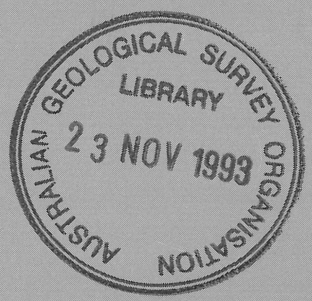
EVALUATION OF THE CONTINENTAL MARGINS PROGRAM



1992/93

Record 1993/84

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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ORGANISATION

AGSO Record 1993/84

The Report of the Evaluation of AGSO's Continental Margin Program (AGSO Record 1993/84) was produced prior to the Review of the Australian Geological Survey Organisation's Composition, Structure and Administrative Arrangements, chaired by Dr Max Richards. Its conclusions were taken into account by the Richards Review and by the Commonwealth Government in formulating its response to the Review. This Evaluation Report is published in line with government policy of publicly releasing the results of major portfolio evaluations.

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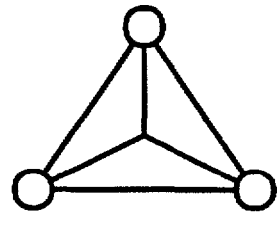

ADVISORY COUNCIL EVALUATION PROGRAM

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Resources: Hon. Michael Lee, MP
Secretary: Greg Taylor

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Executive Director: Harvey Jacka

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Executive Summary:

The need for the Continental Margins Program;

1. The deliberations of the Evaluation Panel and the material it has gathered indicate that there is an identified need, and significant support, for the Continental Margins Program (CMP).

2. At its November 1992 meeting, the Advisory Council reiterated that the evaluation needed to include an attempt to quantify measures of benefit from the CMP. This has been attempted by staff of AGSO in consultation with external consultants and people with the information required to undertake the analysis (Appendix D).

3. Some of these measures are necessarily indirect and circumstantial, others are anecdotal, and some provide useful links between the CMP outputs and benefits. However, the evaluation methodology needs to be further developed to determine and quantify the benefits of this type of program.

4. The Panel found that the Continental Margins Program has delivered a wide range of benefits to Government, industry and the community over the last seven years. These benefits fall into three broad categories:

   - benefits that directly relate to the expected production of a marketable item (petroleum, fish, exploration techniques, etc)

   - benefits that accrue to Government programs which would otherwise have to find some other (generally more expensive) way of acquiring the data and advice they need

   - benefits that accrue to the scientific community.

5. The Panel found that the CMP has been particularly effective in improving the efficiency of offshore petroleum exploration activity by gathering geoscientific data and undertaking research in "frontier" areas related to the potential for petroleum in Australia.

6. The Panel also found that the CMP has made, and will increasingly need to make, an important contribution to the delineation of Australia's maritime boundaries and in defining the limits of Australia's jurisdiction under the 1982 UN Convention on the Law of the Sea.

7. With the exception of the Department of Finance representative, the Panel were confident that, although there were considerable benefits flowing to the private sector from the CMP, the CMP should be funded by Commonwealth Government appropriation. The Panel also concludes that the CMP should be regarded as a national priority.

R1. The Panel recommends that funding for the Continental Margins Program be continued by the Commonwealth Government for at least a further 5 years from 1 July 1993.

The relevance of CMP objectives;

8. The Panel found that the CMP's objectives were relevant to needs but recommends that the previously stated objectives be reworded to better reflect the primary focus of the CMP and incorporate provision of information in relation to marine parks and protected areas.

R2. The Panel recommends that the objectives of the Continental Margins Program stress its role in maximising the socio-economic value of Australia's offshore resources as follows:

"To provide geoscientific information and advice, consistent with the principles of ecologically sustainable development, to:

- *improve offshore petroleum and mineral exploration efficiency and effectiveness*
- *support Government decision making on offshore petroleum and mineral exploration and development*
- *maximise and sustain Australia's legal continental shelf claim in preparation for when UNCLOS comes into force*
- *support inter-governmental negotiations between Australia and its nearest neighbours on the delineation of sea-bed boundaries*
- *assist with resource and environmental advice in relation to marine parks and protected areas."*

R3. The Panel further recommends that the scientific strategies for the CMP to fulfil the above objectives be to:

- *". deliver a knowledge and understanding of the geological framework of the continental margins around Australia and its territories*
- *identify the petroleum and mineral resource exploration potential of the offshore area*
- *develop models of the geological processes which have formed the continental margin and led to economic accumulations of petroleum and minerals."*

9. The Panel was concerned that the lack of adequate core funding and the need to obtain extra funding to make the ship operations cost effective was pushing, or had the capacity to push, the CMP away from fulfilling its core objectives. This

concern has perhaps been manifest as a perceived emphasis on data acquisition rather than data output. The issue of funding was seen by the Panel to be a major issue.

10. The Department of Finance representative expressed concern about the relative lack of immediate tangible (ie financial) returns from the Government's investment in the CMP. He felt that greater cost recovery in response to industry priorities was the most important means of testing the value of the CMP to industry and a significant factor in measuring performance; he further felt that further change in CMP objectives to require it to meet the priorities of external agencies/companies was appropriate. Those points of view were not held by any other member of the Panel.

11. The Panel considered that the meeting of additional objectives may merit expansion of the CMP, subject to the appropriation of additional resources for such purposes, and should be considered depending upon the opportunities and capabilities of the CMP as circumstances dictate. However, the focus of the CMP should remain on the agreed objectives (R2).

R4. The Panel recommends that any work in the marine environmental field unrelated to marine protected areas result from either:

- *an explicit Commonwealth Government decision matched by extra funding*
- *full external funding separate from the core CMP appropriation.*

R5. The Panel recommends that the RV Rig Seismic not undertake routine commercial seismic acquisition in competition with domestic contractors in Australian petroleum exploration title areas.

12. The Panel noted that the Marine Geoscience and Petroleum Geology Program (MG&PG), which has corporate responsibility for the implementation of the CMP, had reached a watershed in its evaluation of "direct hydrocarbon detection" (DHD) as an exploration tool in Australian waters. The Panel noted that the work completed to date, when completely written up, provides a valuable evaluation of the application of the technique in Australian waters but that further routine operation was of limited relevance to most ongoing aspects of the CMP. Also, DHD development lies outside the core objectives of the CMP.

R6. The Panel recommends that routine Direct Hydrocarbon Detection (DHD) be discontinued as it is not core business and any savings applied to core CMP activities.

R7. The Panel further recommends that MG&PG's DHD technology be offered for commercialisation with a view to making the technology available to industry in Australia and to facilitate the application of the technique for environmental monitoring purposes.

Efficiency and effectiveness;

13. The Panel noted that the two major questions that arise in looking at the efficiency and effectiveness of the delivery of the CMP relate to the two major costs – the method of data acquisition and the method of data processing. Specifically:

    - is the RV *Rig Seismic* the most efficient and effective way of acquiring the data required to fulfil the objectives of the CMP?

    - are the current data processing arrangements the most efficient and effective to fulfil the objectives of the CMP?

14. The Panel noted that specific steps have been undertaken recently in relation to data acquisition and data processing to improve the quality and timeliness of CMP data and products. The Panel nonetheless remained concerned that there was inadequate quality control in seismic data processing and timeliness in data output. This concern was reflected in a significant number of submissions.

15. The Panel noted that the cost of in-house seismic processing appeared to be significantly higher than the current cost of seismic processing provided by commercial groups on contract. The Panel also noted that some clients perceived that, in the past, too much emphasis had been placed on data acquisition in the CMP rather than data processing and release.

Data Acquisition;

16. The Panel found that:

    - the operation of RV *Rig Seismic* was conducted to commercial standards and that, although there was no exact commercial equivalent, the rate, quality and cost of seismic acquisition was comparable to industry

    - fulfilling the objectives of the CMP could keep one research vessel fully occupied

    - there is no alternative vessel in Australia or the region currently configured for high resolution seismic acquisition and geological/geochemical sampling

    - AGSO occasionally experiences demands arising at short notice to meet government priorities to which it is able respond by rescheduling cruises; it would be difficult and expensive to do this commercially

    - the CMP's deep multi-channel seismic acquisition costs in 1991/92 were arguably below comparable commercial data acquisition costs in Australian waters and on the low end of the commercial range in South East Asia

- one-off costs to AGSO of contracting out offshore seismic and related data acquisition could run between $A8-10 million; without additional funds, this would require suspension of the program for 2 years and provide program platforms of uncertain or lesser capability and possibly higher cost

- although utilisation of the CSIRO's RV *Franklin* is not an option, the new AMSA vessel may become a realistic option for data acquisition sometime in the next few years.

17. The Panel concluded that, under current circumstances, the RV *Rig Seismic* was the most effective and efficient option for fulfilling the data acquisition objectives of the CMP.

R8. In relation to the cost of operation of the RV Rig Seismic, the Panel recommends that MG&PG management:

- *conduct external technical audits of shipboard systems and acquisition procedures in seismic and non-seismic acquisition regularly; depending on the cruise schedule, 2 audits of seismic operations and 1 audit of non-seismic operations should be conducted annually using quality control consultants*

- *maintain systematic retrospective and prospective cost analysis of the CMP over a rolling 5 year period for the purposes of planning and cost control in order to facilitate financial decision making and underpin key decisions, eg vessel replacement*

- *establish a standard method of cost accounting for the operational aspects of the CMP to reflect true program attributable overheads and appropriate depreciation rates accurately*

- *develop an options paper immediately which examines the costs of continuing the CMP using RV Rig Seismic, versus provision of the required data, samples and services via alternative platforms and agencies*

  - *this options paper should include consideration of the costs of RV Rig Seismic contract termination and re-delivery and the availability of other platforms to provide full geological, geophysical and geochemical data acquisition in a timely fashion during the next 5 years of the CMP*

- *commence planning for replacement of RV Rig Seismic in line with ASTEC's recommendation with a view to presenting a proposal for a range of fully costed options and schedule for replacement in the 1993/94 Budget context.*

Data Processing;

18. The Panel found that:

- steps had been taken to improve seismic data processing, quality and timeliness but were still concerned that there was inadequate quality control in seismic data processing and timeliness in data output
- the past cost of seismic processing was significantly higher (approximately 100-350%) than the current cost of seismic processing on contract
- it would be premature to cease seismic data processing within AGSO at this time as the benefits of the new seismic processing system, in which significant resources have already been invested, have yet to be fully realised.

19. In the Evaluation Panel's view, although MG&PG has taken steps to address the seismic processing issues identified here, specific additional action is required to improve throughput, quality control and costs consistent with maintenance of research capability.

R9. The Panel recommends that the performance of the AGSO in-house seismic processing be monitored regularly to ensure that the requirements of the program are being met and that standards of quality and timeliness are being achieved.

R10. In relation to data processing, MG&PG management should:

- *conduct regular external technical audits of MG&PG's overall processing procedures to assist in the implementation of up to date processing and quality control measures; at least two such consultations should be undertaken in the next 6 months*
- *introduce interactive processing as soon as practicable to improve the efficiency of, and use of manpower in, seismic processing having regard to costs and funding priorities*
- *allocate additional staff resources to seismic processing for the purpose of quality control and assistance in parameter selection also having regard to costs and funding priorities*
- *develop and implement a strategy for storage and copying of CMP data which addresses issues of timeliness, quality of service and efficiency, and whether such services can better be provided through contracting out*
- *prepare a report on the future direction of seismic processing to be provided to the AGSO Advisory Council no later than the June 1993 meeting.*

R11. The Panel recommends that once the operation is bedded down, in say six months, the cost competitiveness of the Seismic Processing Centre (SPC) be examined to ensure that retention of an in-house seismic processing capacity is the correct choice.

R12. The Panel further recommends that a specific plan of action to address all options for reducing processing costs commensurate with the objectives of the CMP be prepared for the Advisory Council on progress and the way ahead, including consideration of various contracting out options for seismic processing

- *considerations should include, in order of importance, quality control, turn around time and costs whilst maintaining research capability.*

20. The CMP has developed significantly since its inception and has a proven track record in achieving technical and efficiency improvements. It is now delivering a much improved product although real budget outlays have decreased. However, this situation needs to be continually monitored to ensure optimum efficiency.

Other scope for improvement;

Planning;

21. The Panel found that:

- the Petroleum Consultative Group, set up after the Wood's Review to provide advice on the strategic direction and issues associated with the CMP has been largely ineffective
- the APEA Exploration Committee has proved more useful and predictable in terms of its Canberra meeting schedule and membership
- the CMP has a well developed procedure for developing and monitoring projects through its Future Program Committee

but

- there is a lack of in depth knowledge of the CMP in the exploration community, particularly at higher management levels
- there can be improved co-ordination in the planning of CMP projects, the schedule of new acreage releases and meeting the needs of State agencies.

R13. In relation to the planning of the CMP work program and cruise schedule, the Panel recommends that MG&PG management should:

- *develop a 5 year strategic plan to complete data acquisition related to the definition of Australia's Legal Continental Shelf (in the light of the*

impending ratification of the UNCLOS) and unresolved bilateral boundaries (between Australia and Indonesia, and Australia and New Zealand) in conjunction with the Department of Foreign Affairs and Trade (DFAT) and Attorney-General's (AGs)

- *MG&PG should also seek the support of DFAT and AGs for funding of this proposal including acquisition of a swath mapping capability*

. *hold discussions with DASET (sic, DEST) and other appropriate agencies on their forward programs with a view to gathering baseline data in areas that may be considered for new marine parks or protected areas*

. *improve communications with the Australian Petroleum Exploration Association (APEA) and seek agreement to the APEA Exploration Committee and its Seismic Operators Sub-Committee being the routine vehicles for canvassing future CMP directions and associated issues with the petroleum industry*

. *widen consultation in relation to future cruises to include State agencies and improve the synchronisation of release of new CMP data and the gazettal of prospective areas for offshore petroleum (and mineral) exploration.*

22. The Panel suggests that it is insufficient to regard the CMP as a Program which simply produces data of a particular type. The Program also has a role in advancing the way in which all data collected in offshore basins, whether by industry or Government, is interpreted.

R14. MG&PG management enter into consultations with potential industry clients to develop and fund an experimental seismic acquisition program aimed at improving geophysical array design and source configurations suitable for Australian continental shelf conditions.

Funding;

23. The Panel found that it is not cost efficient for the RV *Rig Seismic* to spend less than 150 days (5 cruises) each year acquiring data. If an appropriate level of funding cannot be sustained:

. the utilisation of RV *Rig Seismic* will be unacceptably low and the per unit operational costs will be unacceptably high

. there is doubt whether the CMP can continue to deliver the benefits listed elsewhere in this report in an efficient and effective way.

24. The Panel concluded that the CMP is at a watershed because of its increased dependency on external funding to utilise RV *Rig Seismic* efficiently. This level of dependency is beyond the extent originally envisaged by Cabinet. Such

dependency has the potential to divert the CMP away from its core objectives in favour of sectoral objectives.

R15. The Panel recommends that MG&PG, AGSO and DPIE management examine funding priorities to maintain CMP cruises, focused on core program objectives, at a minimum of 150 days a year (5 cruises).

R16. The Panel further recommends that funding for program activities beyond the core objectives of the CMP should be at full cost recovery rates.

Co-operative Research Centres;

25. The Panel noted that MG&PG had recently been given responsibility for implementation of AGSO's commitment to the Co-operative Research Centre (CRC) for Antarctica and the Southern Ocean Environment. The commitment involves approximately $A600 000 of which approximately $A400 000 is the responsibility of MG&PG and for which only $A50 000 in additional funds was provided. Whilst the Panel notes that AGSO's commitment attracts matching funds to the CRC, the Panel was concerned that the diversion of resources away from the CMP had further compromised its capacity to fulfil core objectives.

R17. The Panel recommends that AGSO reconsider the priorities for its commitment to the Antarctic CRC in the light of the diminished resources available for the CMP.

Program management;

R18. In relation to management of the CMP, MG&PG management should:

- *develop, co-ordinate and implement a public relations/marketing strategy to inform senior petroleum industry management and other stakeholders (including DPIE MinFish, DFAT, A-Gs, etc) of the objectives and benefits of the CMP so that the CMP is more familiar to clients*
  - *marketing efforts should be co-ordinated so that program structure is transparent to industry clients*
- *ensure that literature explaining the national relevance and objectives of the CMP stresses its role in maximising the economic and social value of Australia's offshore resources and promoting their utilisation consistent with the principles of ecologically sustainable development*
  - *current Government petroleum industry policies should be reflected accurately*
- *widely circulate future CMP directions , provide opportunities for the University community to participate in future projects and list current university involvement in the CMP*

- *develop a practical solution to the delivery of mechanical/electronics technical services embodying a single management structure*

- *develop specific procedures for dealing with human resource issues relating to shipboard operations and explore workplace bargaining as a mechanism to address current anomalies in allowances payable*

- *actively pursue opportunities to broaden the experience of MG&PG staff to the benefit of the CMP including:*

  - *involving overseas ships, specialist equipment and personnel in projects that meet the objectives of the CMP*

  - *exchanging staff with private companies and overseas research agencies.*

An information resource;

26. The Government faces major decisions in relation to the CMP. By 30 June 1993, the Government must decide whether to terminate the RV *Rig Seismic* contract or not. The contract can be extended year by year until June 30 1998 or the contract can be terminated at any time between now and then. However, terminating before 1998 will incur a penalty cost. It therefore has to be determined at what time, given a whole range of issues (including strategic and financial planning) which are mostly identified within this Report, the contract should be terminated. The Panel therefore recommends that:

- standard cost accounting be established

- a systematic prospective and retrospective cost analysis of the CMP be maintained over a rolling 5 year period

- an options paper for the delivery of the CMP over the next 5 years be prepared

- planning for the replacement of the RV *Rig Seismic* commence.

27. The Advisory Council suggests that, given the uncertainties surrounding the future of AGSO and the CMP, the contract should be allowed to continue for at least one more year until June 30 1994, at which time the Government's response to the Richards' Review will have been released and the required future for the CMP and its data acquisition and processing activities will be clearer.

R19. The Panel recommends that, in consultation with stakeholders, MG&PG management should set new performance indicators for the CMP incorporating the following criteria with respect to:

- *petroleum exploration*

- *whether companies have bought data arising from the CMP and used it in strategic assessments and/or bid formulation*

- *whether petroleum has been found subsequent to the above, recognising the lead times involved in offshore petroleum data collection, exploration, discovery, development and production*

. *jurisdictional matters and delineation of offshore boundaries*

- *whether the CMP can provide the baseline information to establish the scientific basis for Australia's claim on its legal continental shelf and determine the resource potential of areas affected by delineation of national boundaries.*

. *Commonwealth Government decisions on new marine parks and protected areas*

- *whether the CMP can provide the baseline information to allow the Department to advise the Government on resource/environmental matters*

. *program relevance*

- *whether the Australian community, including industry, assesses the CMP to be useful as indicated by records of data requests and usage of CMP products.*

Conclusion;

28. The Panel considered that of the recommendations made, several were of immediate priority. These were:

. securing agreement for the continuation of the core CMP program

. securing funding to enable the CMP to undertake at least 5 cruises a year focusing on the agreed CMP objectives

. improving strategic planning

. implementing an action plan to improve seismic processing.

29. The Panel is very conscious of the uncertain position of the Continental Margins Program. The need for the CMP and the benefits it provides are not in doubt, yet its future direction is dependent on the availability of adequate government funding to undertake a viable program to meet defined core objectives.

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EVALUATION BACKGROUND

Evaluation in AGSO

1. In 1987 and 1988, the Federal Cabinet agreed to a detailed strategy for enhancing program evaluation in the Australian Public Service. Some of the key features of this strategy are that:

   . annual portfolio evaluation plans must be prepared

   . evaluation should become part of program management

   . all programs should be evaluated every three to five years.

2. One of the recommendations of the 1988/89 Woods Review of the then Bureau of Mineral Resources, Geology and Geophysics (BMR), since renamed the Australian Geological Survey Organisation (AGSO), was that:

   "...review and evaluation procedures be developed further by BMR in consultation with the BMR Advisory Council to monitor the effectiveness and efficiency of the program; projects be formally reviewed against specified performance indicators on a regular basis."

3. In its response, the Government accepted this recommendation and modified the Terms of Reference (TOR) of the BMR Advisory Council (the Council) to include providing advice on the performance of BMR's program.

Generic TOR for the Advisory Council Evaluation Program;

4. At its November 1990 meeting, the Council agreed to a program of evaluations – the Advisory Council Evaluation Program – which included an evaluation of BMR's Marine Geoscience and Petroleum Geology Program (including the Continental Margins Program) beginning in 1992.

5. At that meeting, the Council also approved generic Terms of Reference for the Advisory Council Evaluation Program as follows:

   To evaluate, report and make recommendations on:

   . *the relevance of program goals and objectives of program generation*

   . *the methods and effectiveness of program generation*

   . *the effectiveness of program delivery*

   . *the relevance of program outputs*

   . *the appropriateness of resources to meet program delivery*

   . *the interaction with key stakeholders.*

Specific terms of reference for the evaluation of the Continental Margins Program;

6. At the March 1992 meeting of the Advisory Council, the Council approved specific terms of reference for an Evaluation of the Continental Margins Program (as the major part of the Marine Geoscience and Petroleum Geology Program) as follows:

To evaluate, report and make recommendations on:

. *the need for the Program*

. *whether the Program objectives are relevant to needs*

. *whether the Program is achieving its objectives in the most efficient and effective way*

. *scope for improving the performance of the Program*

. *an information resource which can be used as a basis for consideration of the future of the Program.*

7. The key issues to be addressed and questions to be answered in the evaluation of the Continental Margins Program (CMP) were also approved as follows:

Effectiveness of the Continental Margins Program

. *Has the CMP been effective in:*

- *stimulating offshore petroleum and mineral exploration and development*

- *providing an independent information base to support Government decision making on offshore petroleum and mineral exploration and development*

- *contributing baseline data to the management of Australia's continental and territorial marine environment*

- *supporting Australia's offshore jurisdiction claims under the Law of the Sea and the determination of its sea-bed boundaries by undertaking (geoscientific) research in these areas*

- *contributing to Australia's foreign policy and trade objectives by undertaking international development assistance projects in South East Asia and the Pacific*

- *meeting its cost recovery objectives?*

. *Can the effectiveness of the Program be improved?*

Efficiency of the implementation of the Continental Margins Program by the Marine Geoscience and Petroleum Geology Program

. *Does MG&PG acquire information at no higher cost than other means?*

. *Can the efficiency of MG&PG be improved?*

Benefits and Costs of the Continental Margins Program

. *What are the quantifiable and non-quantifiable benefits and costs to Australia of having the Continental Margins Program?*

Opportunities for Development of the Continental Margins Program

. *Can the CMP objectives be met more effectively and efficiently by varying resource allocation or approach?*

Evaluation Management Strategy;

8. At its meeting on 6 March 1992, the Advisory Council endorsed the terms of reference, and membership of the Panel, for the evaluation of the CMP.

9. The Evaluation Panel operated under the auspices of the Advisory Council with the planning and implementation of the evaluation strategy monitored at Advisory Council meetings in March, June and November 1992.

