

MAPPING THE AUSTRALIAN CONTINENTAL SHELF

ABSTRACT

The surge of interest in the potential wealth of Australia's Continental Shelf in the 1960's led to a Government Decision in 1970 to systematically map this offshore area. The Division of National Mapping was given responsibility for the project in addition to its topographic mapping program and currently the project is about 60% complete.

The Continental Shelf, at the time of the Government Decision, extended only to the 200 metre isobath but subsequent redefinition at United Nations Conferences on the Law of the Sea means that jurisdiction may be extended over an offshore area some four times larger.

The difficulties in surveying the Australian Continental Shelf are outlined, particularly the different requirements for the Great Barrier Reef which is still generally uncharted. The various positioning systems used are described as are the echo sounders and their calibration requirements.

For compilation of the maps the spacing of the survey sounding lines determines the fidelity of the contours. National Mapping's surveys do not endeavour to find every least depth in a survey area and any available Royal Australian Navy hydrographic survey data is incorporated when producing the bathymetric maps. Contouring is at 10 metre intervals between the 20 metre and 300 metre isobaths. All the National Mapping spot depths used to derive the contours are shown on the reverse side of the map.

Some surveys are carried out in co-operation with other agencies interested in other fields of resource mapping. Meteorological and fish-density observations have been carried out concurrent with the bathymetric survey, while at times seismic and magnetometer sensors have been towed to acquire sub-bottom structural information.

The final section of the paper covers some users of the bathymetric maps. The main users are offshore oil and mineral exploration companies, but fisheries and researchers are other important users.

A diagram is included showing the National Bathymetric Map Series for Australia, the 200 metre isobath and the redefined limit of the Continental Shelf based on the 1982 United Nations Convention on the Law of the Sea.

CARTOGRAPHIE DU PLATEAU CONTINENTAL AUSTRALIEN

ABSTRAIT

L'intérêt croissant dans l'évaluation des richesses du plateau continental Australien aux années 1960 avait amené le Gouvernement à approuver en 1979 la préparation systématique de cartes de la région maritime côtière. En supplément de son programme de production de cartes topographiques, la Division of National Mapping avait été donné la responsabilité du projet susdit qui à présent est à peu près 60% achevé.

Le plateau continental, au temps de la décision du Gouvernement, s'étendait seulement jusqu'à l'isobathe de 200 mètres. Une définition ultérieure aux conférences des Nations Unis sur le Droit de la Mer permettrait l'extension juridictionnel sur une région maritime côtière par quatre fois autant.

Les problèmes de navigation pour entreprendre les sondages du plateau continental Australien ont été décrit, particulièrement les différentes exigences à la Grande Barrière qui n'a toujours pas été dressé sur cartes marines. Les divers systèmes de repérage employé sont décrit ainsi que les appareils de sondage par echo et les nécessités de calibrage.

Pour la compilation des cartes marines, la distance entre les levées de sondage déterminera la fidélité des courbes de niveau bathymétriques. National Mapping n'entreprend pas tous les observations hydrographiques, tout les données disponible du Royal Australian Navy sont incorporé dans la production des cartes bathymétriques. Les courbes de niveau sont à 10 mètres d'intervalle entre les isobathes de 20 et 300 mètres. Tout points de sondage observé par National Mapping et employé pour l'interpolation des courbes bathymétriques sont reproduit sur l'envers de la carte.

Certain projets sont exécuté en co-opération avec d'autres agences intéressé dans la cartographie des ressources Australiennes. Les observations météorologiques et ceux sur la densité de bancs de poisson ont été exécuté concurremment avec les observations hydrographiques, tandis qu'à d'autres occasions des appareils électroniques de mesures séismique et magnétique ont été mise en halage pour acquérir des informations structuraux de fonds sous-marines.

La dernière partie du rapport donne un compte rendu sur les usagers de cartes bathymétriques. Les usagers principaux sont les compagnies pétrolières et d'explorations minéraux mais les pêcheries et études marines sont d'autres usagers important.

