplines but new bonds are being made with electronic engineers, computer programmers and systems analysts.

On the bathymetric front the interface with other professions expands even further. Surveyors and technical officers are now regularly working alongside geophysicists during bathymetric surveys and occasionally with geologists, biologists, ornithologists and oceanographers.

It seems likely that surveyors in the next decade will have a working contact with an ever increasing circle of professions. It also seems likely that bathymetric surveyors of the future will increasingly find themselves forming part of a multi-disciplinary team on resource-oriented projects.

### Digital data bases

The larger surveying and mapping organisations are either planning or have started to compile digital data bases of geodetic and topographic information. A natural progression from this is the establishment of a data base of bathymetric information. A demand for digital bathymetric data, as well as the conventional bathymetric line map, already exists in Australia and this trend is likely to continue.

The Canadians have put much effort into automated marine systems and see three major needs:[7]

- reliable, low-cost digital data acquisition and processing in the field;
- a system which permits the conversion of graphical data into digital form and its subsequent manipulation and merging with the digital bathymetry;
- the digital data base itself with all the fundamental questions to be answered — what data to be stored; format; quality control etc.

The data base ". . . is a challenge which can be met only by close cooperation and consultation among all the principals involved including hydrographers, cartographers, computer programmers, equipment specialists and managers . . ."[8].

This project team approach recommended for the data base reinforces the concept mentioned above of a widening circle of professional contacts for the surveyor of the future.

### Combined topographic/bathymetric maps

A spin-off from the bathymetric program could well be a new series of maps for Australia called topographic/bathymetric maps. These are maps which show natural and man-made features on-shore as well as those off-shore. Topographic/bathymetric maps are already being produced by a cooperative effort between the United States Geological Survey and the National Ocean Survey. It is planned to provide complete coverage of US coastal zones at three scales — 1:24 000, 1:100 000 and 1:250 000.

Antill and Banks[9] contend that the consensus from coastal mapping workshops and symposia held since 1974 in the USA is that topographic/bathymetric maps are urgently needed: ". . .With topographic/bathymetric maps, coastal zone managers will be able to develop guidelines; collect, analyse and disseminate coastal zone information; conduct bay and estuarine studies; manage wildlife lands and issue permits involving piers, docks, land fills, etc; evaluate marine resources; lease areas of oil and gas exploration and production; and be able to inventory and map resources including energy, minerals, commodities, lands and water resources. Some specific uses for topographic/bathymetric maps include planning, seismic profiling; offshore geology; geohazards and shallow subsurface geology; evaluation of submarine slope stability; establishing seaward coastal zone boundaries; hurricane surge computations; and evaluating the effects of various human actions in waters of the United States."

### Exclusive Economic Zones

Much has been said recently about surveying and mapping the 200 nautical mile Exclusive Economic Zones. If today's economic climate continues, it is unlikely that any Government would fund such a massive undertaking. If the project did go ahead, however, as much useful information as possible should be collected — geomagnetic, gravimetric and seismic profiling data should be obtained as well as bathymetric data. Once again the surveyor would find himself as part of a multi-disciplinary team.

### Education

Teaching institutions are showing an increasing interest in techniques and instrumentation used for off-shore surveys. Course content on marine surveying is likely to be expanded in the future. In the long run, however, it is up to the individual to maintain his continuing education. Technology alone is changing so quickly that surveyors and cartographers must continually reassess their methods and techniques and be prepared to confidently change when the time is right.

## Conclusion

I have attempted to set the scene for the decade ahead as it may affect Australia. It is not just Australia, however, that has a quickening interest in offshore affairs — it is a worldwide phenomenon. As Rear Admiral G.S. Ritchie, CB, DSC, FRICS, RN (Ret.), President of the International Hydrographic Bureau, recently said, "Man's involvement with the oceans is rapidly increasing. As bathymetry is the foundation upon which all marine affairs are founded, these are perhaps the most challenging years so far to face those charged with defining the bathymetry of the world's oceans. The need is pressing but the tools exist"[10].

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