10. The implementation of the Evaluation recommendations will be the responsibility of AGSO management under the auspices of the Advisory Council with implementation reports tabled at Advisory Council meetings for as long as the Advisory Council deems necessary. These implementation reports will also be provided to the DPIE Business Committee and the Department of Finance.

Evaluation Panel;

11. The first draft of the evaluation report was prepared by an Evaluation Panel, operating under the direction of the Advisory Council, comprising:

. Dr David Falvey (Associate Director – Petroleum and Marine Geoscience, AGSO)

. Mr John Denham of BHP Petroleum (member of the AGSO Advisory Council nominated by the Australian Society of Exploration Geophysicists)

- Professor Charles Helsley (Director, School of Ocean and Earth Sciences, University of Hawaii)
- Mr Andy Whittle (Exploration Manager, Gas and Fuel Corporation of Victoria)
- Mr Bob Alderson (Acting First Assistant Secretary, Petroleum Division, Minerals and Fisheries Group, Department of Primary Industries and Energy)
- Mr Mike Rombouts, (Chief Finance Officer, Department of Finance).

Evaluation Working Group;

12. Support to the Evaluation Panel and the Advisory Council, especially in the production of the final report, was provided by:

- Dr Trevor Powell, (initially Head, Marine Geoscience & Petroleum Geology Program currently acting Associate Director, Minerals and Environment)
- Neville Exon (formerly acting Head, Marine Geoscience & Petroleum Geology Program)
- Phil Symonds, Frank Brassil, Roy Whitworth, George Chaproniere, Phillipa Wright and Joy Manly (Marine Geoscience & Petroleum Geology Program)
- Alec Nicolson, Louise Emmett and David Bailey (Corporate Relations, Information and Planning Branch).

13. During the final drafting of the report, editorial and economic advice was also sought from Sally Driml, a PhD student at the Australian National University's Centre for Resource and Environmental Studies.

Evaluation Methodology;

Request for Submissions;

14. All members of the Advisory Council, all AGSO staff and 75 external stakeholders were formally invited to make a submission to the Panel. The external stakeholders included both Commonwealth and State/Territory Government departments, representatives of the oil industry both within and outside Australia, service companies and universities.

15. 37 written submissions were received, some relating to one specific area of the CMP others giving comments on two or more areas of the CMP:

- 6 submissions originated from overseas, 31 from Australia

- 6 from industry (including a composite submission from APEA representing all its members)

- 16 from AGSO (including 9 from within the Marine Geoscience and Petroleum Geology Program).

16. A list of the people/organisations who provided written submissions in included in Appendix A. In addition, a number of people made oral presentations and responded to questions from the Panel (Appendix B).

Coopers and Lybrand Study;

17. A study of the CMP was undertaken by Coopers & Lybrand during July - September 1992. Coopers & Lybrand interviewed 28 petroleum industry representatives, including resident (25) and non-resident (3) petroleum exploration companies, and Commonwealth Department (2) representatives as part of this survey. The Executive Summary of that Study is included as Appendix C.

Meeting of the Evaluation Panel;

18. The Evaluation Panel met in Canberra during the period Monday 21 September to 23 September 1992. The three day program included:

- agreement by the Evaluation Panel on the proposed process

- meeting with MG&PG staff to outline the agreed process and to receive comment on any matters concerning the evaluation process and the CMP

  - at this meeting, two representatives from Coopers & Lybrand presented its findings and responded to questions from MG&PG staff relating to its report

- review of the Benefit Cost Analysis Report and interview with consultants

- review of submissions received

- presentations by MG&PG staff followed by questions from the Evaluation Panel

- agreement on key issues arising from the submissions

- development and clearance of an outline of the draft report and the schedule for completion of a draft Evaluation Report for the AGSO Advisory Council meeting, 6 November 1992.

AGSO Advisory Council meeting, 6 November 1992;

19. The draft evaluation report was tabled and discussed at the AGSO Advisory Council meeting on 6 November 1992. It was concluded at that meeting that:

- the report needed to be amended in consultation with stakeholders
- additional material required by the Department of Finance needed to be added
- more attention needed to be paid to quantification of the benefits of the CMP.

Current Status;

20. Under the direction of the Advisory Council, the report was reworked by AGSO's Corporate Relations, Information and Planning Branch, with detailed consultation with MG&PG staff. It was submitted to the 23 March 1993 Advisory Council meeting for their consideration and endorsement. The Advisory Council endorsed the Report, subject to some minor editorial changes indicated in earlier discussion and the provision of an implementation Report at the next Council meeting. The finalised Report was then negotiated with Panel members. Where agreement has not been reached, the Report reflects the divergence of views.

Comments on the Evaluation Methodology;

21. The Department of Finance representative on the Evaluation Panel has not been comfortable with the evaluation process as he feels that the role of the Evaluation Panel and the Advisory Council were unclear; this confusion will be eliminated in future AGSO evaluations.

22. Nevertheless, other members of the Evaluation Panel have expressed their satisfaction with the final result. The DPIE Petroleum Division representative went so far as to say that:

"The report has substance. The benefit cost analysis comes through reasonably well....The Report should withstand some fairly solid scrutiny and the authors are to be congratulated."

23. The Report was then forwarded to the Minister for Resources for information. It will also be forwarded to the DPIE Business Committee (via the DPIE Policy Co-ordination Branch) for consideration of corporate implications, and all people who provided a submission to the Evaluation Panel.

24. The final report will then be published as the first of AGSO's Records in its evaluation series and made publicly available through the AGSO Bookshop for the cost of reproduction, postage and handling.

25. The final report will be resubmitted to the next Advisory Council meeting along with a proposed management response and implementation strategy. These reports will also be forwarded to the DPIE Business Committee. Implementation progress reports for this evaluation will be tabled at (at least) the three following Advisory Council meetings to ensure that the evaluation is implemented. Copies of these reports will also be submitted to the DPIE Business Committee and the Department of Finance.

Costs of the evaluation

26. The cost of the evaluation to AGSO was estimated using those items of expenditure which were readily identifiable as directly attributable to the evaluation (Table 1). Staff costs were estimated by listing the staff involved, estimating how much time (in weeks) they spent working specifically on inputs into the evaluation and summing all of the contributions. The costs to other organisations of the involvement of their staff on the Panel and in responding to the request for submissions is not included.

Table 1: Estimated Costs for the CMP Evaluation

Item	Cost
Coopers and Lybrand Consultancy	$A44,926
Evaluation Panel meeting expenses	$A1,554
AGSO staff costs	$A128,458
Postage	$A500
Photocopying	$A2,000
Telephone	$A750
Total	**$A178,187**

PROGRAM BACKGROUND;

Objectives;

27. The socio-economic objectives of the CMP, as articulated in the 1991/92 Annual Work Program, are as follows:

- promote sustainable development of offshore resources
- provide the basic information necessary for the formulation of independent advice to government on offshore resource development.

28. The scientific objectives of the CMP, as articulated in the 1991/92 Annual Work Program, are as follows:

- develop a knowledge and understanding of the geological framework of the continental margins around Australia and its territories
- identify the petroleum and mineral resource potential of the offshore area
- develop models of the geological processes which have formed the Australian continental margin and led to economic accumulations of petroleum and minerals
- provide insights into the mechanisms and magnitude of past environments on the Australian margin

Background;

29. The Continental Margins Program (CMP) was initiated at Cabinet level, and is an important element in the Commonwealth Government's strategy to encourage the exploration for, and development of, Australia's offshore petroleum resources with a view to maximising oil self sufficiency well into the next century. It received strong support from the petroleum exploration industry in 1988 during the Woods' Review of BMR.

30. At present, 90% of Australia's petroleum production is derived from sedimentary basins on the continental margins (Gippsland Basin, North West Shelf, Timor Sea) and it is widely accepted that future large discoveries are most likely to come from offshore basins. However, the perimeter of offshore petroleum exploration has contracted over the last 10 – 15 years, leading to a narrower focus on those offshore basins currently perceived to be more prospective by the exploration industry. In the long term, it will be necessary to encourage exploration in areas now considered frontier but which are believed to hold the resources which Australia will need in the next century.

31. An outcome of the CMP is an increase in the amount of exploration in Australia's legal continental shelf which is around 12 million square kilometres under the 1982 UN Convention on the Law of the Sea. The CMP is designed to gain new insights into basin evolution and petroleum generation in:

- frontier areas (not previously explored)
- areas that have been explored but where companies are not now active
- currently explored areas where techniques not normally used by industry (eg, deep seismic profiling, sea bed and underway geochemistry) may be applied.

Activities;

32. New geological, geochemical and geophysical data relevant to petroleum exploration and prospectivity assessment are acquired on a regional basis from offshore areas using a dedicated geoscience research vessel, the RV *Rig Seismic*, which is fully equipped for modern 2-D seismic acquisition, deep sea sampling and continuous computer recording of other geophysical and geochemical data. The new data are integrated with existing exploration industry data to provide new basin analyses which may incorporate new ideas and understanding of petroleum generation and entrapment.

33. The CMP has been strengthened by Australian involvement in the multilateral Ocean Drilling Program (ODP) through a consortium arrangement with Canada. Under the ODP, the research vessel *JOIDES Resolution* has undertaken drilling off Australia and Antarctica including the Exmouth Plateau region off north west Australia in 1988 and north east Australia in 1990. ODP provides otherwise unobtainable insights into the geological processes and framework, resource potential and past environments of Australia's offshore areas.

34. However, the future of Australia's involvement in the ODP has been brought into question recently with the proposal by the Canadian Government to reduce its 2/3 share of the Canadian/Australian involvement. However, a new consortium may be assembled involving an Asian partner(s).

35. The data from the RV *Rig Seismic* are publicly released as soon as practical after completion of processing, generally within two years of field acquisition. Basin analyses and reassessments of petroleum prospectivity are publicly released within 2-3 years. Industry acquire these data and interpretations, integrate them with their own regional concepts and reassess the prospectivity for petroleum exploration of large areas of the Australian continental margin.

36. In 1991/92, the RV *Rig Seismic* collected new scientific data from a number of basins with special emphasis on the North West Shelf and northern Australia. In 1992/93, at the request of the Department of Foreign Affairs and Trade, the focus will be on the Christmas Island area and other areas where no sea-bed boundaries have been agreed with adjacent states. Other work will be carried out on the North West Shelf, the Sydney Basin and the Lord Howe Rise.

37. An emerging priority relates to modern marine processes. This development is a natural outcome of the need to understand the geoscientific aspects of Australia's offshore environment, the potential impacts of resource development and the recent history of climate and sea level change as recorded in marine sediments.

Program Structure;

38. AGSO is structured into two client oriented groups; the Minerals and Environment Group and the Petroleum and Marine Geoscience Group. The latter Group contains the Marine Geoscience and Petroleum Geology Program (MG&PG) which is responsible for the implementation of the CMP.

39. There has been some confusion as to what the CMP is and what the MG&PG is. The CMP is a group of projects designed to fulfil the objectives stated above (paragraphs 26-27). The MG&PG is the structural unit within AGSO which has been allocated responsibility for the implementation of the CMP.

40. The work of the MG&PG includes the projects designated as CMP projects in the 1991/92 Annual Work Program but there are other projects undertaken by the staff of the MG&PG which are not specifically related to fulfilling the objectives of the CMP. These are recorded in the 1991/92 Annual Work Program as follows but will not be specifically dealt with in this evaluation, except where they have implications for the performance of the CMP:

- CRC on the Antarctic and Southern Ocean Environment
- the Australian Antarctic Territory Margin
- SOPAC geoscience projects: petroleum and mineral resource framework of south west Pacific Island arcs and basins
- Rabaul Harbour heat flow survey
- Philippines offshore seismic project; regional petroleum exploration and evaluation of basin potential

Program Resources;

41. The budget outcomes for the MG&PG since 1989/90 are listed in Table 2. These figures do not include corporate overheads such as the delivery of engineering, cartographic and administrative services to MG&PG.

Table 2: Resources for the Marine Geoscience and Petroleum Geology Program

Item	Cost for 1989/90	Cost for 1990/91	Cost for 1991/92
Salaries	$A2,100,000	$A2,400,000	$A2,700,000
Administration	$A7,500,000	$A9,100,000	$A8,400,000
External funding (including S.35 income)	$A500,000	$A500,000	$A3,200,000
Total*	$A10,100,000	$A12,000,000	$A14,300,000

* The figures for 1989/90 and 1990/91 for external funding are estimates.

EVALUATION FINDINGS;

Is there a need for the AGSO CMP?;

42. To answer this larger question, the Panel had to deal with the following subsidiary questions:

- what are the needs to be met by establishing the CMP?
- what benefits are accruing to who?
- does the meeting of these needs and the delivery of these benefits justify the establishment of such a program?
- who should establish and run the program?

What are the needs being met by establishing the CMP?;

43. From the submissions, the Panel concluded that there was a wide range of needs relating to marine geoscience research in Australia's continental margin including:

- geoscientific data to improve offshore petroleum and mineral exploration efficiency
- geoscientific input into the inter-governmental negotiations concerning the delineation of Australia's sea bed boundaries
- geoscientific input in support of Australia's claim on its Legal Continental Shelf under the United Nations Convention on the Law of the Sea (UNCLOS)
- geoscientific input in support of decision making in relation to the establishment of marine parks and protected areas
- geoscientific input in support of strategic activities in Australia's continental and territorial waters, including the Antarctic margins and the Southern Ocean
- geoscientific input into assessing the impacts and managing the effects of offshore waste disposal and runoff, and offshore resource development
- undertaking research on marine geoscience aspects of global change
- increased understanding of fundamental scientific concepts in relation to the evolution of Australia's continental margins.

What benefits are accruing to who?;

44. There is a clear public good aspect to the CMP through the wide publication and dissemination of geoscientific information and bathymetric maps, with benefits accruing to many sectors of the economy. These are summarised below in

terms of benefits and beneficiaries although clearly many of the categories are interlinked and not mutually exclusive.

- improved exploration efficiency for resource exploration industries
- improved service efficiency of exploration service companies
- improved estimates of Australia's offshore resource (petroleum) potential for Commonwealth government departments (DPIE) concerned with Australia's long-term energy policy
- better planning and regulation of resource (petroleum) exploration and development activity by provision of technical advice/information to Commonwealth departments (DPIE) and State and Territory government departments acting as designated authorities for the Commonwealth (State and Territory mines departments)
- favourable international/national outcomes for Australia by provision of geoscientific information to aid negotiation and definition of Australia's sea-bed boundaries by Commonwealth government departments (DFAT, A-G's)
- favourable international outcomes for Australia by maintaining a scientific presence ('waving the flag') around Australia's remote island territories for Commonwealth government departments (DFAT, A-G's)
- improved management of Australia's maritime jurisdiction by provision of bathymetric/geoscientific information to Commonwealth government departments (AMSA – transport and communications; RAN Hydrographic Office – safety and defence; AUSLIG – mapping and establishing jurisdiction) concerned with Australia's offshore territory
- improved management of Australia's marine environment by provision of technical advice/information to Commonwealth (DEST; Australian National Parks and Wildlife Service) and State government departments and agencies concerned with changes and use of the marine environment
- an ecologically sustainable (well managed) Australian deep sea fishing industry by assisting with policy development through the provision of bathymetric information/maps to Commonwealth government departments (AFMA – DPIE) concerned with deep sea fisheries
- assist identification of new deep sea fishing areas by provision of a bathymetric map series for the deep sea fishing industry
- advancement of scientific knowledge by publication, training and co-operative studies for and with the scientific community.

45. The benefits listed above (paragraph 44) tend to fall into three categories – benefits that directly relate to the expected production of a marketable item (petroleum, fish, an exploration technique, etc); benefits that accrue to Government programs which would have to find some other (generally more expensive) way of acquiring the data and advice; and benefits that accrue to the scientific community (see Table 2, Appendix D).

Benefits that directly relate to the expected production of a marketable item;

46. The first type of benefit – those that directly relate to the expected production of a marketable item – may be amenable to benefit cost analysis. Such an assessment could follow the model recently applied by the Bureau of Industry Economics to some CSIRO research programs (BIE Research Report 39, 1992). In these analyses, both the public and private components of product development are considered together.

47. The value of the CMP information could be isolated by using scenarios with and without the existing CMP. The scenarios would include an evaluation of the projected benefits and costs of petroleum production, if petroleum exploration and projected production in the areas covered by the CMP would not occur, or if costs were to be higher due to exploration being less efficient. The latter would take account of cost savings to government and industry of having greater knowledge of which areas are or are not prospective.

48. However, difficulties in applying benefit cost analysis include the long timelag between acquiring and releasing data and any petroleum production, and the uncertainty involved in projecting any future petroleum production. Therefore, development of a benefit cost analysis is possibly not justified, given the degrees of uncertainty involved.

49. In Appendix D, a more constrained indicator is developed – that of costs and returns to Government from petroleum production. A shortcoming of this indicator is that it may miss out some important social benefits and costs. Possible future benefits in the form of resource rent tax have been estimated based on current exploration expenditure to returns from production.

Benefits that accrue to government programs;

50. The second type of benefit – those that accrue to government programs which would have to find some other (generally more expensive) way of acquiring the data and advice – would not appear to be amenable to formal benefit cost analysis. An important criterion that distinguishes benefits that fall within the first and second types of benefit is that, in the second type of benefit, the CMP provides a data acquisition service to Government agencies, other than AGSO, who need the data to fulfil their own program objectives.

51. It has been suggested that cost effectiveness analysis would be better alternative to benefit cost analysis to assess this second type of benefit. Other than the petroleum industry, the major direct user of information is government

(particularly Commonwealth); the major users are listed in Table 2, Appendix 2. The CMP can deliver economies of scale in the provision of specific information that, in the absence of the CMP, would require the contracting of specific purpose commercial cruises. Contributions to other government agencies in the form of free advice is also listed in Table 2, Appendix 2.

52. A further point to be made here is that it is not necessary for this evaluation to demonstrate the appropriateness, relevance or effectiveness of the objectives of these programs as they are within the bailiwick of organisations outside the direct influence of the MG&PG and AGSO. It is merely important to demonstrate that there are savings to be made to the public purse by these other organisations using the data from the CMP and the advice of its staff rather than acquiring the data or advice from some other source. An attempt to quantify those savings is in Appendix D.

Other benefits;

53. The third category includes those benefits which accrue to individuals whose primary objective may not be to produce a marketable product or to contribute to a Government program. This category would include scientific researchers in universities who may benefit from having access to CMP data but whose research may result in advances in other fields such as the fundamental understanding of marine geoscientific processes. This outcome may ultimately contribute to a first or second category benefit but that would be serendipitous. Other benefits in this category accrue to people who work within the MG&PG.

Does the meeting of these needs and the delivery of these benefits justify the establishment of such a program?;

54. The overwhelming conclusion the Panel drew from the above is that there is a need for the CMP. The next question to answer is whether the meeting of the needs identified above is important enough for money to be invested in a CMP.

55. The CMP produces information which is utilised in a number of ways, some of which may culminate in the production of a market good (petroleum, fish, etc) and other ways which produce benefits that are less able to be measured in dollar values. However, it is probably not possible to quantify in dollar terms all the benefits arising from the CMP. The Panel notes that, in their study of the CMP, Coopers & Lybrand noted:

"Notwithstanding that the benefits of the Continental Margins Program could not be quantified in dollar terms, the analysis has revealed an outstanding list of benefits that have been realised from the outputs of the program".

56. Nevertheless in Appendix D, under the explicit direction of the Advisory Council, AGSO has attempted to derive measures of benefit to beneficiaries of the CMP. Some of these measures are necessarily indirect and circumstantial, others are anecdotal, and some provide more quantifiable links between the CMP outputs and benefits.

57. AGSO believes that this evaluation methodology needs to be further developed to deal effectively with this type of program. The Department of Finance, although strongly supportive of AGSO's attempts to provide a benefit cost analysis for the CMP, concurs with this view and believes that the work requires considerably more development and, as the framework presented is unprecedented, that caution is warranted on the conceptual and empirical analysis.

A note on benefit cost analysis

Benefit cost analysis is an economic analysis technique which employs a defined methodology to measuring and comparing benefits and costs of projects or programs. Measurements are made in dollar terms using discounted net present values of future streams of benefits and costs. This comparison is usually made in the form a benefit cost ratio.

The point of reference of a benefit cost analysis is usually that of a nation state, in this case Australia. Thus benefits and costs occurring outside Australia, for example profits transferred out of the country, are excluded from the analysis. Benefits and costs are measured from a social perspective regardless of whether the program is a public or private venture. Costs such as environmental damage should therefore be included whether or not they appear as a direct cost to the agency undertaking the project. Intermediate services, such as those provided by exploration service companies, are included in the analysis.

An important aspect of this approach is that taxes paid to Government, that is taxes paid on value added, not fees for services, are included in the benefits despite the fact that the taxes are costs to private industry. In the case of the petroleum industry, resource rent taxes and other taxes on profits may represent the major social benefits to Australia where overseas companies and investments are involved.

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(1993)

58. Nevertheless, it is clear that the nature of the benefit will vary from one group to another. For example, consider the situation in which CMP outputs result in improvement and refinement of estimates of Australia's undiscovered petroleum resources. To Commonwealth Government departments concerned with Australia's long-term energy policy, such improvement can be of real benefit to the policy making process and long term considerations of the supply/demand situation. Such an approach denies the real gains which Australia obtains from improving the efficiency of commercial and regulatory activity.

59. It does not really matter to the policy department whether the resource estimate is increased or reduced as a result of the CMP but simply that it is a better more refined estimate than before. The improvement is not realisable by the department in financial terms, but is nevertheless beneficial to it carrying out its function. Also, the provision of such information to the department does not strictly fulfil all the normal criteria of a public good or service.

60. Similarly, if the same information refining Australia's undiscovered resources was provided to an exploration company it would also not be a benefit to the company in terms of a direct realisable financial return. However, it may well help the company plan its future exploration strategy resulting in efficiencies in

its exploration program, which, in turn, could be financially realised at some time in the future. Such information can be considered to be an intermediate benefit to the company.

61. Hence CMP outputs that may be of real benefit to government may only be of intermediate benefit to exploration companies, and may not be realisable by either as a direct financial benefit. In Appendix D, however, AGSO views such outputs and outcomes as being valid benefits to the general petroleum industry.

62. The list above includes two major benefits which the Advisory Council believes demonstrate that the CMP is important enough for money to be invested in it:

- offshore petroleum and minerals exploration efficiency
- advice to government on Law of the Sea and in support of sea bed boundary negotiations.

Offshore petroleum and minerals exploration efficiency;

63. In relation to the petroleum and minerals exploration industry, the existence of the CMP enhances Australia's attractiveness as an offshore exploration investment destination. Other countries provide various incentives for exploration companies to operate in their countries including taxation, fast tracking of development approval, development assistance, infrastructure support and the provision of baseline geoscientific data.

64. Private investment in exploration is governed by three key factors – estimated exploration and development costs, assessed after tax profitability and assessed exploration risk. An important factor in the assessment of risk is the amount of geoscientific information available; the more information available, the better.

65. The provision of baseline geoscientific data from the CMP improves exploration efficiency in Australia, in that current and potential investors have more and better information with which to make investment decisions, and reduces the perception of high risk which has popularly been associated with Australia's offshore basins.