Un tableau synoptique est inclus montrant la Série Nationale de Cartes Bathymétriques pour l'Australie, l'isobathe de 200 mètres et la limite du plateau continental comme déterminé par la Convention 1982 des Nations Unis sur le Droit de la Mer.

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HISTORY

In 1969 a submission to the Federal Government drew attention to the potential wealth of the Australian Continental Shelf and recommended approval of a plan to map this area and thereby provide the basic knowledge of topography that is necessary for development of the natural resources of the Shelf and the waters above it. A committee was empowered to investigate a program for bathymetric mapping of the Australian Continental Shelf.

The committee found that there was already a latent need for bathymetric maps to assist planning searches for minerals in the shallower waters over the continental shelf. Such maps would enable more efficient planning of the required geological and geophysical surveys and reduce exploration costs by concentrating the exploration on surveys in areas where mineral recovery would be viable.

Another area the committee found could benefit was in the field of scientific research programs. Oceanographic and meteorological studies in particular could be assisted, not only by the completed maps, but also from observations made during the bathymetric mapping operations. The maps would be valuable as base maps on which to portray other scientific data gathered over the shelf area.

The committee noted that already topographic, geological and geophysical maps of the Australian mainland had both primed and facilitated mineral discoveries. They reasoned that similar resource mapping of the Continental Shelf would provide a similar background within which other scientific studies could be made.

The findings of the committee resulted in a second submission to the Government in 1970.

It was emphasised that if Australia were to maximise the benefit from the potential wealth of its Continental Shelf then it must systematically search for and assess that wealth. Mapping the area was the first vital step. Maps were recognised as essential for the efficient exploration, resources assessment and development management of the continental shelf.

Adequate maps would enable the placing of surveillance equipment, be necessary for patrolling remote areas where oil rigs might become established and would provide navigational data for submarines.

Further mapping operations would benefit scientific research programs of oceanography and meteorology.

It was also pointed out that to maintain such sovereign rights as we have under international law Australia would need to be active in the survey, investigation and development of its Continental Shelf and the waters above it. The provision of maps was and is a basic preliminary requirement for such systematic investigation and development.

The Government agreed with the findings and subsequently approved the completing of a 1:250 000 scale bathymetric mapping program of the Australian Continental Shelf. The general responsibility for the project was given to the Department of National Development through its Division of National Mapping and it was estimated at the time that the project would take 10 to 12 years and cost about \$18 million.

DEFINITIONS

Australian Continental Shelf

At the time of the 1970 Government decision the continental shelf was defined by the United Nations State Parties to the Convention of the Continental Shelf of 1958 as follows:

"... the term "Continental Shelf" is used as referring to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the Territorial Sea to a depth of 200 metres or beyond that limit, to where the depth of the superjacent waters admit of the exploitation of the natural resources of the said area".

This definition has since been modified significantly following examination and debate at the UN Conferences on the Law of the Sea. In practical terms, it means that the offshore area over which Australia is now entitled to claim jurisdiction has increased from 2.3 million square kilometers to at least 10 million square kilometers. (Article 76 of the Law of the Convention refers). Australia became a signatory to the Convention on the 10th December 1982.

Figure 1 shows the 1958 and 1982 Conventions' limits of the Continental Shelf. The latter redefined limit is still subject to relevant delimitation agreements to be arrived at between Australia and neighbouring countries.

Bathymetric Maps

The maps of the National Bathymetric Map Series are based on the 1:250 000 topographic series sheets with extensions for irregular coastline or continental shelf edge features. The face of the map contains the contours derived for the area and a source and sounding line spacing diagram. The reverse side of the map shows the selected soundings obtained by National Mapping's own or contracted surveys.

Differences Between Bathymetric Maps And Hydrographic Charts

Bathymetric maps are a resource tool showing the general topography of the sea floor. Hydrographic charts are an aid to navigation and show information such as the least depths and hazards of the seabed which may affect mariners. The main difference therefore between the two types of map is that the bathymetric map shows detail soundings but no attempt has been made to define least depths between lines as is done during hydrographic surveys.