66. If this information was not provided, then Australia's attractiveness for offshore petroleum (and mineral) exploration companies would be reduced. This would result in a drop in private investment in a sector which, according to ABS Bulletin 8412.0, spent $A338.8 million in Australia in 1991/92.

67. The total cost of the CMP in 1991/92 is estimated at $A20.7 million, however, it is estimated that only 60% ($A12.42 million) of the CMP effort is directed towards petroleum exploration related outcomes. Therefore, a drop of any more than 3.7% (=12.42/338.8) in private sector investment in offshore petroleum exploration in any one year, due to any changes to the CMP, would be greater than cost of the petroleum aspects of the CMP in 1991/92.

68. The Advisory Council believes that the contribution of the CMP to the attractiveness of Australia as an offshore petroleum exploration target is much greater than 3.7% and therefore the CMP is worthwhile.

69. The Panel based its conclusions on the Coopers & Lybrand study, where support from industry and Commonwealth Government users of CMP data was expressed. They concluded that the CMP has contributed substantially to the commitment of exploration expenditure. Additional material subsequently provided by AGSO on the benefits of the CMP supports this conclusion (see Appendix D).

70. The Panel concluded from the submissions and the Coopers and Lybrand study that the CMP has been effective from the industry's perspective in stimulating petroleum exploration activity, in gathering valuable geoscientific data and in undertaking research in "frontier" areas related to the potential for petroleum in Australia. The Panel noted that work on sedimentary minerals had been of limited extent.

Advice to government on Law of the Sea and in support of sea bed boundary negotiations;

71. Substantial morphological and geological data and expertise are required to support sea-bed boundary negotiations with adjacent countries and to allow Australia to maximise its Legal Continental Shelf claim under the 1982 UN Convention on the Law of the Sea.

72. These data are only available in Australia through the CMP. No other publicly owned research or survey vessel has the minimum seismic survey system capable of determining the sediment thickness to the extent required.

73. The Panel also found that the 1989 paper by P A Symonds and J B Willcox – "Australia's Petroleum Potential in Areas Beyond an Exclusive Economic Zone" BMR Journal of Australian Geology & Geophysics, Volume 11, Number 1 – was of considerable assistance to government departments when considering maritime jurisdiction issues.

74. According to the 1991/92 DPIE Annual Report, over $A1 021 million was collected in resource rent tax, excise and royalties during that year. According to ABARE's Quarterly Mineral Statistics (Vol 4, No 3), petroleum production for this period amounted to 31.3 million kilolitres of crude oil and condensate, of which the three main producing areas were the Bass Strait fields in the Gippsland Basin (16.9 million kilolitres or 54%), the Carnarvon Basin fields (7.3 million kilolitres or 23%) and the Bonaparte Basin (3.8 million kilolitres or 12%). The return to Government was therefore around $A31 for each kilolitre of oil produced.

75. Coopers and Lybrand have suggested that the total cost of the CMP in 1991/92 was $A21 630 722. Therefore, based on historical figures, the exclusion from Australia's maritime jurisdiction of just one offshore oil field of around

0.7 million kilolitres (or just over 2% of total 1991/92 production) due to the cessation of the CMP would, over one year, be a greater cost to the Government in foregone revenue than the total cost of the CMP in 1991/92.

Conclusion;

76. The Panel therefore accepted that the CMP is a worthwhile program to undertake and has no doubt that the CMP should continue. On the basis of the core objectives and the need for data on Australia's continental margin and the other needs identified above, the Panel also concludes that the CMP should be regarded as a national priority. However, there was debate within the Panel as to whether the direction should remain as it is or move more into environmental research. The majority, however, favoured little change.

Who should establish and run the program?;

77. So far, it has been suggested that there are needs to be met by the CMP and that establishing the CMP to meet these needs is a worthwhile decision to take. However, who is the most appropriate agent to undertake the Program? Several options are available:

. public or private?

. if public, the Commonwealth or the States and Territories?

Public or Private;

78. The CMP contributes raw and interpreted data to many different clients, including a wide range of Government programs, industry, the academic community and the public. However, should it be carried out by Government?

79. In providing CMP data to be used in the Government decision making process and the subsequent management of development, AGSO contends that, although the CMP is not exclusively a "public good" program as many of its products can be, and are, sold even if at a non-commercial price, its outputs underpin the delivery of Government programs in a range of portfolio areas (DPIE, DEST, DFAT, A–Gs, DoD, etc). These programs fall quite comfortably within the range of functions described by Dolan[1] which need to be carried out by Government.

Public Good;

80. If it can be demonstrated that the CMP is a public good, it more than likely demonstrates that the private sector will not provide the service. It does not necessarily demonstrate, however, that Government should provide the service. Theoretically, only if the fulfilment of the objectives of the CMP are perceived by Government decision makers to be more desirable than the

[1]Dolan, EG (1977); Basic Economics

fulfilment of the objectives of competing public good services should the CMP be funded. Discussion of this issue is beyond the scope of this evaluation, although the information collected will be valuable inputs into this decision making process.

The Role of Government

In a pure market economy, there would probably be no need for Government. However, there is no such thing as a pure market economy and Dolan contends that the Government has a major role to play where the market fails in fulfilling the following five functions:

- the provision of public goods
- the transfer of income and wealth from one citizen to another
- the stabilisation of the economy by controlling unemployment, inflation, growth, etc
- the regulation of private business
- the administration of justice.

81. By definition, public goods cannot be provided to one citizen without being also supplied to that citizen's neighbours and, once provided for that citizen, the cost of providing them to others is zero. Public goods are traditionally provided by Government because their special properties make it hard for private businesses to market them profitably.

82. The CMP itself is almost but not quite consistent with Siegler's[2] definition of a public good used by Coochey[3] in his evaluation of the RAN Hydrographic Program. However, if the Government programs which are underpinned by CMP data are measured against Dolan's functions of Government, it is clear that they are, and by implication the CMP probably is, appropriately carried out by Government.

83. If the CMP information is supplied to DFAT to assist with their UNCLOS negotiations (intrinsically a pure public good), such supply of data does not reduce the amount of data available to other clients or prevent:

- DPIE's MinFish Petroleum Division from using it in the policy development process relating to their offshore acreage release program (stabilisation) or administration of offshore petroleum exploration (regulation)
- AFMA from using it in fisheries management planning (regulation)

[2] Siegler, SE; The Dictionary of Economics and Business

[3] Coochey, J (1992); An economic analysis of the benefits of the RAN Hydrographic Program

. the RAN Hydrographic Office from using it to improve bathymetric maps (public good).

What is a public good?

Siegler describes public goods as goods or services "that cannot be priced accurately and hence cannot be efficiently supplied by private industry". They are further described in terms of several key characteristics:

. non-diminution in consumption; consumption of a public good by one individual does not diminish the amount available for other individuals

. non-rivalness in consumption; once a public good is supplied to an individual, it can be supplied to others at no extra cost

. non-excludability; individuals cannot be deprived of a public good even though they may refuse to pay for it

. impossibility of rejection; individuals cannot reject the public good, even though they may wish to.

84. Also, providing this data to Government programs does not prevent offshore petroleum exploration companies from using the information to develop their exploration strategies. Information collected by Coopers and Lybrand[4] suggests that industry would not carry out the work currently undertaken by the CMP if the CMP did not exist as the costs are high and outputs are of such a nature as to make it very difficult to internalise the benefit, exclude others from profiting and obtain a return within a commercially acceptable timeframe. In relation to data to underpin offshore petroleum exploration, it is therefore a text book example of where the market fails and Government must intervene.

85. Again, borrowing from Siegler's definition of a public good, if an individual refused to pay for the Government program underpinned by CMP data and advice, the Government could not exclude that individual from the benefits that accrue to the nation from the program. Similarly, individuals cannot choose to reject the benefits of the program although not making use of the CMP outputs directly themselves.

Stabilisation of the economy;

86. Expensive regional data, such as that produced by the CMP, are not collected by exploration companies except in areas over which they hold tenure. New exploration ventures begin with a statistical assessment of the probability that hydrocarbons exist in a particular area being offered for exploration. These assessments are based to a large degree on publicly available data. If the risk assessment is acceptable, the company will attempt to obtain tenure; if not, the company will look elsewhere. Any increase in the quantity and/or quality of publicly available data therefore reduces the assessed risk.

[4] Coopers and Lybrand (1993); Benefit Cost Analysis of the Continental Margins Program

87. The geological risk accepted by Government is relatively small because it is spread over all basins on the continental margin and the ultimate return to Government in the form of taxes from any subsequent petroleum production is much higher than that received by any individual corporation. Clearly then, compared to any private company, the CMP is operating in a low risk, potentially high return, low investment area.

88. Data on frontier fields are only available in Australia through the CMP. CMP data on surveyed fields is considered in addition to data lodged under the *Petroleum (Submerged Lands) Act* but is of special value as a result of its regional coverage. No other research or survey organisation or vessel has the mandate to carry out such work.

89. Individual companies are reluctant to do their own framework studies prior to taking up ground because of the very low internalisation of benefit from such work. There is strong competition for exploration investment funds between countries; good publicly available framework studies, such as that provided by the CMP, encourages companies to invest in Australia.

90. Therefore, the possibility of the CMP becoming a private undertaking is not realistic; this view seems to be confirmed by overseas experience. Even leaving aside the probability that many of the public benefits of the CMP would not be met if the work was undertaken privately, as a result of commercial pressures to keep data confidential and internalise benefits, feedback from the offshore petroleum exploration industry to Coopers and Lybrand suggests that, even though they believe the CMP to be a valuable program, industry would not consider undertaking this type of work. Industry noted that:

- the CMP provides pre-exploration data which enables explorers to make investment decisions
- the CMP provides an incentive for petroleum explorers to work in Australian waters rather than elsewhere
- the returns to industry from this kind of activity would be so far into the future and so strategic in nature as to render investment of this type unprofitable.

91. The Panel concluded therefore that the CMP is most appropriately funded publicly.

Commonwealth or State function;

92. The public good aspect of geological surveys in general, and marine geological surveying in particular, appears to be recognised world-wide, therefore many national governments support such activities because the knowledge derived:

- underpins important resource export industries

- supports resource, land/marine and environmental management
- contributes to meeting international obligations.

93. Marine geological surveying is fundamental to answering questions as basic as "what are the limits of Australia's territory and jurisdiction?" The limits of Australia's land territory are readily recognised by its coastline but definition of its adjacent marine territory requires geoscientific mapping beneath vast tracts of ocean. Whilst there are many ways of acquiring such information, through both government agencies and private contractors, the overall responsibility for such activities is generally seen as that of central government.

94. The CMP involves the collection of data over Commonwealth land, Australia's "legal continental shelf" more than three miles offshore, following the Constitutional Settlement between the Commonwealth and the States in 1979. While there are benefits to the States arising from offshore exploration activity and development, historical precedent, declining funding to State geological surveys and the fact that sedimentary basins follow geological rather than political boundaries as well as the logistics of multiple administration of a single vessel strongly indicate that the CMP must remain a Commonwealth Government program.

Are CMP objectives relevant to needs?;

95. The Panel considered that the CMP exists to optimise the economic and social value of Australia's natural and mineral resources offshore, consistent with the principles of ecologically sustainable development. The Panel also felt that MG&PG should stress the broader economic and social value of the CMP in its promotional and scientific literature.

96. The CMP also helps to establish the scientific basis for Australia's claim to its legal continental shelf through geological research and the provision of scientific information and advice. The Panel also noted that the objectives of the CMP had evolved in recent years to allow a more environmental focus.

97. However, there is still much to be done in the fields for which the CMP was originally established. In light of the considerable support for the existing priorities and the needs identified above, the Panel concluded that the socio-economic objectives for the CMP should be:

To provide geoscientific information and advice, consistent with the principles of ecologically sustainable development, to:

- *improve offshore petroleum and mineral exploration efficiency and effectiveness*
- *support Government decision making on offshore petroleum and mineral exploration and development*

- *maximise and sustain Australia's legal continental shelf claim in preparation for when UNCLOS comes into force*

- *support inter-governmental negotiations between Australia and its nearest neighbours on the delineation of sea-bed boundaries*

- *assist with resource and environmental advice in relation to marine parks and protected areas.*

98. The Panel further concluded that the scientific strategies for the CMP to fulfil the above objectives be to:

- deliver a knowledge and understanding of the geological framework of the continental margins around Australia and its territories

- identify the petroleum and mineral resource exploration potential of the offshore area

- develop models of the geological processes which have formed the continental margin and led to economic accumulations of petroleum and minerals.

99. The Panel, however, noted that recent CMP literature emphasised that the Government is interested in "maximising oil self sufficiency well into the next century" and that this is an incomplete statement of Government policy on petroleum exploration. The Government's policy is to promote the efficient exploration and development of petroleum exploration and the efficient use of other resources (labour and capital) for the benefit of all Australians.

100. Currently, the CMP is specifically funded to fulfil the above priority objectives. However, any further work in the marine environmental field unrelated to marine protected areas should result from an explicit Commonwealth Government decision matched by extra funding or be clearly funded from external sources separate from the core appropriation for the CMP. All other environmental work should be externally funded and international work funded on a full cost recovery basis.

101. The Panel noted that the AGSO commitment to the Antarctic CRC was entered into in the belief that its activities were valuable to the nation and that AGSO's involvement would strengthen the CRC and the core CMP. However, new funding was not provided, thus constraining core CMP work. The Panel recommends that such decisions not be made in future.

102. Other needs were considered worthy of consideration for the expansion of the CMP, subject to the appropriation of additional resources for such purposes, and should be considered depending upon the opportunities and capabilities of the CMP as circumstances dictate. However, the focus of the CMP should remain on the agreed objectives described above.

103. The Panel was concerned that the lack of adequate core funding and the need to obtain extra funding to make the ship operations cost effective was pushing, or had the capacity to push, the CMP away from fulfilling its core objectives. This was seen by the Panel to be a major issue.

Are the CMP objectives being achieved in the most efficient and effective way?;

104. The two major questions that arise in looking at the efficiency and effectiveness of the delivery of the CMP relate to the two major costs – the method of data acquisition and the method of data processing. Specifically:

- is the RV *Rig Seismic* the most efficient and effective way of acquiring the data required to fulfil the objectives of the CMP?
- are the current data processing arrangements the most efficient and effective to fulfil the objectives of the CMP?

Data acquisition - the RV *Rig Seismic;*

105. Information for this section of the Report is drawn largely from the submissions from David Falvey, Associate Director – Petroleum and Marine Geoscience (Appendix E) and Roy Whitworth, Manager – Ship Operations, MG&PG (Appendix F). It must be pointed out that this information, along with Appendix D was not available at the time of the meeting of the Evaluation Panel; the collection of this information was specifically requested as a result of the consideration of the draft Report by the Advisory Council at their November 92 meeting.

Non seismic data;

106. The Panel found that it was difficult to assess the efficiency and effectiveness of non-seismic operations (geological, geochemical sampling; gravity, magnetic, heat flow, bathymetric data acquisition) in the absence of a suitable benchmark and makes a specific recommendation for regular technical audits of non-seismic acquisition to address this issue. The scientific value of this work needs to be considered in the context of the quality and relevance of reports and advice coming out of the CMP.

Seismic data;

107. There have been concerns about the quality of seismic data collected by the RV *Rig Seismic*. The Panel noted that the seismic operations of RV *Rig Seismic* were conducted to commercial standards and that the rate, quality and cost of seismic acquisition was comparable to industry equivalents. Subsequent figures available from the final draft of the Coopers and Lybrand study (Appendix C) suggest that the rate, quality and cost of seismic acquisition may actually be cheaper than industry equivalents.

108. The Advisory Council noted that the operational efficiency of the RV *Rig Seismic*, in terms of kilometres shot per cruise, had improved since the CMP's commencement and that the ship managers felt that further efficiencies were available.

109. However, concern has been expressed that current arrangements to charter and operate RV *Rig Seismic* were inappropriate, and that AGSO will slip behind industry standards for seismic acquisition. A question has therefore been raised that the RV *Rig Seismic* charter could be terminated and AGSO move to contract operations for both seismic and geological acquisitions offshore. This concern has been expressed on several previous occasions.

110. There are compelling arguments, however, for both continuing with the RV *Rig Seismic* and planning for an eventual replacement, rather than contracting out. It should be noted that the largest single component of marine operations is already out-sourced – namely ship charter and maritime (ie non-scientific) operations. The cost of this component, $A5.4 million in 1992/93, is the main discretionary element of the CMP budget allocation from which the cost of contracting and the costs and penalties of decommissioning RV *Rig Seismic* could be found.

111. In order to fulfil the objectives of the CMP (see paragraph 94), specific operational systems and methods are required:

- multi-channel seismic acquisition – long, regional lines tying existing wells where possible; extending into very deep water; involving extended record lengths of up to 16 seconds, and an energy source designed to give deep penetration

- high-resolution multi-channel seismic acquisition – focusing on the "post-break-up" sedimentary cover; stratigraphic relationships and evolution; definition of geological/geochemical sampling targets; involving 0.5 to 1 millisecond sampling and short record lengths of 1 to 2 seconds; the high-resolution energy source is changed to meet the problem

- underway geophysics/geochemistry – routine gravity, magnetics and bathymetric data acquisition, contributing to the national database; targeted trace hydrocarbon anomaly detection ("sniffing")

- sea-bed sampling – coring, dredging and heat flow measurements in water depths of up to 7 000 metres.

112. This workload could readily keep one research vessel fully occupied for many years. Apart from the RV *Rig Seismic*, there is no single vessel of any kind in Australia, or the region:

- specifically configured for the deep seismic acquisition mode, although several contractors could presumably meet these specifications at a price. None, however, could meet the full spectrum of functions performed with existing vessels.

- currently configured for high resolution seismic acquisition and geological/geochemical sampling; a key factor is that the CMP regional focus does not require 3-D acquisition or intermediate resolution 2-D acquisition, where the focus is prospect definition in the 1 to 4 second depth range.

The difference between 2-D and 3-D seismic

It is important to differentiate between 2-D and 3-D seismic acquisition and the overheads involved. The equipment used is essentially identical, but the intensity of acquisition is different.

The RV *Rig Seismic* could shoot 3-D seismic, albeit inefficiently. A 3-D boat could shoot 2-D seismic but, because of the huge investment of equipment for 3-D work (4 seismic cables and up to 8 airgun arrays worth $A20-50 million compared to $A5-10 million for 2-D), the overheads would make it uneconomic; it would be like using the latest computing technologies for basic word processing.

To AGSO's knowledge, all seismic vessels in the Australian region have been converted to 3-D operation because of the lack of a viable market for commercial prospect based 2-D operations.

113. Geological acquisition of the type required by the CMP can only be done on a specialised vessel. Comparison with international geoscience agencies shows RV *Rig Seismic* costs to be comparable with vessel operating costs in France and the United States, and markedly cheaper than those in Japan. Each of these agencies undertakes regional seismic surveys and employs only 2-D equipment. Australian productivity on the RV *Rig Seismic* is considered to be very high.

114. With the erratic demand for their services, commercial seismic contractors must often take those jobs on offer as they come up. They cannot wait for the large jobs with the comfortable profit margins. To get work done exactly when required usually costs a premium, such as to bring a vessel in to meet the time constraints. Otherwise, one waits in the queue. AGSO not infrequently has demands arising at short notice to meet government priorities to which it is able to respond by rescheduling cruises. It would be more difficult and expensive to reschedule cruises in a commercial environment.

Recent improvements to the RV *Rig Seismic;*

115. When operations started with RV *Rig Seismic* in 1984, the demands of the regional geophysical and geological survey work were relatively low key. However, following the Woods Review, there has been a major effort to bring the equipment up to a level comparable to that needed by industry to better

meet the changing requirements. This upgrade is now essentially complete and includes:

- a commercial differential GPS navigation system that provides 5-10 metre accuracy anywhere around the Australian continental margin; this offers accuracy approaching that of radio navigation, at a fraction of the price, and is gradually being accepted world-wide

- sleeve gun arrays – these use the types of air gun that have almost become the industry standard because of their reliability and efficiency in the use of high pressure air

- a transformer-less seismic streamer cable with 288 seismic channels – this top end analogue cable is now giving noise levels comparable to those of digital cables costing at least twice the price; the best deep seismic penetration in Australia has been obtained by the RV *Rig Seismic*

- compass units and an active tailbuoy to accurately position the cable to make its output compatible with the 3-D seismic data collected by industry.

116. The Panel also noted that staffing levels have been increased to cope with increased sophistication and quality control in shipboard operations.

117. Over the years, considerable assistance has been willingly provided by several major equipment suppliers. The active co-operation of Teledyne Exploration, Halliburton Geophysical Services and GECO has helped us ensure that the vessel is fitted out to best advantage. The involvement of, or advice from, other companies such as Syntron and Western Geophysical has also been of benefit to the CMP.

118. It is generally considered that it takes about five years to bring a boat up to a level where it produces quality results. By utilising the resources and expertise of these companies, AGSO's path has been smoothed considerably and the RV *Rig Seismic* now produces data of a comparable quality to industry.

119. AGSO therefore contends that any concern over the quality of seismic data has been laid to rest with the upgrade which is now essentially complete. Occasional critical comments on data standards presumably come from assessment of published seismic data which was collected largely before the Woods Review which, while adequate for many of the CMP's objectives, did not necessarily reach industry standards.

Comparisons with commercial operators;

120. The CMP's deep multi-channel seismic acquisition costs in 1991/92 were around $A600/kilometre. This is arguably below comparable commercial data acquisition costs in Australian waters and on the low end of the commercial

range in South East Asia, despite the vessel being geared to multi-purpose operations which necessarily carries a premium.

121. The quality of current CMP deep regional seismic data must be judged against its purpose for basin (not prospect) analysis. Over the last 12 months, AGSO has been highly praised by industry for the quality of its CMP data (particularly surveys 101 and 110). This has been reflected in data sales (AGSO share) of $A383 000 in the first half of 1992/93.

122. AGSO has also been recently asked to tender for regional seismic acquisition in Vietnam by both PetroVietnam and NOPEC on a commercial basis. Also, the Philippines data have been acknowledged as the best in the region.

123. In summary, current indications are that one-off costs to AGSO of contracting out offshore seismic and related data acquisition could run between $A8-10 million. Without additional funds, this would require suspension of the program for 2 years and provide program platforms of uncertain or lesser capability and possibly higher cost.

Comparison with the RV *Franklin;*

124. The smaller CSIRO vessel, the RV *Franklin* (length 55 metres), is not currently equipped to carry out the high-resolution seismic and geological/geochemical role. Recently, CSIRO sought (unsuccessfully) some $A4 million to extend its oceanographic role through major refit and hull "stretching".

125. It is clear that funds of this magnitude would be required just to modify the RV *Franklin* to provide a platform equivalent to the RV *Rig Seismic*. In addition, several million dollars extra would be required to install the existing deep sea winch and at least 2 compressors, and permanently equip a geophysical and geochemical laboratory.