The other difference is in the datums adopted for the soundings. On bathymetric maps the soundings are reduced to mean sea level datum whereas hydrographic charts were based on a number of datums but mainly Indian Spring Low Water datum. Recently chart datum for new hydrographic publications has been changed to Lowest Astronomical Tide to accord with international hydrographic practice.

PROBLEMS MAPPING THE CONTINENTAL SHELF

As the Australian Continental Shelf varies from about 16 kilometers width off Port Macquarie NSW to in excess of 300 kilometers off the North West Shelf the majority of the Shelf area to be surveyed requires a ship capable of being able to stay at sea for many days. Since 1972 National Mapping has been using the MV "Cape Pillar", a 2100 tonne NAVAIDS vessel owned and operated by the Department of Transport. The average utilization has been 180 days each year and the ship has been used in the deeper water areas of the Continental Shelf where it can work 24 hours each day on sounding operations. The biggest advantage of using a ship of this size is that it can continue working in fairly rough seas.

The inshore limit of survey is the 20 metre isobath and, as it would be too dangerous to take such a big ship close inshore, the "Cape Pillar" also carries a 7 metre survey launch which is used for the shallow-water surveys around rocks and islands as well as along the many stretches of hazardous coastline.

It is uneconomic to use such a large vessel in the Great Barrier Reef so a second charter has been organised and

currently the TSMV "Febrina", a 20 metre vessel, is used to survey around the reef areas. Sounding in and around the reef areas is confined to daylight hours only as the majority of this area has not been mapped or charted before.

Investigations are currently being made into using false colour enhancement of the components in the Landsat imagery related to water penetration to aid reef definition and hence navigation in this area.

POSITIONING AND DEPTH

The "Cape Pillar" is equipped with a Doppler satellite/Doppler sonar navigation system for obtaining positions while at sea. The Doppler satellite positioning system interrogates the satellites from the worldwide position fixing system known as the Navy Navigation Satellite System. A satellite fix of the ship is obtained about every two hours and the Doppler sonar system works out the ship's position between the satellite fixes. The average accuracy of an acceptable satellite fix at sea using course and speed data, derived from a gyro compass and the Doppler sonar, is in the order of 75 metres which provides adequate absolute accuracy for bathymetric mapping at 1:250 000 scale. This accuracy is insufficient for more detailed hydrographic survey work.

In the Great Barrier Reef the "Febrina" is positioned using Decca Hifix 6 with Motorola Miniranger backup. The Hifix 6 system is a radio-positioning system which utilises the phase comparison of signals transmitted from known stations on shore and these are interpreted at the receiver as lane counts, each lane representing a division of the frequency of transmission. The Miniranger system is a radar-based time lapse measuring system. With suitable placement of the shore stations the accuracy of fixing in the survey area is about 25 metres.

Water depths are measured using Atlas Deso 10 Echo Sounders which measure the depth of water by timing a low frequency pulse reflected off the sea bed and recording this as a continuing trace on chart paper. To achieve survey accuracy the echo sounder must be carefully calibrated and checks are made in the Great Barrier Reef by calibrating the echo sounder against a 2.5 metre disc-check. On the "Cape Pillar" an expendable bathythermograph is used to determine the temperature profile of the water column beneath the ship at regular intervals and the values obtained from this are used to set the echo sounder.

During each survey tide gauges are deployed at suitable sites to provide the tidal variations for correcting the water depth to give the depth below mean sea level at the required survey points.

COMPILATION OF THE BATHYMETRY

In order to depict the continental shelf in sufficient detail for the 1:250 000 mapping scale the lines of sounding are usually surveyed at 3000 metre spacings between the 20 metre isobath at the inshore limit and the 300 metre isobath at the outer edge of the shelf. These sounding lines are run generally perpendicular to the contours and interlining at 1500 metres or closer intervals is done to pick up detail where this is necessary to portray the contours adequately. Along each sounding line the echo sounder records continuously but the positioning system acquisition is timed to give spot depths at approximately 600 metre intervals. Extra points are interpolated where slope changes are encountered.