126. Additional costs would be incurred in working the vessel up to the performance level currently available on the RV *Rig Seismic*. At the end of the day, the best advice available to AGSO casts doubt on the operational viability of such a refit. The nearest comparable vessel world-wide is the *Moana Wave* (Hawaii Institute of Geophysics, length 64 m), a vessel fundamentally more robust and flexible than the RV *Franklin* could ever be.

127. It is also worth noting that the RV *Franklin* day costs are currently (without refit) only slightly less than those of the RV *Rig Seismic*, and that it carries the same number of crew but has much less room for scientists. Also, an additional 2 to 3 months cruise operations per year on the RV *Franklin* would inevitably be affected by the requirements of the existing 6 months of oceanographic program.

Possible new vessel for AMSA;

128. A preferable option, and one that could potentially carry out some of the activities of the RV *Rig Seismic* in the longer term (ie, beyond 1996/97), is a new vessel that the Australian Marine Safety Authority (AMSA) has exchanged contracts on which will be delivered in 1994. This vessel would be of comparable size to the RV *Rig Seismic*, and could be made available by AMSA for several months each year. However, it will be fully occupied on maritime safety work for AMSA for the first two years of its operation and would not be as efficient as the RV *Rig Seismic* without substantial "working up".

Other advantages of the RV *Rig Seismic;*

129. Every other major marine geoscientific agency (USA, Canada, Japan, France, Germany and UK) operates one or more dedicated multi-role marine geoscience vessels. The principal reasons are an ability to:

- fine tune an institutional platform to institutional program needs
- schedule a complex formal scientific program with confidence.

130. The RV *Rig Seismic* occupies a niche in the market that would be difficult to service by using a seismic contractor and another vessel to provide the geological capabilities. There are other benefits, in that the money spent and the expertise developed is retained within Australia, even when operating in foreign waters such as is the case with the Philippines project.

131. In terms of Australia's foreign development assistance objectives, the RV *Rig Seismic* has been a very high profile platform for projecting Australian scientific and technological capabilities. AGSO contends that AIDAB will not be as enthusiastic about future Philippine-type regional programs if the platform is a US, French or Norwegian contractor.

132. It also provides a mechanism for training Australian scientists and technicians that gradually spreads out to the industry. Exposure to training and operations by foreign nationals influences them in AGSO's and Australia's favour, and opens up special opportunities for Australian industry to penetrate foreign markets again such as in the Philippines project.

133. The one-off costs of decommissioning RV *Rig Seismic*, re-delivery of the vessel to Norway and paying the penalty for mid-term termination of the charter are estimated at $A3.5 million (see Appendices F and G).

Optimum arrangements;

134. The Panel noted that the issue of under-utilisation because of under-funding has been recognised as a significant problem for the operators of all civilian research vessels in Australia and has been the subject of several representations to Government through Heads of Marine Agencies and the Co-ordinating Committee of Science and Technology.

135. For MG&PG, the target for maximising the cost effectiveness is 270-320 days each year on the basis of 240 days effective data acquisition each year. There is considerable potential demand from outside the CMP for the use of a vessel with the RV *Rig Seismic*'s capabilities. AGSO believes that:

- 180 days should be dedicated to the CMP (the original scope of operations established in 1983 and renewed in 1988, but more than can be managed with present funding and staff)
- 30 days should be dedicated to its role as a national facility
- 30 days should be dedicated to other contracts, including AIDAB.

136. The remaining time would be spent in major transits, refits in a ship yard, and trials which are essential for a research vessel with continually changing demands, plus the necessary time in port for crew change and minor repairs. (see Appendix E).

137. The Panel concluded that, at that stage, the RV *Rig Seismic* is the most effective and efficient option for fulfilling the data acquisition objectives of the CMP but recommends that core appropriation funding be allocated to ensure that the CMP has a minimum of 150 days effective data acquisition each year.

138. In order to carry out a balanced program in the national interest, core funding for the RV *Rig Seismic* should be increased to the level originally agreed by Cabinet so that at least five full funded cruises (150 cruise days) can be carried out each year. In 1993/94, this would amount to an increase of about $A2 million.

139. A replacement for the RV *Rig Seismic* needs to be programmed before the end of its operating life in 1998. A New Policy Proposal (NPP) is therefore required for the acquisition of a replacement vessel for the RV *Rig Seismic*. As an NPP, the submission will be subject to New Policy Proposal rules including offsets.

140. The requirement is for replacement of the RV *Rig Seismic* in 1998 with provision of an appropriate platform to allow the continuation of the CMP with its core objectives (see paragraph ??).

141. The RV *Rig Seismic* and its long term replacement will provide a marine geoscience capability across the complete section of marine geosciences to give Australia the ability to understand its vast Economic Exclusion Zone (EEZ) and establish an appropriate profile in international marine geoscience. Failure to maintain a marine geoscience research capability will lead to Australia's inability to address or even be aware of the economic potential of its EEZ.

Technical audits;

142. The Panel noted that, despite its multi-purpose scientific role, the RV *Rig Seismic* was manned and operated along commercial lines and that

MG&PG has achieved substantial improvements in technical performance in data acquisition, ship manning and quality control. The Panel noted that it was normal practice for independent quality control audits to be conducted on industry vessels by clients. The Panel was of the view that MG&PG could benefit from industry practice by undertaking regular technical audits of shipboard operations by experienced industry consultants.

Options for the future;

143. In the current circumstances, the Panel believes that there are four possible ways in which the CMP may head in the next few years:

- the CMP could continue on its current course which will result in progressively less RV *Rig Seismic* cruise time being devoted to core CMP objectives and more management time being devoted to seeking "soft" funding to utilise the RV *Rig Seismic* efficiently

- the CMP could continue but under different operational conditions and at a significantly lower level, without the RV *Rig Seismic,* but with a potential saving to the public purse in the short term

- the CMP could be fully funded by Government to ensure that the core CMP objectives can be met in a timely fashion with a consequent saving in management time being devoted to seeking "soft" funding, increased CMP output and additional industry exploration investment

- move to the AMSA option at some stage during the remaining years of the RV *Rig Seismic* contract.

144. It is AGSO's view that the CMP cannot continue on its present course and that the third option is the best option for the time being as the benefits accruing to Australia and certain sectors of the economy are orders of magnitude greater than the costs of the CMP. AGSO believes that such an increase in funding will free MG&PG to concentrate wholeheartedly on fulfilling the objectives of the CMP rather than spending time trying to compete with private interests for specialist contracts.

145. At some stage, over the next five years, the AMSA vessel option may become more cost effective than the penalty cost of terminating the RV *Rig Seismic* contract. At this stage, however, this option is not available.

ASTEC Recommendations on the Replacement of the RV *Rig Seismic;*

146. The Australian Science and Technology Council (ASTEC) has supported the present mode of operation by AGSO (and the then BMR) since 1979. The Woods Review did not challenge the use of the RV *Rig Seismic* for delivery of the CMP.

147. The Panel also noted the recommendation by ASTEC in its March 1992 Report into Major National Research Facilities that RV *Rig Seismic* be replaced. ASTEC assessed the relevance and importance of 24 short listed proposals and selected seven proposals for likely development over the next 5-10 years, subject to the findings of in depth assessment procedures.

148. One of these seven was a joint BMR/COGS (Consortium for Ocean Geosciences of Australian Universities) proposal for an ice strengthened multi-role marine geoscience research vessel to replace, in ASTEC's words, "the ageing RV *Rig Seismic* and provide a basis for a broadly based strategic research capability in marine geoscience."

149. The seven proposals were said to "build upon existing research activities with a proven record of performance but require a substantial capital injection to achieve their objectives." They were also "judged to have high priority on the grounds of their outstanding scientific value, relevance to the needs of Australian industry, benefits to the Australian community and promotion of Australia's international standing." The seven proposals were further said to "exemplify the need for large scale, co-operative and often multi-disciplinary major national research facilities to keep Australia at the cutting edge of international research."

150. Replacement of the RV *Rig Seismic* with an ice strengthened multi-role marine geoscience research vessel would have many advantages. In fulfilling ASTEC's definition of a major national research facility, a replacement vessel would:

- be built around substantial instrumentation, equipment and other facilities
- satisfy an identified national research need
- provide a shared resource for use by the widest pool of users from different organisations, disciplines and areas of application according to the merit of their proposals
- create opportunities for international co-operation and participation.

151. For AGSO, the replacement vessel being available for the widest pool of users from different organisations, disciplines and areas of application according to the merit of their proposals would decrease the pressure on resources which is currently experienced by the MG&PG and referred to above.

152. An option would be to extensively modify the new AMSA vessel to enable it to carry out the full range of activities of the RV *Rig Seismic* and to extend those activities to Antarctica because of the vessel's ice-breaking capacity.

153. A further option, that seismic and geological activities be done under charter with different vessels, supposes that adequate savings could be made by giving

up the RV *Rig Seismic* and associated staffing costs. In reality, such savings would probably not be realised.

154. AGSO supports and endorses the ASTEC recommendation and considers that planning for the replacement of RV *Rig Seismic* should commence as soon as possible. A solid, business oriented, fully-costed case will need to be developed covering all possible options. Proposed capabilities and options will need to be canvassed widely throughout the Australian geoscience community.

155. The Department of Finance believes that the ASTEC Report and this Evaluation Report should be used as a vehicle for drawing more involvement from industry into the investigation of options for the replacement of the RV Rig Seismic and for prompting an immediate start to debate on the issue. Within the time available, more concrete evidence will be brought forward concerning the value of the CMP to industry as an integral part of the business case for a new vessel.

Current data processing arrangements;

156. This section specifically relates to the operations of the MG&PG's Seismic Processing Centre (SPC). It must be pointed out that the information included in Appendix H was not available at the time of the meeting of the Evaluation Panel; the collection of this information was specifically requested as a result of the consideration of the draft Report by the Advisory Council at their November 1992 meeting.

157. The Panel noted that specific steps have been undertaken recently in relation to data processing to improve the quality and timeliness of CMP data and products:

- staffing levels have increased to allow coverage of processing operations
- a CONVEX 3420 super-computer has been installed to improve seismic processing throughput and the range of processing routines that can be undertaken
- a commercial joint venture had been undertaken with NOPEC a/s to process an accumulated backlog of seismic data and to market products to industry.

158. The Panel was of the view that significant improvements were required in the area of seismic processing if MG&PG was to deliver CMP products effectively. The Panel noted that steps had been taken to address the backlog of seismic processing through:

- a commercial joint venture with NOPEC
- reorganisation and re-staffing of the processing group

. acquisition of new processing equipment.

159. The Panel also noted steps taken to improve seismic data processing, quality and timeliness but expressed concern that there were three issues which needed to be addressed. This concern was reflected in a significant number of submissions. In order of importance, the three issues are:

. inadequate quality control in seismic data processing

. timeliness of data output and product delivery

. cost of processing; the Panel noted that, at that stage, the cost of seismic processing was significantly higher (approximately 100-350%) than the cost of seismic processing on contract.

Quality control;

160. The Panel noted that only 2 qualified and experienced staff were available to undertake parameter selection and quality control on seismic processing and that one of these had significant managerial responsibilities for the Seismic Processing Group. The Panel was of the view that insufficient experienced staff resources were being applied to parameter definition, quality control and the conduct of special projects in seismic processing.

161. The Panel was of the view that MG&PG lacked sufficient experience in modern marine seismic processing and that MG&PG could benefit considerably from regular technical audit and input for the purpose of recommending improvements in procedures.

162. The Panel also noted the absence of an interactive capability for parameter development and was concerned this would continue to effect the rate and quality of production. Acquisition of an interactive capability will require additional funds and will consequently impact on the cost of the CMP.

163. Subsequent to the meeting of the Panel, there has been considerable work put into addressing many of the timeliness and quality problems identified by the Panel. Use has been made of external consultants to improve and verify processing parameter definition. Investigations to evaluate interactive seismic processing for parameter analysis are proceeding. Installation of such a facility would, however, improve productivity and quality of processing.

164. The Panel noted that the CONVEX system has enabled MG&PG to apply a wider range of processing techniques than had been possible otherwise and that it also facilitated batch processing.

Timeliness of data output and product delivery;

165. The group has completed processing of the equivalent of over 6 000 kilometres of conventional seismic data since the CONVEX was installed in 1992. This is

approaching the required productivity and indicates that the data can be processed in a reasonable time.

166. The first major production deadline for the Philippines project (Ragay Gulf) was met to the satisfaction of the external consultant supervising the processing. This further supports the SPC's ability to meet required processing deadlines.

Cost of processing;

167. The Panel noted that, at that stage, the cost of seismic processing in MG&PG appeared to significantly exceed that of industry. Initial work by Coopers & Lybrand available to the Panel estimated SPC seismic processing costs at around $A182/kilometre compared with contracts on processing of CMP data ranging from $A62/kilometre for conventional seismic data to $A92/kilometre for deep seismic data.

168. However, the costs per line kilometre on a batch of processing in early 1993 are estimated by AGSO to be about $A115-120, a considerable reduction. This compared favourably with the contemporary contract price of $A85/kilometre. Under contract processing, AGSO would still require the equivalent of $A20/kilometre to supervise and manage contracts and the data handling between AGSO and the contractors. This suggests that on a purely cost basis, the SPC is becoming quite competitive with private contractors.

169. Significant steps are also being taken with external organisations including NOPEC, Digital Exploration Ltd (DEL) and CONVEX, to reduce the costs of processing. NOPEC have expressed a willingness to invest up to $A300 000 in the SPC; this is a significant contribution and will make AGSO even more competitive with commercial operators. DEL are interested in a proposal to share excess capacity between both sites. SPC management is also negotiating with CONVEX to reduce hardware maintenance charges.

Conclusion;

170. The Executive Summary of the Coopers and Lybrand Study suggested that it would be somewhat premature to cease seismic data processing within AGSO at that time and, given that so much had been and was being done to improve the operation of the SPC, it was perhaps best to allow the in-house group the opportunity to continue to improve. A more fully argued case by AGSO is provided as Appendix H but the main reasons are that:

- the most recent cost comparisons are not nearly as great as was suggested by the original Coopers and Lybrand Study available at the time of the Evaluation Panel meeting

- substantial gains have been made in the productivity of the SPC and the quality of the product has improved markedly

- the benefits of the new seismic processing system, in which significant resources have already been invested, have yet to be fully realised and there are still improvements which can be made.

171. Disposal of the CONVEX would cause substantial losses. Realisation of staff costs would be a slow and expensive process, with the need for additional funds to cover salaries and contract costs at the same time. To meet current processing requirements by contract, additional annual cash outlays of $A690 000 are estimated to be required.

172. The Panel proposed that, once the operation is bedded down say by the end of 1993, performance of the AGSO in-house seismic processing be monitored regularly to ensure that:

- the requirements of the program are being met
- standards of quality and timeliness are being achieved
- retention of an in-house seismic processing capacity is cost effective.

173. The Panel identified an urgent need to improve staff numbers and skills, product turnaround and quality over the next six months. MG&PG needs to prepare an action plan on seismic processing to look at all options for reducing seismic processing costs commensurate with the objectives of the CMP. This should include comparison between, and consideration of:

- contracting out and contracting in (while contracting out may appear attractive at this point in time, the requisite funds are not available this financial year)
- sharing/leasing of the facilities and joint arrangements with processing companies
- maintaining and improving staff skills and numbers
- the hire or exchange of a Quality Control expert and the conduct of technical evaluations
- the purchase of an interactive processing capability.

174. The outcome would be a report to the AGSO Advisory Council, through the AGSO Executive, on the way ahead. At that point in time, it may be possible to make specific recommendations for implementation in the following financial year on contracting out and the introduction of interactive processing. The report could also cover improvements derived from the acquisition of additional staff resources and the implementation of up to date processing and quality control measures.

175. The Panel also agreed that MG&PG needed to maintain a minimum, in-house research capability in seismic processing which should not be seen as an overhead on routine processing.

176. The Department of Finance also believe that MG&PG should have made a greater effort to explore all options for data processing prior to making the decision to upgrade to the CONVEX. The Department further believes that this may be a valuable principle to adopt for all areas of AGSO.

Conclusion;

177. The Panel concluded from the submissions and the Coopers and Lybrand study that the CMP has been effective from the industry's perspective in:

- stimulating petroleum exploration activity
- gathering valuable geoscientific data
- undertaking research in "frontier" areas related to the potential for petroleum in Australia.

178. The Panel noted that work on sedimentary minerals had been of limited extent.

179. The CMP has also made an important contribution to the delineation of Australia's maritime boundaries and in defining the limits of Australia's jurisdiction under the 1982 UN Convention on the Law of the Sea. The paper by P A Symonds and J B Willcox, 1989 "Australia's Petroleum Potential in Areas Beyond an Exclusive Economic Zone" BMR Journal of Australian Geology & Geophysics, Volume 11, Number 1, was of considerable assistance to government departments when considering maritime jurisdiction issues.

180. The Panel based its conclusions on the Coopers & Lybrand study, where support from industry and Commonwealth Government users of CMP data was expressed, and concluded that the CMP has contributed substantially to the commitment of exploration expenditure. Additional material provided by AGSO on the benefits of the CMP supported this conclusion (see Appendix D).

181. In summary, the Panel found that MG&PG is effectively achieving the objectives of the CMP albeit, under increasing budgetary pressure, slower than might have been originally expected. The Panel further found that the CMP has developed significantly since its inception and is now delivering a much improved product even as real budget outlays have decreased.

182. However, without adequate funding to ensure the cost effective use of the RV *Rig Seismic*, the efficiency of the CMP is questionable. Also, the pursuit of the utilisation of the RV *Rig Seismic* for cost recovery purposes to defray overheads runs counter to the public good objectives of the CMP which have been well articulated.

Is there scope for improving the performance of the CMP?;

183. Despite the obvious support for the CMP and the steps taken to improve the efficiency and effectiveness of the CMP in the last few years, the Panel considered there were areas where there was still room for improvement.

Program Development and Client Consultation;

184. A Petroleum Consultative Group was set up after the Woods' Review to provide advice on the strategic direction and issues associated with the CMP. The consultative group has met only three times and has been largely ineffective. In AGSO's view, it has proved impractical to assemble a large representative group of industry specialists on a consistent basis.

185. The Associate Director – Petroleum and Marine Geoscience and relevant Program Heads have outlined AGSO's forward petroleum work program to the APEA Exploration Committee annually over the last two years. This forum has proved more useful and predictable in terms of its Canberra meeting schedule and membership.

186. Despite these activities and the marketing of individual CMP products to industry, the Panel is concerned at the lack of in depth knowledge of the CMP in the exploration community, particularly at higher management levels.

187. The CMP has a well developed procedure for developing and monitoring projects through its Future Program Committee, by consultation with:

- the Petroleum Division (Minerals and Fisheries Group – DPIE) which is responsible for administering the Areas Release Program
- the Petroleum Resource Branch (BRS – DPIE) concerning new acreage releases
- petroleum companies on specific aspects of surveys.

188. Nevertheless, the Panel is of the view that there can be improved co-ordination in the planning of CMP projects, the schedule of new acreage releases and meeting the needs of State agencies.

189. In the light of the impending ratification of the UNCLOS, a specific plan needs to be developed to address the remaining data requirements associated with the definition of Australia's Legal Continental Shelf and unresolved bilateral boundaries between Australia and Indonesia, and Australia and New Zealand. The MG&PG has identified the need for eight additional CMP cruises to address the data requirements for the Legal Continental Shelf. These should be undertaken over the next 5 years during the balance of the contract life of RV *Rig Seismic*.

190. The Panel further found that it would be desirable for the RV *Rig Seismic* to upgrade its technology in order to carry out this work more efficiently and effectively by acquisition of swath mapping (side scan sonar) equipment for imaging and mapping large segments of the sea floor to assist definition of the sea-bed boundary.

191. The Panel was of the view that the CMP has an important role in providing the framework for estimating the resource potential of areas that may be nominated for status as marine parks and protected areas. It is not practical for the CMP to await an announcement to declare an area as a Park in order to plan its program. Closer liaison with DEST is necessary to ensure adequate lead time for such studies before any announcement.

192. In the event of such an announcement, the Department of Primary Industries and Energy will be asked to produce a potential resource assessment of prospective park areas and will need to have baseline information available at that time for such an assessment to be feasible. There is some certainty that some parks will be established but early assessment of potential resources is not possible under present arrangements.

193. The Panel concluded that attention to these areas, improvements in vessel data acquisition and seismic processing and improved liaison with government agencies potentially interested in the work of the vessel would be of substantial benefit to the CMP.

Funding of the CMP;

194. The Panel was deeply concerned with the financial status of MG&PG as revealed in the budget analysis. The inadequate core funding for the RV *Rig Seismic* has meant that CMP objectives have been distorted in the search for "soft money" to keep the RV *Rig Seismic* on the water and therefore operating cost effectively..

195. The MG&PG can afford to conduct only three appropriation-funded cruises for 1992/93 focusing on agreed CMP objectives. This situation has arisen as a result of a deteriorating budget position over the last two years. Because of the high overhead associated with running the RV *Rig Seismic*, the effect has been to reduce funds available for actual cruises. A further $A1.5 million is required to restore funding to allow 5 RV *Rig Seismic* cruises (150 days) each year.

196. If extra funds are not forthcoming, the utilisation of RV *Rig Seismic* will be unacceptably low and the per unit operational costs will be unacceptably high. In the Panel's view, it is not efficient for RV *Rig Seismic* to be operating in scientific acquisition at less than 150 days each year.

197. The Panel therefore considers that at least 150 appropriation funded cruise days should be devoted to the CMP but additional cruises, possibly outside the CMP and on a full cost recovery basis, would assist the total operation to be more cost effective. If this level of funding cannot be guaranteed, then the Panel believes

that there is significant doubt as to whether the CMP can continue to deliver the benefits listed elsewhere in this report in an efficient and effective way.

198. Significant funds are currently invested in leasing, equipping and manning RV *Rig Seismic;* it seems inefficient to fail to utilise such a significant capital investment. The Panel noted that because of a shortfall in operating funds and the consequent drive to defray fixed overhead costs through jointly funded projects with external agencies some 20% of RV *Rig Seismic* activities will be outside the core CMP objectives in 1992/93. This situation may well worsen in future years.

199. All members of the Panel except the Department of Finance representative agree that the fulfilment of CMP objectives are being jeopardised by the increasing need to acquire "soft" or external funding. The Panel strongly urged that more funds be redirected into the CMP to facilitate core activity and protect the integrity of the program. Funding priorities within AGSO should be re-examined but funds should also be sought through the setting of portfolio priorities and the new policy proposal process.

200. Professor Helsley, however, disagreed with changing the emphasis to greatly reduce environmental studies which he considers to be an important part of marine geoscience.

201. The Panel noted the submission by the Department of Environment, Sport and Territories (DEST) supporting work on the Antarctic margins, the sub-Antarctic plateaux and in the Southern Ocean and that MG&PG had recently been given responsibility for implementation of AGSO's commitment to the Co-operative Research Centre (CRC) for Antarctica and the Southern Ocean Environment.

202. The commitment involves approximately $A600,000 of which approximately $A400,000 is the responsibility of MG&PG and for which only $A50,000 in additional funds was provided. Whilst the Panel notes that AGSO's commitment attracts matching funds to the CRC, the Panel was concerned that the diversion of resources away from the CMP had further compromised its capacity to fulfil core objectives.

Program Management;

Cost Analysis;

203. The CMP accounted for 44% of AGSO's budget in 1991/92 (after allowing for those elements of the then BMR transferred to BRS in 1992) and is expected to account for 44% in 1992/93. The bulk of this expenditure lies in data acquisition (the RV *Rig Seismic*) and data processing. Both of the areas are similar to commercial operations.

204. In view of the costs involved, MG&PG should maintain accurate costing information on the various aspects of the CMP to ensure cost efficiency and that charges set for externally funded non-core projects accurately reflect true costs

(eg appropriate assignment of overheads) relative to commercial alternatives and for planning equipment purchase and major maintenance cycles.

205. This information will be invaluable background to the Cabinet Decision that is due by 30 June 1993 on the future of the RV *Rig Seismic*. Continuation of the CMP, and therefore further funding, requires positive affirmation of the performance of the CMP so far and the performance of the RV *Rig Seismic*. The ground rules are yet to be decided for the next financial year as regards technical new policy and new policy proposals.

206. In terms of costings, the CMP is now at a critical point because of its increased dependency on non-core funds. The Panel believes that a detailed prospective estimate of costs associated with various alternatives for delivering the CMP will need to be undertaken for Cabinet consideration. This will have to include costs associated with termination of the charter of RV *Rig Seismic* such as penalty for early termination, costs of refurbishment, decommissioning, redundancies (if any) and for restoration of the CMP cost to a operationally cost effective level.

Strategic planning;

207. The Panel also considered that it was extremely important to improve CMP's strategic planning effort. The issues that needed to be dealt with by management included:

- development of prospective and retrospective costings over a 5 year period
- establishment of a standard method of cost accounting with specific provision for depreciation
- full costing of all options for the delivery of the CMP.

208. The outcome would:

- highlight specific costs to the program
- assist financial decision making
- allow cost effectiveness comparison of alternative ways to deliver the CMP including:
  - identifying the costs inherent in termination of the RV *Rig Seismic* contract within the next five years
  - if necessary, allowing planning to commence for the replacement of the RV *Rig Seismic* in line with ASTEC's recommendation.

Content of the CMP;

Direct Hydrocarbon Detection;

209. As indicated previously, the Panel was of the view that MG&PG should concentrate on the core objectives of the CMP (see paragraph ?? above). The Panel noted that the CMP had reached a watershed in its evaluation of "direct hydrocarbon detection" (DHD) as an exploration tool in Australian waters. The Panel noted that the work completed to date when completely written up provides a valuable evaluation of the application of the technique in Australian waters but that further routine operation was of limited relevance to most ongoing aspects of the CMP.

210. The applicability of the technique for pollution tracer work has been demonstrated by tracking outfall dispersal plumes off the coast of Sydney. However, such work lies outside the core objectives of the CMP. The Panel noted that AGSO is currently modularising the technology for use on smaller vessels with potential to commercialise the technology.

211. Another consideration is that DHD is of considerable value for development assistance programs overseas. However, the Panel believes that if DHD continues for such purposes, it should be funded externally.

Seismic imaging;

212. The Panel noted that a major issue, and environmental/technological obstacle facing petroleum explorers in Australia was the difficulty of obtaining adequate seismic images of the sub-surface because of thick, usually Tertiary, carbonate sequences in the near-surface environment which absorbed or reflected much seismic energy.

213. This problem is virtually unique to Australia. In general, seismic vessels operating in Australian waters were configured for conditions found elsewhere in the world and were poorly designed for experimental work. The Panel noted that only RV *Rig Seismic* has this experimental capability and therefore is in the best situation to conduct experimental work to improve seismic resolution under Australian conditions. This work will improve petroleum (and mineral) exploration and development efficiency. However, a major effort in this area would require some modification of the vessel's equipment.

214. The Department of Finance is strongly in favour of using the RV Rig Seismic as a testing platform to advance technology in customising seismic configurations to Australian conditions. The Department believes that it is not sufficient to regard the CMP as a Program which simply produces data of a particular type; the Program also has a role in advancing the way in which all data from offshore basins is collected and interpreted.

Offshore aeromagnetic surveying;

215. The Panel noted submissions calling for further aeromagnetic work in the offshore region and for greater incorporation of analyses of industry data into project activities. The Panel was of the view that, in the current resource environment, expansion into these areas, however desirable, was not possible at the cost of the shipboard program. However, should adequate funding be available, for example by cost recovery, such work would be justifiable.

Activities of the CMP;

Operational requirements;

216. The Panel noted that because of the year round operational requirements of the vessel, staffing and management issues encountered by MG&PG were unlike those encountered elsewhere in AGSO. In particular, the Panel was concerned at the apparent dysfunctional relationship in the management of mechanical/electronics technicians working in MG&PG whereby management responsibilities were split between AGSO's Engineering Services Unit (ESU) and MG&PG.

217. The Panel was also concerned at the apparent difficulties in recruiting staff in a timely fashion for shipboard operations, managing performance of individuals in the shipboard environment and the impact of anomalies in conditions of employment (eg AILOT barrier) on staff motivation and promotion.

218. The Panel believed that additional Executive attention needed to be paid to these issues.

Marketing of CMP products;

219. The Panel also noted submissions related to the efficiency of marketing of CMP products. Issues raised include:

- targeting of stakeholder groups
- efficiency of information systems relating to sales and market analyses
- responding to stakeholders on a timely basis
- potential for dysfunctional relationship between marketing at a corporate (AGSO) versus program (CMP) level
- contracting out of AGSO's Copy Service (currently within the Corporate Relations, Information and Planning Branch).

External involvement;

University involvement;

220. The Panel noted the substantial level of university involvement in the CMP over the last 3 years. Nonetheless, the Panel was concerned about the lack of recognition by Australian universities of the opportunity for university involvement in the CMP but recognised that the limited funding for university participation is a significant inhibitor to further involvement.

221. The Panel noted the initiatives by MG&PG to open up a dialogue with the Consortium for Ocean Geoscientists of Australian Universities regarding future involvement of university staff and students in the CMP and the involvement of Sydney University in projects off the coast of eastern Australia.

Involvement of overseas agencies;

222. The Panel noted the plans for co-operation with overseas institutions on projects around the Australian margin involving swaps of ship time with vessels with complementary capability to the RV *Rig Seismic* and the mounting of special equipment on RV *Rig Seismic* to address particular scientific questions eg use of swath mapping in regions with surface expression of tectonics. The Panel further noted the importance of such activities in diversifying the marine geoscience experience of MG&PG personnel to the benefit of the CMP.

An information source which can be used as a basis for consideration of the future program;

Performance Information;

223. The measurement of the performance of strategic scientific research such as the CMP is difficult given the lack of solid quantitative data and the long lead times between data acquisition and release and socio-economic impact, in this case the discovery and development of offshore petroleum resources.

224. The Coopers & Lybrand Study suggested that benefits could not be fully quantified in dollar terms. However, exploration companies were positive concerning the contribution of the CMP to their decisions on exploration in Australia and were strongly supportive of the continuation of the CMP.

225. In contrast to the results reported in the Coopers & Lybrand study, the industry response to the invitation to make a submission to the Evaluation Panel was weak and the submission from APEA, although generally supportive, contained surprising misconceptions concerning the scope and operational framework of the CMP.

226. The Panel noted in the conclusion of the Coopers & Lybrand study that, despite the fact that Australia's continental margin is under-explored and that lead times from regional data acquisition to demonstrated interest from petroleum explorers can be up to ten years, the CMP has contributed to the commitment of exploration expenditure of over $A120 million for acreage release in the period 1987-1991. In addition, there are proposed work plans for over $A250 million of

further exploration contingent on the findings from the initial committed work.

227. To date, there is no evidence that the CMP has directly led to petroleum discovery but the Panel noted that this is not inconsistent with industry lead times, and that there are clear indications that the CMP has contributed to stimulating private sector exploration investment in Australia that might otherwise have been invested in other countries.

228. The Panel recommends that a case study on lead times from pre-exploration through to development and production would be a useful exercise to undertake. It is, however, emphasised that this type of information purely relates to the petroleum aspects of the CMP.

229. The Panel noted that for 1991/92, the direct return to Government from petroleum production through secondary taxation was $A1.4 billion and that domestic production of 200 million barrels of crude oil annually equated to around $A5.5 billion in import replacement and that close to $A1 billion of export earnings from LNG was achieved. The costs of the CMP are a tiny fraction of these and the Panel believes that the support provided by the CMP to this major industry is clearly justified.

230. Commonwealth Government Departments, the other major users of CMP outputs, were also positive about the benefits and those directly involved in jurisdictional determination and petroleum exploration indicated their work effectiveness was contingent on data of the kind provided by the CMP.

231. Nonetheless, concern was expressed by the Department of Finance representative about the absence of tangible (ie financial) returns from the Government's investment in the CMP. He felt that greater cost recovery in response to outside industry priorities was the most important means of testing the value of the CMP to industry and a significant factor in measuring performance; he further felt that some change in CMP objectives to meet the priorities of external agencies/companies was appropriate.

232. This view was not supported by the Panel as a whole. The majority view was that the CMP was largely designed to attract companies to explore for offshore resources owned by the Australian people. The funds allocated to the CMP are for the conduct of a program in the national interest and should not be driven by sectoral interests. AGSO is not in the commercial business of hiring out ships. Indeed, it is inappropriate to do so since funding for the CMP does not allow for commercial risk or performance bonds to meet normal commercial targets.

233. The Panel further considered that it was inappropriate for the CMP to undertake competitive, commercial seismic acquisition over active exploration permits in Australian waters in competition with the seismic service industry. Overseas operations that are fully cost recovered (including all overheads and depreciation) and that meet corporate commercial cost recovery and/or foreign

policy objectives were endorsed. Such operations, however, should not be seen as part of the CMP and were consequently of lower priority.

234. The question of appropriate performance information for the CMP is therefore a vexed one. The Panel notes that the Cabinet Decision to extend the CMP in 1988 was accompanied by a requirement for cost recovery of 5% cost (around $A1 million in current terms). This is unlikely to be realised from the sale of products alone, but it is not an unrealistic expectation if it includes cost shared program (not related to the core CMP objectives) such as the studies carried out jointly with the Sydney Water Board.

235. The majority of the Panel believe that any cost recovery, other than the cost of reproducing materials, is inappropriate and counter-productive to CMP objectives. Cost recovery should be on the basis of the taxation or royalty on discovered and developed resources. Treating cost shared programs as cost recovery is also inappropriate for it tends to drive MG&PG into areas that direct resources away from the core objectives of the CMP.

236. Appropriate CMP performance information to be collected by MG&PG over the next 5 years should be agreed by all key players (MG&PG, AGSO Executive, AGSO Advisory Council, DPIE Petroleum Division and the Department of Finance). The Department of Finance felt that Appendix D was a good start and a considerable advance on the information available to the Evaluation Panel at its original meeting.

Future Priorities;

237. The Panel considered that of the recommendations made, several were of immediate priority. These were:

- securing continuation of the core CMP
- securing core funding to enable the RV *Rig Seismic* to undertake at least 5 annual cruises focusing on the agreed objectives of the CMP
- improving strategic planning
- improving seismic processing.

238. Other important but not immediate priorities include the:

- upgrading of equipment
- completion of data acquisition related to Australian Maritime Boundary definition
- consultation with DEST (sic, DEST) on the early identification of areas which may be the subject of Marine Park declarations in the future.

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- Jim Colwell
- Barry Willcox
- Howard Stagg
- Chris Pigram
- John Marshall
- Roy Whitworth
- Frank Brassil
- Chris Johnston

Also interviewed

- Coopers & Lybrand Consultants
  - Dr Hugh Watson
  - Mr McGregor Grant
  - Mr Peter Wright

EXECUTIVE SUMMARY

Introduction

1. The Australian Government wishes to encourage the exploration and development of its offshore petroleum resources with a view to maximising oil self-sufficiency well into the next century. The Government also wishes to conclude seabed boundary definitions through negotiations with its neighbours and under the Law of the Sea Convention that maximise the resource base to which Australia is entitled. It also has a policy to develop more marine parks.

2. Australia's continental margin is an area of about twelve million square kilometres and, in international terms, is relatively under-explored. Very little is known about the structure, history, or resource content of our marine environment. To achieve its goals, information is required on Australia's offshore areas or continental margin.

3. To overcome these data limitations and to meet its needs, the Government, in 1983, agreed to put the Continental Margins Program (CMP) in place under the management of the then Bureau of Mineral Resources (BMR). The CMP currently operates under the Marine Geoscience and Petroleum Geology Program (MGPGP) of the Australian Geological Survey Organisation (AGSO), formerly the BMR. The CMP was designed to collect and provide data of interest in petroleum and minerals exploration. It was also to collect information of interest in the establishment and management of Australia's seabed jurisdiction.

4. The Advisory Council of the Australian Geological Survey Organisation is conducting a major evaluation of the CMP. The evaluation is part of a rolling evaluation of AGSO programs by the Advisory Council, instigated after the Woods Review in 1988. It also relates to a mid-term review of the program required by Cabinet in the context of the extension of the charter of the research vessel *Rig Seismic*.

5. To assist the Advisory Council in its evaluation, Coopers & Lybrand Consultants have been asked to undertake a benefit cost analysis of the CMP. This report presents the findings of that analysis.

CMP Objectives

6. The CMP aims to provide mission-oriented research into the structure, stratigraphy and evolution of Australia's continental margins, plateaus and adjacent ocean basins and its Exclusive Economic Zone (EEZ) in order to provide a geological framework for petroleum and mineral resource exploration, evaluation and assessment.

7. In addition, it researches marine geological processes to provide data relevant to present environmental management, as well as global geological evolutionary models. It also undertakes studies to assist in the definition of Australia's offshore jurisdiction.

8. The CMP currently has the following objectives:

- to develop a knowledge and understanding of the geological framework of the continental margin around Australia and its territories, to more effectively promote exploration for petroleum by industry;

- to identify the petroleum and mineral resource exploration potential of the offshore area and to provide the basic information for formulation of independent advice to the Federal Government on offshore resource development; and

- to develop models of the geological processes that have formed the continental margin and led to economic accumulations of petroleum and minerals.

9. The strategy adopted by the AGSO to meet the goals of the CMP was to charter a dedicated research vessel, the *Rig Seismic*. The vessel commenced its first operational research cruise in February, 1985, and had completed thirty six cruises by July 1992.

10. *Rig Seismic* has industry-comparable seismic acquisition systems and geological and geochemical sampling capabilities. The ship was built in Norway in 1982 and arrived in Australia to be fitted out by the then BMR for geoscientific research in October 1984. It has a dynamic positioning capability.

11. AGSO also has a Seismic Processing Centre. In June 1992 the processing capability of the AGSO was significantly upgraded by the installation of a Convex super-computer. This upgrade is a radical change in technology for the Seismic Processing Centre and will alter its operation and output dramatically.

12. To assist industry evaluate the potential of areas to be released, AGSO prepares packages of technical data on the regions concerned. These summarise information such as regional structure, stratigraphy, exploration history, palaeogeography, and play concepts. Illustrations might include regional cross-sections, regional two-way-time maps, palaeogeographic time-slice maps, composite logs, well and engineering summaries, prospect montages, burial history and source rock/maturation analyses, and porosity trends.

Cost of Running *Rig Seismic*

13. The total costs directly attributable to the operations of the MGPGP in the year ended 30 June, 1992 are $20,446,899. In addition, an amount of $518,610 was paid in respect of the Federal Government contribution to the Ocean Drilling Program.

14. The total cost of running *Rig Seismic* during the year was $11,518,904 of which $7,613,718 was for seismic data collection and $3,905,186 for non-seismic acquisition. The cost per kilometre of the 12,540 kilometres of seismic data acquired during the financial year was $607. The cost of the 10,348 kilometres of seismic data processed under the CMP was $1,879,805 or $182 per kilometre.

15. With regard to the MGPGP, a significant point to note is that approximately 55 per cent of the total costs are fixed and do not change with the level of activity in the CMP. The average monthly variable component (based on eight months of CMP operations for the *Rig Seismic* in the year ended 30 June, 1992) is approximately $650,000. Assuming similar activities were to be undertaken, the marginal cost of the ninth month would also have been $650,000 or approximately 5.5 per cent of the total cost.

Cost of Acquiring the Information Through Other Means

16. Acquisition of the information through other means can be contemplated at two levels. The first is to consider other options for acquiring the information besides the alternative of using the AGSO (its management, computer processing and interpretation, and use of *Rig Seismic,*). The second is to maintain the AGSO as the co-ordinating or managing agency and data interpreter, and to consider alternatives to using *Rig Seismic* for acquisition and the AGSO's own facilities for processing.

17. In relation to the first level, it can be stated that respondents strongly supported an on-going role for the AGSO and its CMP. There was no suggestion made that there were realistic alternatives to AGSO involvement.

18. At the second level, it was widely reported within the industry that two-dimensional multi-channel seismic can be acquired for $800 to $1000 per kilometre from contractors, and that processing can be obtained for less than $50 per kilometre. These estimates, however, are unlikely to include positioning, mobilisation and demobilisation, or standby charges for seismic acquisition, nor more than basic seismic processing. They are, not surprisingly, substantially less than actual quotations obtained by AGSO and its associates for private sector seismic processing of CMP data. Recent quotations for 16 second processing of Timor Sea data ranged from $80 to $310 per kilometre, a substantial variation straddling the estimated AGSO cost of $182 per kilometre. These private sector estimates do not include the management costs of contract preparation, supervision and quality control which would be incurred by AGSO.

Benefits Arising from the Research in the CMP

19. Notwithstanding that the benefits of the Continental Margins Program could not be satisfactorily quantified in dollar terms, the analysis has revealed an outstanding list of benefits that have been realised from the outputs of the program.

20. Substantial among them were the benefits to the petroleum exploration industry. Despite the fact that Australia's continental margin is under-explored, and that lead times from regional data acquisition to demonstrated interest from petroleum explorers can be up to ten years, the program has assisted in leveraging committed expenditure for petroleum exploration of over $120 million since the first data releases in 1987. These are commitments by companies for expenditure in the three years following their taking up of an exploration lease. It is possible that expenditure may exceed these minima in the three year period although no data was collected to indicate this. In addition, there are proposed workplans for over $250

million of further exploration in the latter three years of the six year exploration leases. This expenditure is contingent on the findings from the initial committed work, but together, they indicate the extent to which the CMP has contributed to exploration commitment.

21. Exploration companies were positive concerning the contribution of CMP outputs to their decisions on exploration in Australia, and were strongly supportive of the continuance of the CMP.

22. Commonwealth Government Departments, the other major users of CMP outputs, were also very positive about the benefits, and those directly involved in jurisdiction determination and petroleum exploration indicated their work effectiveness was contingent on data of the kind provided by the CMP.

23. There is no doubt that the Government should continue the Continental Margins Program under the management of the AGSO for economic, legal, environmental, and geoscientific reasons. The nation benefits from the CMP through employment in the petroleum exploration industry, investment in petroleum exploration, through advice on the continental margin (or boundary negotiations), through ensuring areas for release for exploration are appropriate, and through the definition of marine park boundaries. There are also other intangible benefits such as increasing the nation's knowledge of our continent and our region.

Improvements in the Benefit Cost Ratio

24. The questions that arise from the analysis on possible improvements to the benefit cost ratio of the program are, first, whether the *Rig Seismic* or some other contracting arrangement is the most cost-effective means of acquiring data, and second, whether AGSO should process data internally or contract out that activity? The answer to the first question is clear, but not so for the second.

25. The seismic acquisition cost per kilometre using *Rig Seismic* is significantly less than the estimated contracting price suggested as reasonable by the industry, supporting the retention of acquisition within AGSO on cost grounds. That there appear to be current CMP activities undertaken using *Rig Seismic* for which contracting opportunities may be limited, for example, deep water sampling, further supports this. In addition, there is a level of security for Government in knowing exactly what the quality of the data output from *Rig Seismic* will be, and some advantage to Government in being confident that *Rig Seismic* is available, particularly for operations that might require a prompt response. The vessel also provides an opportunity for unique research activities such as the venture with the Sydney Water Board, and as a mechanism for dispensing appropriate development assistance to other countries as demonstrated by the successful Philippines venture with the Australian International Development Assistance Bureau (AIDAB).

26. Although there are persuasive financial arguments for retention of acquisition within AGSO, members of the exploration industry did note that contracting out would obviate criticisms of *Rig Seismic* competing with the private sector contractors, and could lead to more program flexibility. That is, the program would no longer be driven by the need to occupy the

Rig Seismic, and further, AGSO would not need to allocate management time to find and win non-CMP work to utilise the ship during periods when it is not directly funded by the program. While releasing the *Rig Seismic* may allow program flexibility and free some management time, this might be balanced by loss of flexibility in non-seismic acquisition work, for there are few alternatives to the *Rig Seismic* for this kind of work, and additional management time for contract administration and supervision.

27. The cost of processing data within AGSO is currently equivalent to costs on the middle of private sector estimates and quotations for similar work. Based on current processing of approximately 10,350 kilometres per year and using the lowest of the AGSO obtained 16 second processing quotations, contracting out would result in savings of approximately $1.05 million per year, less AGSO's management costs. It would also provide scope to reduce the elapsed time for processing quite substantially which would be advantageous to the CMP objectives. The actual savings to be realised, however, cannot be assessed until the true capability of the recently acquired computer system for seismic processing is evident and the cost structure known. A decision on processing, therefore, should perhaps await an assessment of these factors after a full year of operation.

28. Were either acquisition or processing to be contracted out, costs may be incurred through cancellation of existing arrangements, for example, the decommissioning of the *Rig Seismic* or disposal of the newly acquired computer equipment. Decommissioning of *Rig Seismic*, according to the charter contract, will result in re-delivery costs and early termination penalties of 5.4 million Norwegian Krone ($1.17 million at an exchange rate of 4:1). Further, AGSO's ship operator, the Australian Maritime Safety Authority (AMSA), estimate removal of scientific equipment, boat rehabilitation costs and surveys will be a minimum of $0.7 million. They also estimate that the Commonwealth's superannuation payment contribution to the maritime crew on redundancy would be approximately $1.3 million, resulting in a total estimated cost for decommissioning of the vessel at an early stage to be approximately $3.17 million.

29. In summary, there is strong support within the petroleum exploration industry and Government Departments for the AGSO to continue the Continental Margins Program. A strong case exists to retain the acquisition activities within the AGSO and to continue to use *Rig Seismic*. Recent cost structures, however, suggest consideration could be given to contracting out seismic processing, although such a decision might be delayed until a full year of operations can be used to assess the true capability and cost of the new processing system.

Appendix D:

ECONOMIC USES / BENEFITS

OF AGSO'S

CONTINENTAL MARGINS PROGRAM

Paper prepared to accompany the report on the evaluation of the Continental Margins Program

by

P.A. Symonds

Appendix D:

ECONOMIC USES / BENEFITS OF THE CONTINENTAL MARGINS PROGRAM

INTRODUCTION

The Continental Margins Program (CMP) of the Australian Geological Survey Organisation (AGSO) produces information and ideas that are utilised in a variety of ways by both private industry and government. In some cases this utilisation may culminate in the production of a market good, such as petroleum and fish; however, in other cases it may produce benefits that are difficult to measure in dollar terms. It is highly unlikely that all the benefits arising from the CMP are quantifiable in dollar terms.