The data gathered by National Mapping's surveys is integrated with any existing Royal Australian Navy hydrographic survey data or British Admiralty Colonial Survey data. Originally only contours at 20 metre intervals were shown together with spot depths and changes of slope. This has now been superseded by a policy of contouring at 10 metre intervals and not showing any spot depths. As mentioned above the reverse side of the map shows all the National Mapping spot depths used to derive the contours.

The National Bathymetric Map Series Program currently involves 283 sheets including offshore island territories. So far 150 of these sheets have sufficient survey material available to be published and 91 have been published as of April 1984 (see Figure 1). At the current resource level it is anticipated that the survey program should be completed around about 1991.

In the past the bathymetric maps showed little or no topographic information because the topographic program and bathymetric programs were out of step but it is proposed in future to publish topographic data and bathymetry on a combined base.

CO-OPERATIVE ACTIVITIES

Close liaison is maintained with the Royal Australian Navy's Hydrographic Service to avoid duplication of effort and ensure that the bathymetric surveys assist the hydrographic charting program. Bathymetric manuscript data and Navy survey fairchart data are exchanged as soon as they are available after each survey.

Besides acquiring bathymetric data opportunities are taken to record other scientific data where this is practicable without affecting the speed of bathymetric data acquisition. The survey vessel "Febrina" used in the Great Barrier Reef also carries multi-channel seismic acquisition and magnetometer

systems. These systems are manned and operated by the Bureau of Mineral Resources, Geology and Geophysics and acquire data when the ship is working in safer waters away from reefs. On the "Cape Pillar" meteorological observations are carried out for the Bureau of Meteorology and reports transmitted at six hourly intervals while the vessel is at sea. At times information has been gathered for the CSIRO Division of Fisheries, including sea surface temperature and operating a fish finding echo sounder.

USERS OF THE MAPS

Since the commencement of the bathymetric mapping program the maps have provided the basis for an ever increasing variety of applications. The main users of bathymetric maps are the exploration companies, especially those associated with offshore oil and mineral exploration. International companies, such as Esso Exploration, use them to assist in designing seismic survey lines for oil exploration on their offshore petroleum leases.

Another use of the maps is to locate trawling grounds, the users here being the CSIRO and Department of Primary Industry. Several universities use them for academic research studies as does the Bureau of Mineral Resources, Geology and Geophysics.

Other minor but specialised users include the producers of concrete in their search for offshore gravel deposits, the Marine Operations Centre in Canberra for surveillance, the Department of Mines, Western Australia, in researching ocean floor geology, the Australian Oceanographic Data Centre in their research of oceanography and meteorology, Associated Surveys of Perth for the gas pipeline survey to the Rankin oilfield, and Cluff Engineering W.A. for port design. The National Parks and Wildlife Service use them for environmental studies and Hydrographic Surveys Pty Ltd of NSW use them for geophysical interpretation.

The Royal Australian Navy Hydrographic Service uses the information to assist in determining where additional hydrographic surveys are required and the Public Works Department of Western Australia has used them for their charting and mapping programs. The Department of Lands of South Australia is currently using the maps to assist determining their State's sovereignty rights.

The bathymetric information is also supplied to the International Hydrographic Bureau in Monaco and the Department of Interior in the United States of America for incorporation into the International Bathymetric Data Base.

An interesting use of the bathymetric data was by the

Institute of Oceanographic Services, United Kingdom, who were researching the pre-history of the Timor Sea particularly the possibility of an island chain linking Timor and Australia.

An emerging use for the maps is in the area of maritime boundary delimitation where they will be a useful adjunct in administering the new boundaries as they are declared.

Australia, with its resource-based economy, has and will continue to benefit from National Mapping's bathymetric activities.