In their 1992 "benefit/cost analysis" of the CMP, conducted as part of the 1992 AGSO Advisory Council evaluation of the CMP, Coopers & Lybrand Consultants stated:

> *"Notwithstanding that the benefits of the Continental Margins Program could not be quantified in dollar terms, the analysis has revealed an outstanding list of benefits that have been realised from the outputs of the program".*

Although the title of Coopers & Lybrand's study describes it as a benefit cost analysis (BCA), in strict terms this is not the case, as it only includes an analysis of costs and a qualitative description of benefits. Indeed, the question needs to be asked - is it possible to justify a BCA approach for the complex, interlinked economic uses of the CMP?

WHAT IS A BENEFIT COST ANALYSIS?

Benefit Cost Analysis (BCA) is an economic analysis technique which employs a defined methodology to measuring and comparing benefits and costs of projects or programs. Measurements are made in dollar terms using discounted net present values of future streams of benefits and costs. The results of the analysis are normally expressed as a benefit/cost ratio.

The point of reference of a BCA is usually that of a nation state, in this case Australia. Thus benefits and costs occurring outside Australia - for example profits transferred out of the country - are excluded from the analysis. Benefits and costs are measured from a social perspective regardless of whether the program is a public or private venture. Therefore costs such as environmental damage, should be included whether or not they appear as a direct cost to the agency undertaking the project. Intermediate services (e.g. those provided by exploration service companies) can be included in the analysis.

An important aspect of the above approach is that taxes paid to governments (i.e. taxes on value added, not fees for services) are included in the benefits despite the fact that they are costs to private industry. For example, in the case of the petroleum industry resource rent taxes, and other taxes on profits, may represent the major social benefits to Australia when overseas companies and investments are involved.

There are alternative economic analysis techniques to BCA, such as Cost Effectiveness Analysis (CEA), which can be used when it is not possible to quantify benefits. CEA looks for the minimum way to achieve an outcome that is taken to be desirable. This technique is also applicable to aspects of the CMP.

APPLICATION OF BENEFIT COST ANALYSIS TO THE CMP

It should be possible to apply BCA to those components of the CMP which produce outputs that are ultimately used to produce products traded in the market, most notably petroleum. Such an analysis could follow the model recently applied by the Bureau of Industry Economics to assess some CSIRO programs (BIE Research report 39, 1992). In these analyses, both the public and private components of product development programs are considered together. In the case of the petroleum industry this would mean that the entire production process from exploration to petroleum sale should be included in the analysis.

Another approach that can be used to assess and highlight the value of CMP information and products is to consider scenarios "with" and "without" the existing program, the latter case being commonly referred to as the "counterfactual question". Again, considering the case of the petroleum industry, such scenarios would include an evaluation of projected benefits and cost of petroleum production, if petroleum exploration and projected production in areas covered by the CMP did not occur, or if costs were higher due to exploration being less efficient. The latter situation would take account of the cost savings to government and industry of having better knowledge of which areas are, and are not, prospective.

Another, although more constrained, benefit indicator has been developed in this report by considering the costs and returns to government from potential petroleum production. A shortcoming of this indicator is that it may miss out on some important social benefits and costs. For example, possible future benefits in the form government revenue derived from direct taxes (excise, royalties and licence fees; resource rent tax; and income tax) on the petroleum exploration and production industry can be estimated from current exploration expenditure, the finding cost of recoverable petroleum, and the returns from resulting production.

An important consideration in applying BCA techniques to CMP outputs related to the petroleum industry is the long time lag involved from initial reconnaissance surveys, to exploration, to development and finally to production and thus financial realisation of any benefit. Even in the best-case situation where CMP outputs influence exploration area bidding, there could be a 10 year time lag between acquisition and release of the CMP information, and the start of production.

TIME LAGS IN THE PETROLEUM INDUSTRY

As an example of potential time lags involved consider the following possibilities:

1. Frontier area - Exmouth Plateau

1972 - Reconnaissance survey, BMR.
1975/76 - First reports/publications on interpretation of BMR data.
1976 - Regional survey, GSI.
1977 - Exploration permits awarded.
1979 - Scarborough gas field discovered; estimated to contain 350×10^9 m^3 of gas. Gas considered sub-economic and Scarborough remains under a retention lease.

Time lag from initial reconnaissance to discovery was 7 years.

2. Shelf basin - Vulcan Sub-basin, Jabiru

1979-82 - Definition of Jabiru prospect.
1983 - BHP became new operator.
1983 - Jabirui 1A discovered oil.
1984 - Preliminary development proposal.
1986 - First production from Jabiru using floating production facility.

Time lag of about 5-6 years from prospect definition to production. This can be considered a minimum lag because of the floating production system employed.

These examples indicate that time lags involved from exploration to production range from a minimum of 5 years, and can commonly be up to 10 years. This means that CMP data used by an exploration company in a successful bid for exploration acreage awarded in 1988, would probably not result in any production until at least 1993. That is, measurable financial benefits related, in part, to the use of CMP information in 1988, would at best only begin to be realised in 1993. Such lags make it difficult to apply normal BCA techniques to the CMP, which only collected its first data sets in 1985, and made its first major public data releases in 1988. Financial benefits arising from the use of these data could only be expected to become visible about now, at the earliest.

Other major direct users of CMP information and services, other than the petroleum industry, are Commonwealth and State government programs. For these users the CMP can deliver economies of scale in the provision of information that might otherwise require the contracting of specific purpose commercial surveys. Benefits arise through cost savings involved in using CMP data and advice, rather than acquiring it at commercial rates through private industry. Quite often the information can be provided as a spin-off from studies related to other aspects of the CMP. Such benefits are better assessed using Cost Effective Analysis (CEA) rather than BCA.

THE PUBLIC GOOD ROLE OF THE CMP

A **public good or service** is one that cannot be priced accurately and hence cannot be efficiently supplied by industry, and thus is a genuine example of market failure. A public good has the following characteristics:

- *Non-rivalness in consumption* - a good supplied to one individual can be supplied to another at no extra cost.
- *Non-excludability* - an individual cannot be deprived of the good even though he may refuse to pay for it.
- *Impossibility of rejection* - an individual cannot abstain from consumption of the good even though he may wish to.

A more detailed discussion of the characteristics of a public good is contained in the report *An Economic Analysis of the Benefits of the RAN Hydrographic Program* by Coochey (1992).

Apart from specific benefits to client groups there is a clear **public good** aspect to many parts of the CMP through the wide publication and dissemination of geoscientific information and bathymetric maps, with benefits accruing to the resource (petroleum and mining) industries, the fishing industry, government and the scientific community, as summarised below. The public good aspect of geological surveys in general, and marine geological surveying in particular, appears to be recognised worldwide (Coochey, 1992), and many national governments support such activities because the knowledge derived underpins important resource export industries, supports resource, land/marine and environmental management, and contributes to meeting international obligations. Marine geological surveying is fundamental to answering questions as basic as *'what are the limits of Australia's territory and jurisdiction?'* The limits of Australia's land territory are readily recognised by its coastline, but definition of its adjacent marine territory requires geoscientific mapping beneath vast tracts of ocean. Whilst there are many ways of acquiring such information through both government agencies and private contractors, the overall responsibility for such activities is generally seen as that of central government.

ECONOMIC USES AND BENEFITS OF THE CMP

The economic uses and hence benefits of the CMP tend to fall into three main categories:

- **benefits that directly relate to the expected production of a marketable product**, such as petroleum, an exploration technique, and fish. Benefits occur to industry through production/sale of the commodity, and to Government through revenue related to taxes on exploration for, development of and production of the commodity
- **benefits that accrue to Government programs through cost savings** in the acquisition of data and advice.
- **other benefits**, such as those that accrue to the general scientific community, through increased understanding of fundamental scientific concepts, expanded research opportunities and training; and technology transfer.

The following list of economic uses of the CMP is arranged according to the above categories, and expressed in terms of **benefits** and *beneficiaries*. Clearly many of the uses and benefits are interlinked and not mutually exclusive.

BENEFITS RELATED TO A MARKETABLE PRODUCT (Industry and Government):

1. **Improved exploration efficiency** for *resource exploration industries*

2. **Improved service efficiency** of *exploration service companies*

3. **Assist identification of new deep sea fishing areas** by provision of a bathymetric map series for the *deep sea fishing industry*

Underlying these three benefits to industry is a benefit to Government in the form of increased taxation revenue; the value of these benefits are quantified where possible.

BENEFITS THAT ACCRUE THROUGH COST SAVINGS (Government):

4. **Improved estimates of Australia's offshore resource (petroleum) potential** for *Commonwealth government departments (DPIE) concerned with Australia's long-term energy policy.*

5. **Better administration and regulation of resource (petroleum) exploration and development activity** by provision of technical advice/information to *Commonwealth departments (DPIE) and State and Territory government departments acting as designated authorities for the Commonwealth (State/Territory mines departments).*

6. **Favourable international/national outcomes for Australia** by provision of geoscientific information to aid negotiation and definition of Australia's seabed boundaries by *Commonwealth government departments (DFAT, A-G's).*

7. **Favourable international outcomes for Australia** by maintaining a scientific presence ('waving the flag') around Australia's remote island territories for *Commonwealth government departments (DFAT, A-G's).*

8. **Improved management of Australia's maritime jurisdiction** by provision of bathymetric/geoscientific information to *Commonwealth government departments (AMSA - transport and communications; RAN Hydrographic Office - safety and defence; AUSLIG - mapping and establishing jurisdiction) concerned with Australia's offshore territory.*

9. **Improved management of Australia's marine environment** by provision of technical advice/information to *Commonwealth (DASET; Australian National Parks and Wildlife Service) and State/Territory government departments/agencies concerned with changes and use of the marine environment.*

10. **An ecologically sustainable (well managed) Australian deep sea fishing industry** by assisting with policy development through the provision of bathymetric information/maps to *Commonwealth government departments (AFMA - DPIE) concerned with deep sea fisheries.*

OTHER BENEFITS

11. **Advancement of scientific knowledge** by publication, training and co-operative studies for and with *the scientific community*

MEASURES OF CMP BENEFIT

In this paper we attempt to derive measures/indicators of benefit to beneficiaries of the CMP. Some of these measures are necessarily indirect and circumstantial, others are anecdotal, and some provide more quantifiable links between the CMP outputs and benefits. In the case of benefits related to a marketable product a BCA approach has been attempted where possible; for benefits accruing to Government a CEA approach has generally been used; and for other benefits (e.g. to the scientific community) a combination of CEA and a simple listing of benefits has been adopted.

It is important to realise that a single CMP output can be used in different ways, and produce different benefits, for each of the beneficiary groups. For example, consider the situation in which CMP outputs result in improvement and refinement of estimates of Australia's undiscovered petroleum resources. To Commonwealth government departments concerned with Australia's long-term energy policy such improvement can be of real benefit to the policy making process and long-term considerations of the supply/demand situation. It does not really matter to the policy department whether the resource estimate is increased or reduced as a result of the CMP, but simply that it is a better more refined estimate than before. The improvement is not realisable by the department in financial terms, but is never-the-less beneficial to its carrying out of its function. Also, the provision of such information to the department does not strictly fulfil all the normal criteria of a public good or service, particularly if the information is kept confidential. Similarly, if the same information refining Australia's undiscovered resources was provided to an exploration company it would not benefit the company in terms of a direct, realisable, financial return. However, it may well help the company plan its future exploration strategy resulting in efficiencies in its exploration program, which, in turn, could be financially realised at some time in the future. Such information can be considered to be an intermediate benefit to the company. Hence, CMP outputs that may be of real benefit to government, may only be of intermediate benefit to exploration companies, and may not be realisable by either as a direct financial benefit. In this paper we view such outcomes as being valid benefits to the general petroleum industry.

We now examine measures/indicators of benefit to the various beneficiary groups in the order listed above.

Benefits related to a marketable product

1. RESOURCE EXPLORATION INDUSTRIES

The CMP was approved by Cabinet in 1983 with one of its main objectives being to stimulate offshore resource, particularly petroleum, exploration and development. During recent years this resource-related objective has evolved, in line with general Government policy, and is now commonly stated to be to improve offshore petroleum and mineral exploration efficiency, in a manner consistent with the principles of ecologically sustainable development. In 1985 the CMP

collected its first data using the chartered vessel ***Rig Seismic***, and its first major public data releases began in 1988.

Prior to 1977 Government stimulation to offshore petroleum exploration was through direct subsidy payments to exploration companies. In the 1970's regional reconnaissance data to locate new basins and provide regional geological understanding of known basin systems, was collected around Australia by major multi-national exploration companies such as Shell, Mobil and Gulf. The BMR's 1970-72 Continental Margins Survey also provided some stimulus to exploration, particularly in remote, deep water areas such as the Exmouth Plateau. However, because of the increasing tendency of exploration companies to concentrate on the regions where discoveries were initially made, and their necessary focus on exploration permits, there was an general lack of good quality regional data available for understanding basin framework. It is difficult for exploration companies to risk scarce exploration resources on regional studies with no guarantee that the investment will even lead to more efficient exploration, let alone a discovery. A lack of regional understanding of the basin system, or the absence of a particular piece of information that is critical to understanding basin development, is what commonly leads to stagnation in exploration in a particular basin. Effectively, a 'market failure' develops, as pure market mechanisms are incapable of optimum allocation of resources. This can be overcome to some extent by Government strategies, such as the 1990 "Offshore Strategy", and programs such as the CMP.

The CMP can stimulate exploration by locating new exploration territory, and by the provision of new approaches and ideas that reduce exploration risk. The ultimate way to quantify the benefit of the CMP to the petroleum industry is by showing that CMP output has resulted in the discovery and production of petroleum from which both industry and government has gained financially. However, given the time lags involved (as previously discussed), it is unlikely that any such benefit can be identified at this stage, only some five years after CMP's first major data release. The approach adopted here is to examine shorter-term indicators of exploration activity and thus attempt to assess whether or not the CMP has had a positive effect on exploration. Indicators such as the number of new players in Australian exploration, the area under exploration, exploration expenditure, exploration success and CMP product sales have been used, as well as, less direct anecdotal evidence of CMP influence on investment decisions, and the CMP's predicted effect on the level of proven reserves and production. Some of these indicators allow estimates to be made of the expected financial benefit that will be realised by industry and government through production of petroleum.

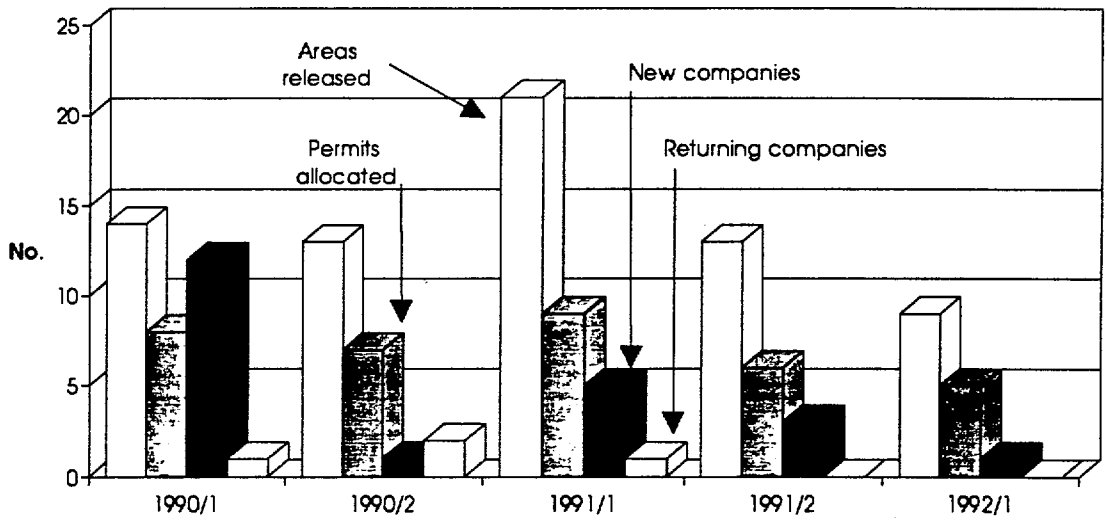
- **New players in the Australian offshore petroleum exploration industry since the CMP was established.**

Information on this measure has only been compiled for acreage releases since early 1990 and is summarised in Table 1 and Fig. 1a.

TABLE 1.

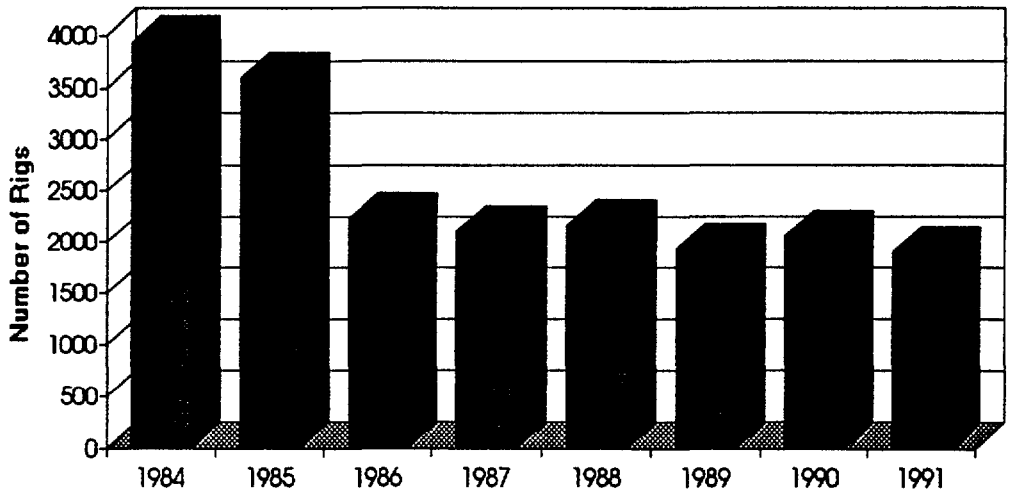
YEAR/Rel. No.	Areas released	Permits allocated	New companies bidding	Returning companies bidding
1990/1	14	8	12	1
1990/2	13	7	1	2
1991/1	21	9	5	1
1991/2	13	6	3	0
1992/1	9	5	1	0

Figure 1a. Acreage releases and new players



- During the five acreage releases from 1990/1 to 1992/1, 22 new companies that have not previously explored offshore from Australia submitted applications, and 4 companies that have previously explored in Australia expressed an interest in returning to the region.

Figure 2: World-wide Rig Count



- Figure 2 illustrates the world-wide downturn in exploration activity from 1985 to 1986 as shown by the total active rig count. This was caused by the dramatic decrease in the world oil price related to a sudden increase in Saudi Arabian production. There is a slight downward trend in world-wide activity from 1986 to 1991. This is quite different to the level of offshore exploration activity in Australia over the same period as indicated by permit take-up (Fig. 3), exploration expenditure (Fig. 4), exploration drilling (Fig. 12), and exploration seismic (Fig. 13). All these indicators show the decrease in activity to 1987 related to the low world oil price, but, unlike the world scene, this is followed by a rapid increase in activity to a 1990 high, with a relatively high level of activity being maintained throughout the early 1990's.

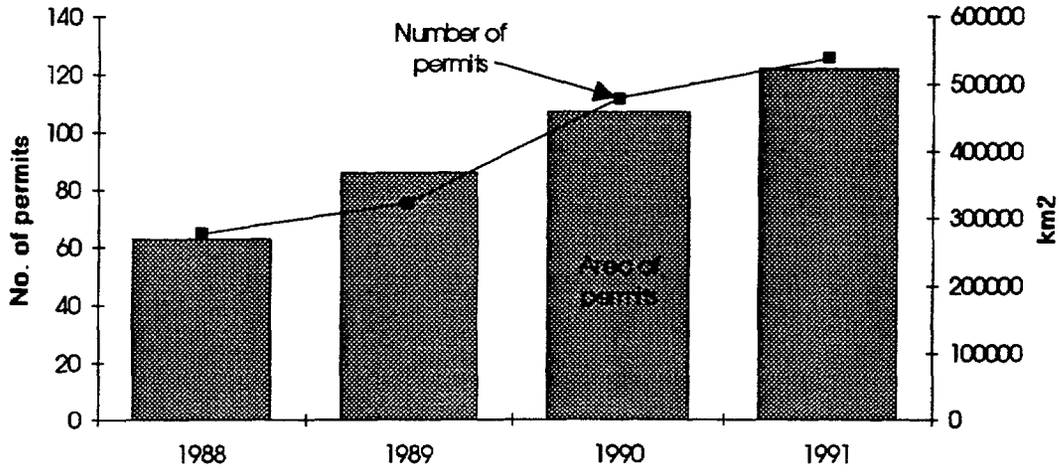
- There are undoubtedly a variety of reasons for this increased interest in offshore exploration in Australia during a general world-wide downturn, amongst which are the new acreage release policy contained in the DPIE 'Offshore Strategy" document (1990); improved marketing of new exploration areas and strategies; the perception of the international oil industry that Australia is an attractive country for new-venture exploration; an attractive taxation regime; and the ready availability of regional data, ideas and advice, such as that coming out of the CMP.

- ***It is clear that some component of the increased interest in Australian offshore exploration is a result of products, presentations (particularly at overseas meetings) and ideas generated by the CMP.***

☐ Area under exploration.

The number of offshore permits and area under exploration for the period 1988 to 1991, is shown in Fig. 3.

Figure 3. Number and area of permits



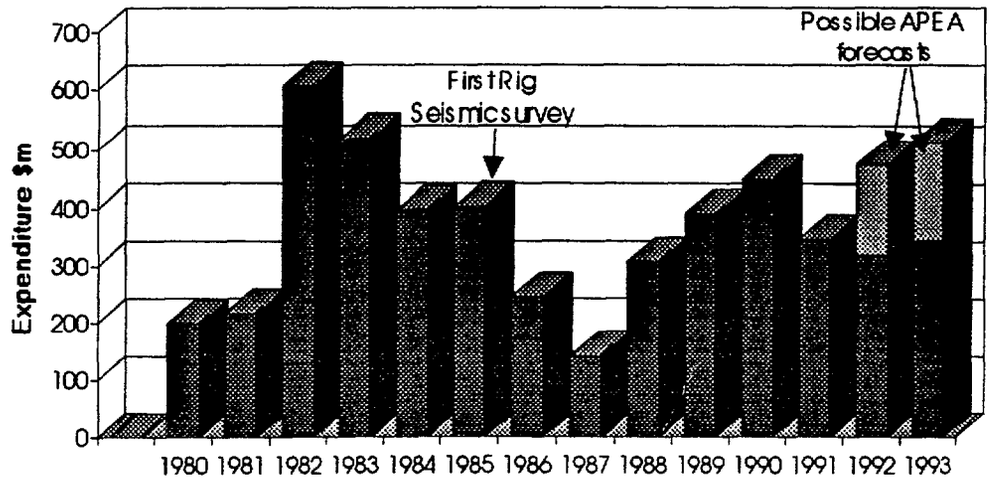
- From 1988 to 1991 there was a substantial increase in both the number of permits and the offshore area under exploration. This corresponds with a big increase in offshore exploration expenditure as shown in Fig. 4.

- Renewed interest by industry, as measured by increased bidding and take-up of petroleum leases, was in part prompted by new tectonic models and play concepts developed by the CMP (for example, in the Perth Basin, Otway Basin, Bass Basin, Eyre Sub-basin, King Island Sub-basin, Polda Basin, Duntroon Basin, Strahan Sub-basin, and Vulcan Sub-basin).

❑ Exploration expenditure.

Offshore exploration expenditure (in constant dollar value) from 1980 to 1991, including APEA expected expenditure for 1992, and its forecast for 1993, is shown in Fig. 4.

Figure 4. Offshore exploration expenditure



- Offshore exploration expenditure increased from a low of $143 million in 1987 to a high of $450 million in 1990, with possible expenditures of $474 million in 1992 and $511 million in 1993, based on APEA forecasts. Using only APEA's probable forecast level (shown by the dark grey on Fig. 4), expenditure has averaged about $330 million since 1990. Although the 1990 peak is substantially below the 1982 "boom" high of $600 million, it represents a significant investment in exploration, particularly given the depressed economic conditions in Australia during the early 1990's.

- Exploration expenditure appears to have stabilised during the last few years at a level that is probably above that of the mid-1980's (taking into account APEA's 'possible' forecast level).

- The $300 million increase in exploration expenditure from 1987 to 1990, and associated increase in the number of permits and area under exploration, all occurred prior to the release of the DPIE "Offshore Strategy" document. It partly reflects an increase in global oil prices and thus the financial return from exploration, although the minimum oil price of about Aus$22-23 per barrel occurred during 1988-89 (see APEA Petroleum Exploration and Production, May 1992). ***That is, exploration expenditure started to increase even while the price per barrel was dropping. This can be partly attributed to the CMP, and the general perception that it has helped create of Australia being an attractive place for new-venture exploration.***

- ***The increase in expenditure to a level beyond the $400 million of the mid-1980's (particularly given APEA's 'possible' expenditure forecasts for 1992 and 1993), may well reflect the influence of the CMP outputs.***

- A significant portion of the new commitment indicated by the permit take-up figures of Fig.3, is probably not yet fully reflected in exploration expenditure, as drilling is often not conducted until years 3-5 of a permit tenure. This time lag implies a further increase in expenditure during 1994.

- **Value of benefit related to increased exploration expenditure:**

  If it is assumed that exploration expenditure remains low when oil prices remain low, then the increase in offshore expenditure during 1988 and 1989 when oil prices are lowest implies some other factors are at work - perhaps in part the CMP. If the 1987 low is taken as the normal expenditure for this period, then the increases in 1988 and 1989 resulted in a total average annual extra expenditure of about $200 million above the norm. At a finding cost of $8 per barrel, this translates to an annual additional discovery of 25 million barrels of oil/gas equivalent, or about 12.7 million cubic metres (kilolitres).

  Assumptions: *An average finding cost of $5 per barrel. Finding cost is the average cost of discovering a unit of petroleum (oil and gas equivalent), that is probably commercially viable to produce. It is a difficult factor to determine accurately, but various approaches can be used to deduce an approximate estimate. Estimates using different approaches vary from about $3 to $8 per barrel, and an average of $8 has been used for this analysis.*

$5

1. ***Value of benefit to petroleum industry -***

   If exploration is 32% of total petroleum expenditure and the average after tax return is 8.1%, then $200 million equates to around $625 million in total petroleum expenditure and an annual return of around $50.6 million. If CMP contributed to 10% of that return then it would be worth $5.06 million to industry.

   Assumptions: *Exploration expenditure has been about 32% of total petroleum expenditure (exploration, development and production) since 1986. Average effective after tax return on funds employed was approx. 8.1% for 1988-89 (APEA Petroleum Exploration and Production, May 1992).*

2. ***Value of benefit to government -***

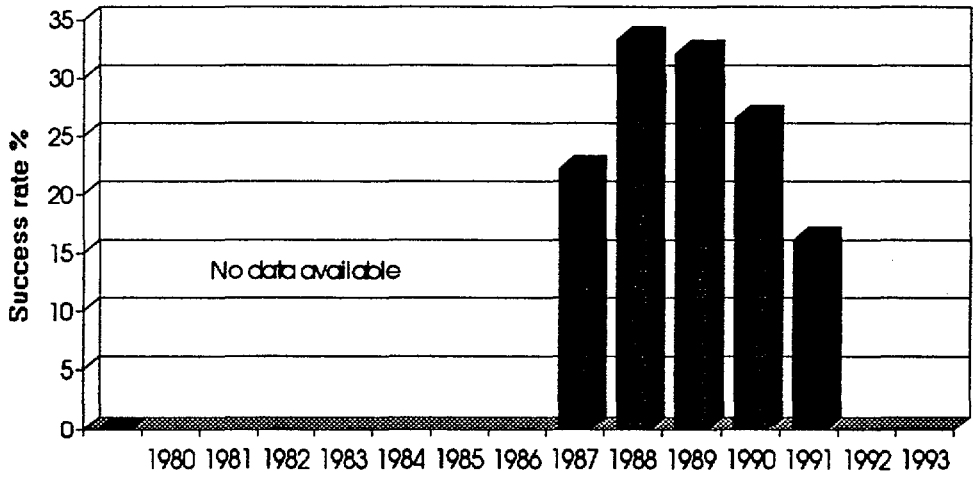
   About $233 million ($9.30 x 25M) from direct taxes, **$23.3 million related to CMP** assuming it produced 10% of increased expenditure.
   About $245 million ($9.80 x 25M) from all taxes etc. (direct, company, employees etc.), **$24.5 million related to CMP** assuming it produced 10% of increased expenditure.

   Assumptions: *Average Government revenue from direct taxes in 1988-89 was about $9.30 per barrel oil/gas equivalent. Average Government revenue from all taxes etc. in 1988-89 was about $9.80 per barrel oil/gas equivalent.*

- **Exploration success.**

The offshore new-field wildcat success rate (%) for the years 1987 to 1991 is shown in Fig. 5. Data were not readily available for previous years.

Figure 5. Offshore new-field wildcat success rates - %



- Success rate increased to a peak of about 32% in 1988/89 and accompanied increasing permit take-up and exploration expenditure. Peak success was reached prior to peak expenditure (1990), probably indicating discoveries were made from well defined prospects that had been put on hold during the 1987 downturn in exploration.

- ***It seems highly likely that CMP outputs contributed to improved regional understanding during this period (1988/89 was a time of relatively high CMP product transactions - Fig. 8), and thus had some influence on the increasing success rate during the late 1980's.***

❑ **CMP product sales.**

This is an important indicator because it is directly related to the use of CMP outputs. Can it be shown that the use of CMP products is of direct benefit to the petroleum industry because it results in the production of a marketable item - oil and gas?

The total cumulative revenue from CMP product sales since July 1988 is shown in Fig. 6. Prior to this time accurate records of product sales were not kept, and data releases were generally from remote deep water surveys that were not of immediate interest to exploration companies. Fig. 7 shows revenue from CMP product sales on a monthly basis from July 1988, and Fig. 8 shows the number of transactions on a monthly basis, as well as exploration acreage release dates and CMP product release dates. Fig. 8 allows a comparison to be made between the purchase of CMP products and the release of new exploration areas.

- From July 1988 to December 1991, product sales proceeded at a relatively even rate of about $200,000 per year. During 1992 the rate increased dramatically to about $600,000 per year, undoubtedly reflecting the release of our deep seismic data (processed and marketed jointly with NOPEC) for the Vulcan and Petrel Sub-basins, and southern NW Shelf (SNOWS I).

- A more appropriate way of analysing CMP product sales is through the monthly revenue and transactions figures of Figs. 7 and 8. These show the increase in sales of CMP products during 1992, but also indicate a saw-tooth characteristic to sales throughout each year, which mainly correlates with the release of exploration acreage, but also with major CMP product releases. In particular, early 88, early 89, late 89, early 90, late 90, late 91, early 92 and late 92 releases are followed by an increase in CMP product transactions (Fig. 8), and ***clearly indicate that exploration companies are utilising CMP products during their evaluation of acreage.*** For the purposes of this analysis it matters little whether these companies proceed to bid on an area or not, but simply that ***they have used CMP data to improve their exploration efficiency*** and direct their exploration dollar to the areas they perceive as being most prospective. Clearly some of the companies were successful in their bids, as indicated in Table 1, and Appendices P and Q of the Coopers & Lybrand benefit/cost report.

- In their analysis of the benefits of CMP outputs to company prospectivity assessments and bidding, Coopers & Lybrand compiled data on workplan expenditure for companies that successfully bid on areas and had purchased CMP data relevant to the permit area. ***Clearly CMP data contributed in some way to their geological understanding of the permit area, and thus contributed to their successful bid.*** For permits awarded from 1987 to 1992(first release) these companies planned to spend a total of $128.6 million in the first three years, and $262.2 million in the second three

Figure 6.

Total Marine Program Sales

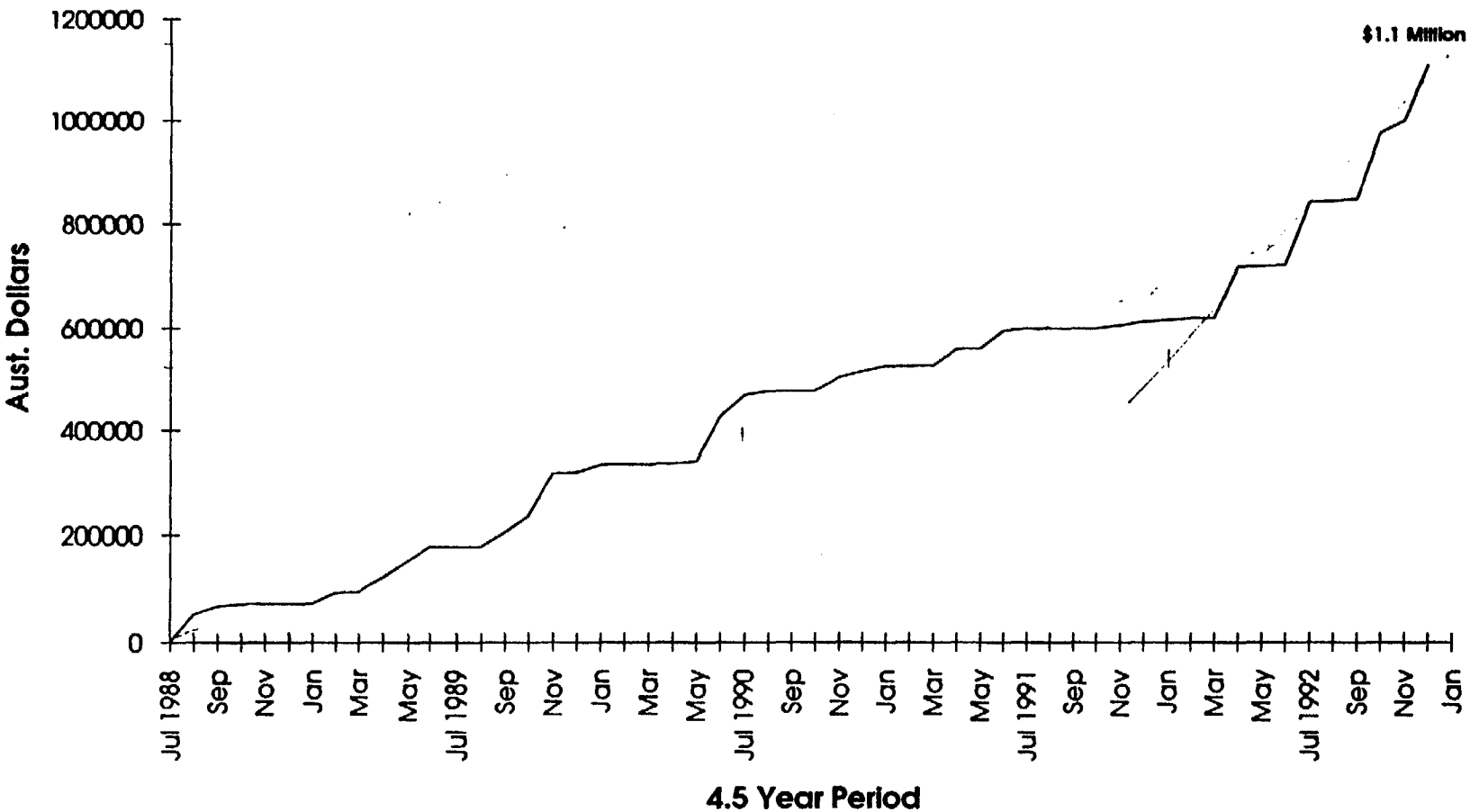


Figure 7.

Marine Program - Monthly Sales

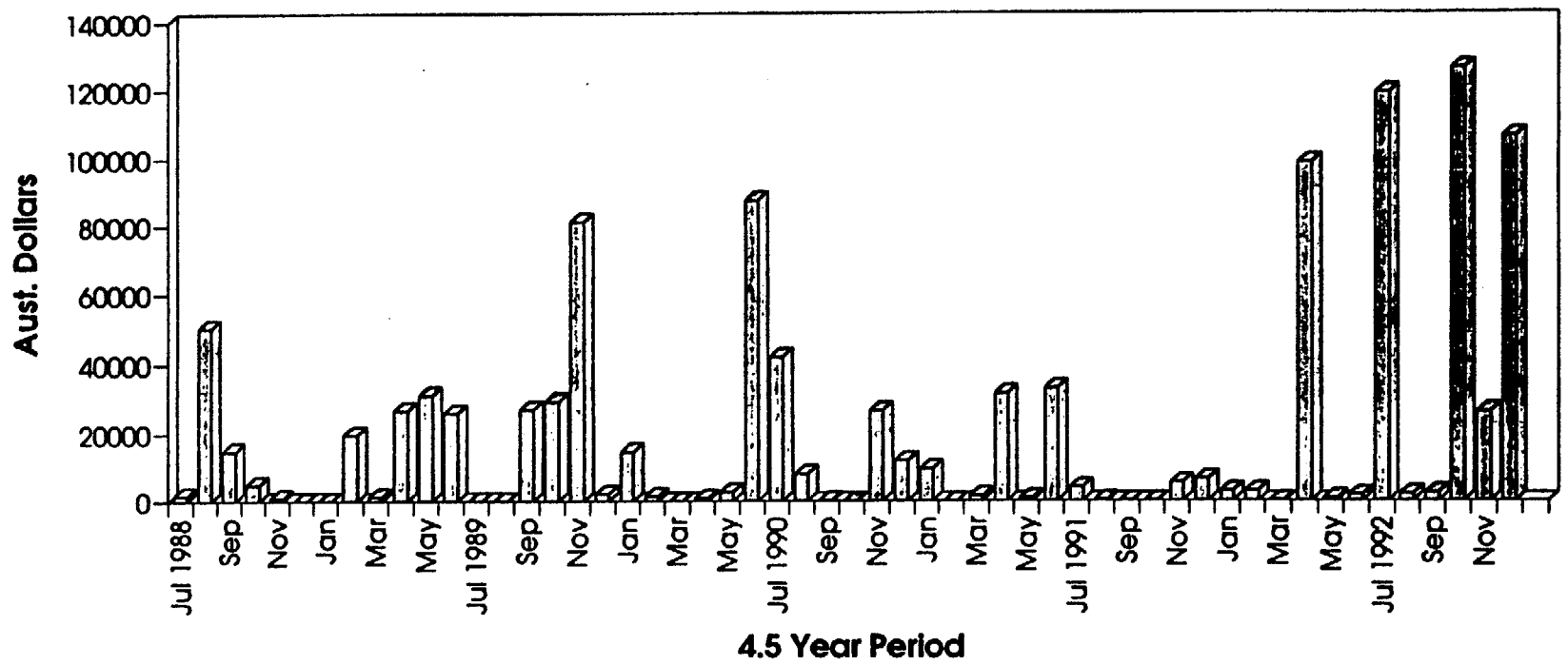
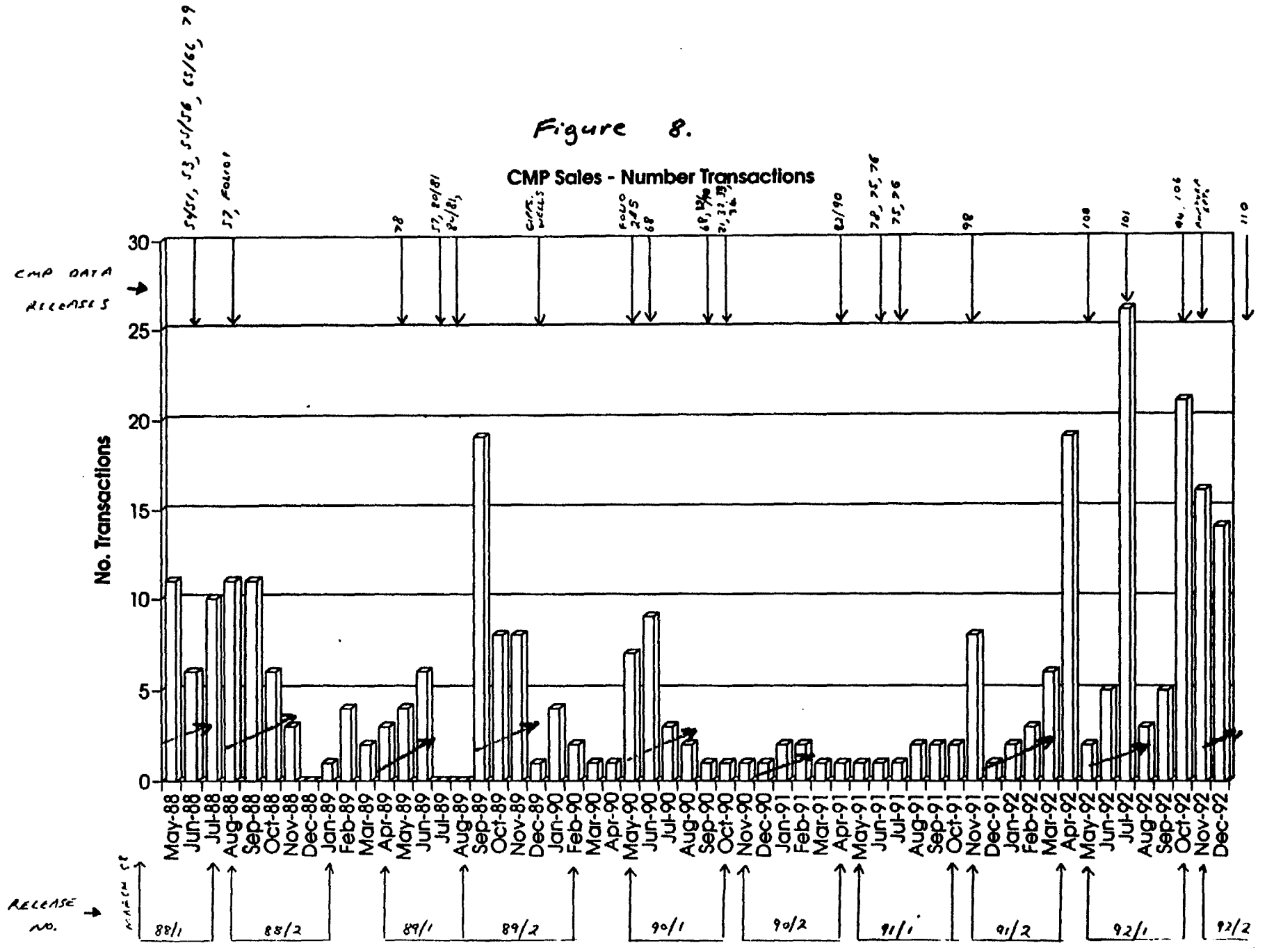


Figure 8.


CMP Sales - Number Transactions
No. Transactions
CMP DATA RELEASES
RELEASE NO.
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15
20
25
30
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Jun-88
Jul-88
Aug-88
Sep-88
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years of their permit tenure. ***That is, CMP data has contributed to producing a total planned exploration expenditure of $390.8 million during the 11 years from 1987 to 1997, from 10 acreage releases over 5 years.*** This equates to the CMP contributing to an average planned exploration expenditure of about $39.1 million per release, or about $78.2 million per year, assuming that this rate of expenditure is maintained throughout the period. Given an average offshore expenditure over the last few years of about $330 million, this translates to the ***CMP products influencing, in some way, an average of about 23.7% of exploration expenditure per year*** *(based on planned expenditure bid for permit releases from 1987 no. 1 to 1991 no. 2).* It needs to be pointed out that this influence is largely prior to the impact of our deep seismic program over the NW Shelf and northern Australian margin, which, going on current product sales, will have a much greater effect on the bidding process in the years to come.

- **Value of benefit from influence of CMP products on permit bidding:**

For exploration areas released in 1990 and 1991, and awarded in 1991 and 1992, companies that had purchased relevant CMP data planned to spend a total of $312.08 million on exploration over six years. Assuming this rate of planned expenditure continued, then the annual average, given 3 year exploration permits, is $156 million. At an average finding rate of $8 per barrel, this translates to the expected annual discovery of 19.5 million barrels of oil/gas equivalent, based to some extent on the use of CMP data.

1. ***Value of benefit to industry*** -
About $78.5 million per year
About $7.85 million per year related to the CMP assuming its outputs produced 10% of the expenditure.

Assumptions: *Exploration expenditure has been about 32% of total petroleum expenditure (exploration, development and production) since 1986. Average effective after tax return on funds employed was approx. 16.1% for 1990-91 (APEA Petroleum Exploration and Production, May 1992).*

2. ***Value of benefit to government*** -
About $156 million p.a. from direct taxes, $15.6 million p.a. related to CMP assuming it produced 10% of increased expenditure.
About $163.80 million p.a. from all taxes etc. (direct, company, employees etc.), $16.38 million p.a. related to CMP assuming it produced 10% of increased expenditure.

Assumptions: *Average Government revenue from direct taxes in 1990-91 was about $8 per barrel oil/gas equivalent. Average Government revenue from all taxes etc. in 1990-91 was about $8.40 per barrel oil/gas equivalent* ***(APEA Petroleum Exploration and Production, May 1992).***

About $195 million p.a. would be obtained from taxes, of which **$19.5 million p.a. could be related to the CMP** assuming 10% influence on expenditure.

Assumptions: *If Government revenue is increased to $10 per barrel for oil/gas equivalent (a figure suggested by DPIE's Petroleum Division).*

❑ **Proven reserves and level of production.**

Plots of total initial recoverable resources and cumulative production (offshore and onshore including both category 1 - currently commercial proved and probable reserves; and category 2 - reserves not yet declared commercial) for oil, sales gas, LPG and condensate for the period 1980 to 1990 are shown in Figs. 9 and 10.

Figure 9. Initial Reserves (Category 1+2)

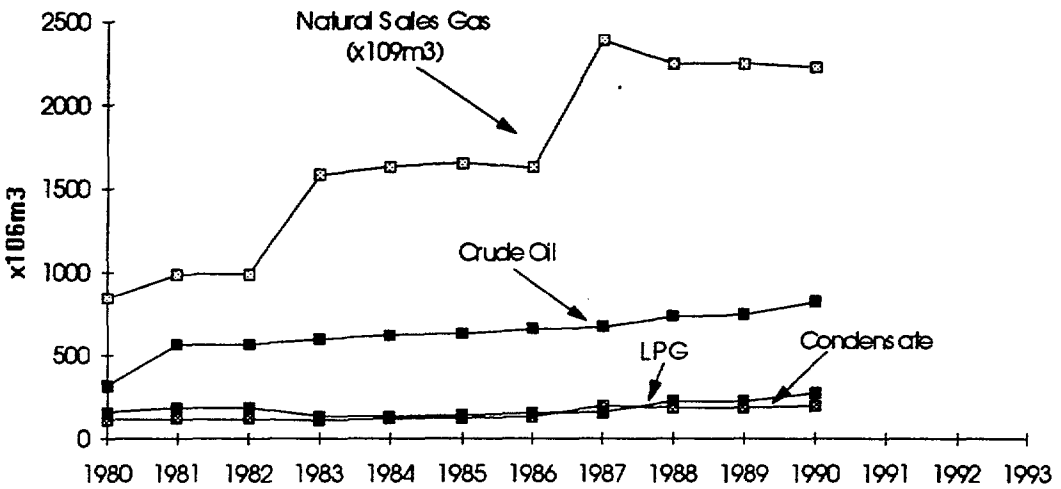
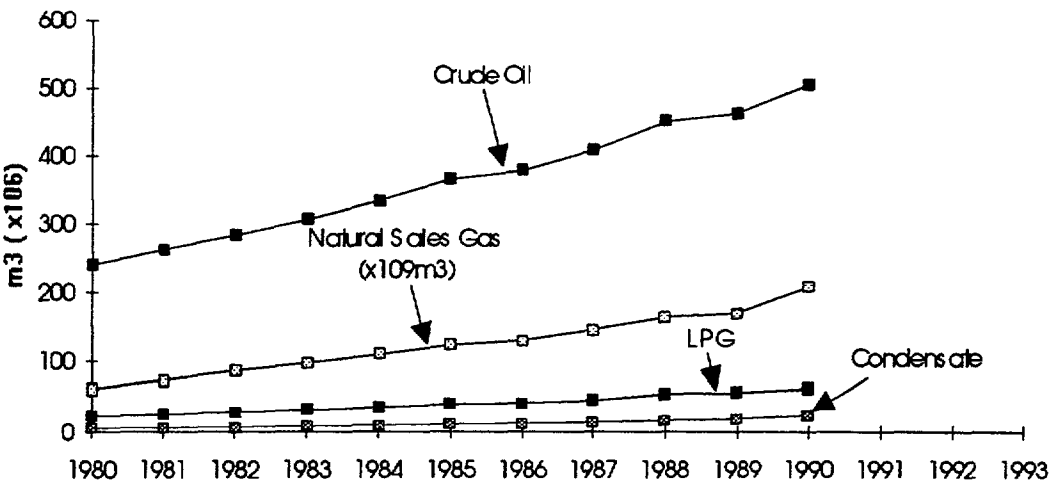


Figure 10. Cumulative Production



- Oil reserve increases and production have proceeded at a steady rate since 1981, and figures indicate that the remaining recoverable oil reserves have remained virtually unchanged since 1980 at about 260 million kilolitres. That is, the discovery of oil and increased reserves in known fields have kept pace with the use of indigenous crude oil. Remaining recoverable gas reserves have nearly trebled during the same period, mainly as a result of major discoveries on the NW Shelf.

- ***As outlined above, CMP outputs have contributed to increased permit take-up and exploration expenditure from 1987 to 1990, and general exploration efficiency,***

and will therefore contributed to the discovery of oil that should continue to allow the remaining recoverable oil reserves to be maintained at about their 1983 level.

- It will become more and more difficult to maintain the level of recoverable oil reserves as the 'easy' discoveries are made, and exploration starts to employ more complex and subtle play concepts, and needs to proceed into ever deeper water in search of prospective, virgin acreage. This is the time when regional geological understanding, such as that provided by CMP outputs, can have an increasing influence on exploration strategies. As recently stated by Mr. Nayoan, Senior Vice President and Director, Exploration and Production for Indonesia's Pertamina:

  "Unfortunately, levels of exploration activity are governed by the ideas of the petroleum geologists and available technology. I can't say that with the (new government) incentives we are going to sign so many production contracts, or find so many barrels of oil. ***It depends on the geological side."***

  Ultimately it is the geology of a region and the level of geological understanding that will control exploration expenditure and discovery of new reserves.

❑ **Anecdotal evidence - investment decisions use CMP outputs.**

There is a substantial body of anecdotal evidence both from AGSO files and communications, and from interviews with companies conducted during the Coopers & Lybrand cost/benefit study, that CMP outputs have influenced exploration investment decisions. A series of cases are summarised below to indicate the variety of such influence:

- **Bridge Oil (1988-89):** Bridge Oil held the exploration acreage over the Boobyalla Sub-basin of the Bass Basin in the late 1980's. They obtained the field tapes from AGSO CMP survey 82 over the sub-basin and processed 1100 km of data. The processed data was provided to AGSO by Bridge Oil at no charge. ***These CMP data were interpreted, combined with other pre-existing data and used by Bridge to produce maps, define prospects and aid exploration investment decisions.*** The data contributed to the definition of well sites, but drilling did not proceed at this stage because partners could not be found. Bridge Oil informed AGSO that the ***CMP seismic data in the area were the highest quality data ever shot in the permits.***

- **Conga Oil (1988-89):** Conga Oil is a very small exploration company mainly concerned with the Tasmanian region. They did not have the resources to meet the mobilisation charges for a seismic survey in the Bruny Is area off southern Tasmania, even if a contract seismic vessel had been available. During a CMP survey in the region, data was collected that allowed Conga Oil to assess the prospectivity of the southern Tasmania Basin. They also drew on CMP regional knowledge and expertise during their analysis. Such ***CMP work has the effect of initially producing a "level playing field" within the Australian exploration scene, such that very small, but perhaps innovative companies can obtain the regional data to allow them to assess exploration risk.***

- **Mobil (1991):** Mobil identified deep water prospects from CMP seismic data over the Great Australian Bight Basin, which they evaluated during their assessment of deep water acreage released during November 1991. Mobil did not proceed with a bid on this occasion, as an analysis of production economics indicated a discovery would not be viable at that time. Never-the-less, ***CMP outputs allowed them to make an efficient exploration decision***, and the prospects have been identified for further consideration at some time in the future. They contribute to Australia's inventory of undiscovered resources.

- **Maxus (1992):** Maxus recently used a combination of old AMOCO seismic data, and more recent CMP regional seismic data and interpretations to develop new prospects for the Strahan Sub-basin off west Tasmania. ***CMP data has resulted in renewed interest in a previously explored and sparsely drilled (one well) basin, with potential for discoveries.***

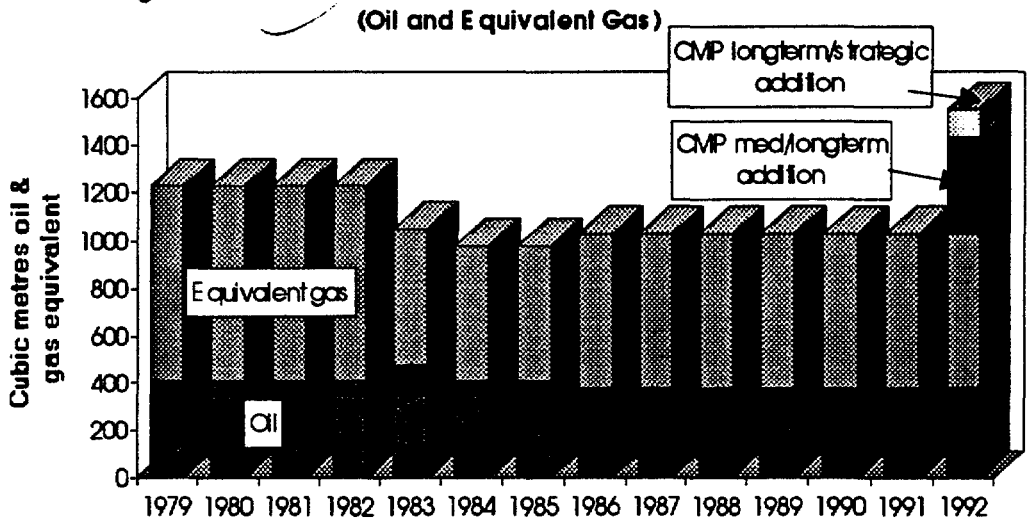
- **BP, Conoco, Enterprise Oil, Shell:** Major international explorers often conduct regional evaluations of the potential of virgin areas with a view to permit acquisition at some time in the future. In the Australian region the CMP is virtually the sole provider of regional seismic and other geological information in remote deep water areas around Australia. CMP outputs and expertise have directly contributed to evaluation of the Lord Howe Rise region by BP, Conoco, Enterprise, and Shell, and the ***CMP has played a part in long-term exploration investment decisions by these companies.***

❑ Undiscovered resources

An important function of the CMP is to collect data and carry out studies to advise government on Australia's offshore resource potential, particularly in the remote, deep water areas where there is no exploration activity.

Fig. 11 shows AGSO's estimates of total undiscovered petroleum resources (oil and equivalent gas) based on four assessments from 1979 to 1986. AGSO's last major systematic assessment, in 1986, indicated that there is the potential to find an average of 380 million kilolitres of oil and an average of 650 billion cubic metres of gas. That is, an average of 1030 million kilolitres of oil and equivalent gas. However, it needs to be borne in mind that this estimate only refers to conventional oil and gas accumulations contained in structures or stratigraphic traps that are not presently known to contain oil or gas, and that could be brought into production within the next 20-25 years. It therefore does not include any potential resources in very remote, deep water areas. Clearly this estimate does not represent Australia's total undiscovered resources within the whole of its offshore jurisdiction.

Figure 11. AGSO's Estimates of Total Undiscovered Resources (Oil and Equivalent Gas)



We consider that the CMP has had a substantial impact on the perceived petroleum prospectivity of Australia's continental shelf, slope, marginal terraces and plateaus. In general, it has enabled the potential petroleum resources to be upgraded. This upgrade has occurred in two main areas:

1. Specific plays and structures, new basins and extensions of basins beneath the shelf and adjacent margin that were imaged on CMP seismic data. These are considered to be **medium to long-term additions** to Australia's undiscovered resources. The main outcomes of the CMP in this area have been:

    - definition of specific petroleum plays and structures, such as the Triassic Reefs on the North West Shelf and the Bremer Basin anticlines, which lend themselves to statistical estimates of resource potential using Monte Carlo simulations;

    - mapping extensions to known basins, such as the Abrolhos and Houtman Sub-basins of the Perth Basin, from which basic estimates of petroleum potential can be determined using averaged parameters derived from regional seismic and well data;

    - discovery of new basins in exploitable and economically viable water depths, such as the Arafura Basin, from which crude estimates of petroleum potential can be made using volumetric yields from global analogues;

    - downgrading of potential, and consequent economy of exploration effort, in areas such as the Eucla Basin, Denman Basin, and probably Maryborough Basin, and throughout large continental margin provinces such as the Marion Plateau - the negative result is just as important as the positive in terms of exploration efficiency.

2. A general improvement in the regional knowledge of major, remote deep water features that has lead to the discovery of new, generally poorly defined basins or basin provinces. These are considered to be **long-term or strategic additions** to the undiscovered resources. The main outcomes of the CMP in this area are:

- discovery of remote basins, often in deep water, which may be a strategic resource into the next century (for example, the Gower Basin on the Lord Howe Rise with identified diapiric structures, the South Tasman Rise rift basins, the Recherche Sub-basin in the Great Australian Bight with numerous nappe-like structures, and the Raggatt Basin on the Kerguelen Plateau).

In the case of the medium to long-term resources, a study was carried out to examine the impact of the CMP in areas where new or renewed play concepts have been developed on the basis of CMP data. An attempt was made to provide an estimate of the risked additional resources created by the CMP. Owing to the frontier nature of many of the basins, potential reservoir parameters had to be estimated or extrapolated from the nearest explored areas, or alternatively potential petroleum yield was estimated using volumetric/analogue methods. Estimates were made for new features/play types in the Gippsland, Arafura, Maryborough, Capricorn, North Perth, Bremer, Polda, Denman, and Eucla Basins, the Eyre Sub-basins, Triassic/Jurassic reef plays of the NW Shelf. ***The total risked additional undiscovered resource potential based on CMP data in the medium to long-term category is 402 million cubic metres.***

Symonds & Willcox (1989) estimated the potential petroleum recovery of features beyond a 200 nautical mile Australian Exclusive Economic Zone. In several areas (Lord Howe Rise, West Norfolk Ridge, northwest Exmouth Plateau and Kerguelen Plateau) their estimates were based on new knowledge gained from CMP surveys. The full potential petroleum recovery for Lord Howe Rise is roughly double that beyond an EEZ. Using the figures of Symonds & Willcox (1989) the 'best' estimate of total potential petroleum recovery (oil and equivalent gas) for the above features is 2400 million cubic metres. If we leave aside the Kerguelen Plateau, because of its extreme remoteness, the estimate is reduced to 1500 million cubic metres. ***If we risk the total estimate at 0.05, then the average undiscovered resource potential in the long-term and strategic category is 120 million cubic metres.***

The total CMP-induced addition to Australia's undiscovered resources is about 520 million kilolitres of oil and gas equivalent, *as shown in Fig. 11.* ***That is, about one third of the total estimate of 1552 million cubic metres.***

- **Value of benefit from influence of CMP on assessment of undiscovered resources:**

  The assessment of benefit derived from additional undiscovered resources predicted by the CMP is based on expected financial return from production of some part of the resource.

  The CMP induced addition to Australia's undiscovered petroleum resources is 520 million kilolitres of oil/gas equivalent, or 3270.8 million barrels. This additional resource has been assessed from 8 years of CMP surveying, implying that about 408.9 million barrels have been added per year.

1. ***Value of benefit to industry -***
   About $1645.8 million per year
   About $16.46 million per year related to the CMP assuming 1% of resources assessed per year could eventually be produced.

Assumptions: *$8 per barrel to find. Exploration expenditure has been about 32% of total petroleum expenditure exploration, development and production) since 1986. Average effective after tax return on funds employed was approx. 16.1% (**APEA Petroleum Exploration and Production, May 1992**).*

2. ***Value of benefit to government*** -
About $4089 million p.a. from direct taxes, **$40.89 million p.a. related to CMP** assuming 1% of resources assessed per year could eventually be produced.

Assumptions: *Average Government revenue from direct taxes is about $10 per barrel oil/gas equivalent.*

- **Value of benefit (cost saving) to exploration companies through CMP definition of non-prospective areas - improved exploration efficiency:**

CMP collects seismic data over large areas of Australia's margin and basin systems. Sometimes these surveys are specifically designed to examine the petroleum potential of areas that are virtually unexplored, and such areas may turn out to have no petroleum potential. The saving to exploration companies of not collecting reconnaissance seismic data over such non-prospective areas, means that they can invest the equivalent resources in more prospective areas.

1. ***Value of benefit to industry*** -
About $0.75 million p.a. (Assumes same factors as used in previous calculations in undiscovered resources section).

2. ***Value of benefit to government*** -
About $3 million p.a. (Assumes same factors as used in previous calculations in undiscovered resources section).

2. EXPLORATION SERVICE COMPANIES

CMP benefits to the exploration service industry are derived from enhanced opportunities due to the development of new techniques and approaches, and from increased exploration expenditure and activity resulting from the use of CMP outputs, particularly at bidding time during acreage release.

❑ New techniques and approaches.

The CMP has introduced and developed several techniques and approaches that are recognised as being of great help to the exploration industry. In some cases it is only the results from these systems that are of interest, and in other cases companies see benefit in being able to routinely collect the data themselves. Both situations, but particularly the latter, open up new survey and acquisition possibilities for exploration service companies.

- **Deep regional multichannel seismic lines** - CMP developed a technique of acquiring long, regional seismic lines tying existing wells; extending across the whole margin and basin province; extended record lengths of up to 16 sec., capable of imaging the lower

crust and upper mantle; with an energy source designed to give deep penetration; and with acquisition parameters that give an excellent result in both the shallow and deep parts of the section. This technique has been used to study the primary basin architecture of the NW Shelf over the last few years, and the results have created enormous interest with explorationists. The data is readily purchased by industry and used for regional evaluations, prospectivity assessments, and as an important aid during permit bidding. Data of this type has rarely been acquired by industry in the past, but the CMP surveys have illustrated the important part deep data can play in understanding basin evolution and regional tectonics, which are fundamental to the development of petroleum systems.

The success of the CMP within this niche is illustrated by the considerable company interest in, and purchase of, the data; pre-commitment to some deep seismic data sets; and the fact that some interest has been expressed in contractors attempting to collect similar data sets themselves. This could open up new possibilities for seismic service companies, but possibly at the expense of the CMP.

- **High-resolution watergun multichannel seismic acquisition** - focusing on the 'post-breakup' sedimentary cover to resolve stratigraphic relationships in the drillable section; definition of geological/geochemical sampling targets; images 'modern' structural reactivation influencing trap formation and migration; improves well ties; allows modern process studies of depositional systems (e.g. reefs) that are important to the development of source and reservoir facies. The full potential of this approach has yet to be realised both within and outside the CMP.

- **Direct Hydrocarbon Detection (DHD - 'sniffing')** - CMP pioneered the systematic use and testing of the technique around Australia, and considerable interest has been expressed by the exploration industry, as seen by product purchases. A hydrocarbon expert from the United States Geological Survey recently said that the CMP's DHD program has produced the only believable DHD data that he has seen. It is currently the most significant DHD program anywhere in the world. ***The CMP has the potential to open up new possibilities for service companies.***

- **Regional data integration studies** - CMP has been in the forefront of carrying out regional studies using a wide variety of integrated data sets such as image-processed, high resolution aeromagnetic data, bathymetric/terrain data, gravity data, landsat images etc. to examine the tectonic setting and structural framework of basin systems. Many of the approaches were developed within the recently completed Vulcan Sub-basin study. Such studies are increasingly recognised by industry as important contributions to the geological understanding of their permit areas, and the development of new play concepts and exploration strategies. ***The growing interest in acquiring, processing and integrating such data sets has opened up new opportunities for exploration service companies.***

- **Value of benefit from new techniques and approaches:**

  Assume that CMP outputs resulted in the running of the equivalent of two high resolution aeromagnetic surveys per year.
  Value of benefit to service companies is about $0.11 million p.a.

Assumptions: *One 10,000 km aeromagnetic survey costs $150,000 for acquisition at $15 per km. and about $20,000 to process giving total cost of about $170,000 ($17/km). Assume company profit margin of 50% on top of normal running cost i.e. about 1/3 total cost of the program giving benefit of $56,700 for each survey.*

- **Anecdotal evidence of benefit to exploration service companies.**

  - **Enterprise Oil (1992):** Enterprise Oil stated that their decision to acquire two large scale high resolution aeromagnetic surveys over their Perth Basin and ZOC permit areas was strongly influenced by the results and approach of the CMP's Vulcan Sub-basin study. Enterprise encouraged CMP to continue with this type of study in its research over Australia's continental margin. ***The Enterprise surveys will result in increased service company activity.***

  - **Aerodata (1992):** Aerodata is an Australian geophysical service/consulting company which has its head office in Perth and operates internationally. The company indicated that the CMP's regional integrated studies of parts of the NW Shelf have influenced exploration companies around the world to consider such an approach over their permits. ***Aerodata consider that the results of the CMP study of the Vulcan Sub-basin area helped them win a large high resolution aeromagnetic survey in the Irish Sea.***

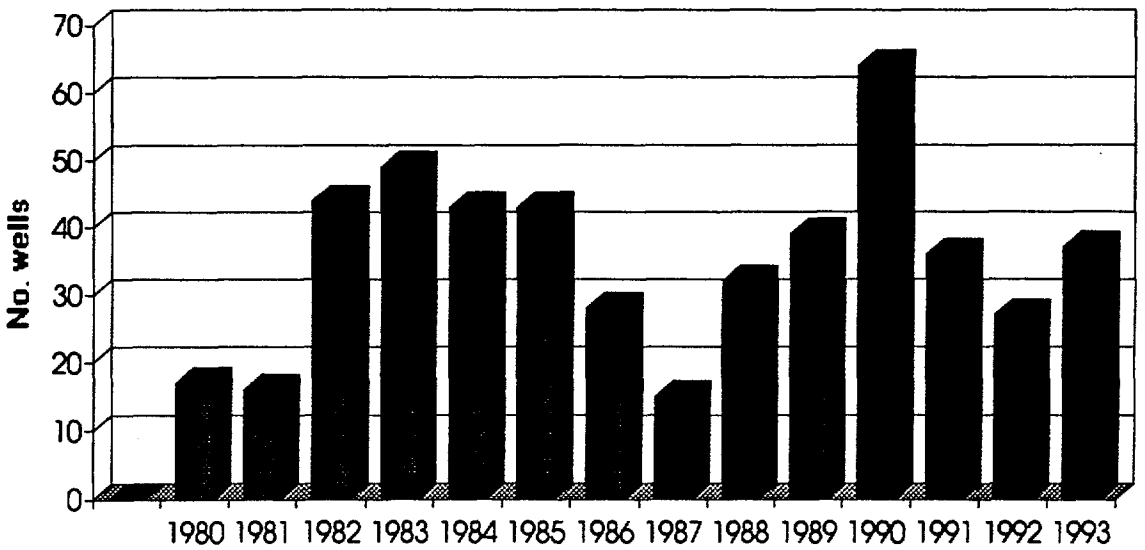
  - **Value of once off benefit to companies of these surveys promoted by CMP outputs:**

    Three high resolution aeromagnetic surveys plus processing.
    Value of once-off benefit to service companies is about $0.17 million (Uses same assumptions as outlined above for new techniques and approaches).

- **Exploration wells.**

  The number of exploration wells drilled in offshore Australia from 1980 to 1982 is shown in Fig. 12. The 1993 level is an APEA forecast.

Figure 12. Offshore exploration drilling



This graph has a similar form to previous plots illustrating offshore exploration activity - that is, there is a rise from a 1987 low of 15 wells to a 1990 high of 64 wells.

- As previously stated, CMP outputs have had some influence on the increasing exploration activity in the late 1980's, and therefore helped produce new possibilities and expanded opportunities for service companies, in this case drilling contractors. However, it needs to be said, that given the time lags involved in exploration and that drilling commitments are often made 3-5 years into permit tenure, ***significant increases in drilling activity related to the use of CMP products are not to be expected at this stage.***

  The drilling of the Yolla prospect in the Bass Basin by Amoco in 1985 was largely based on a BMR study of the basin, but much of the data used was obtained pre-CMP. Yolla made a non-commercial oil discovery.

- **Value of benefit to service companies through influence of CMP outputs on drilling:**

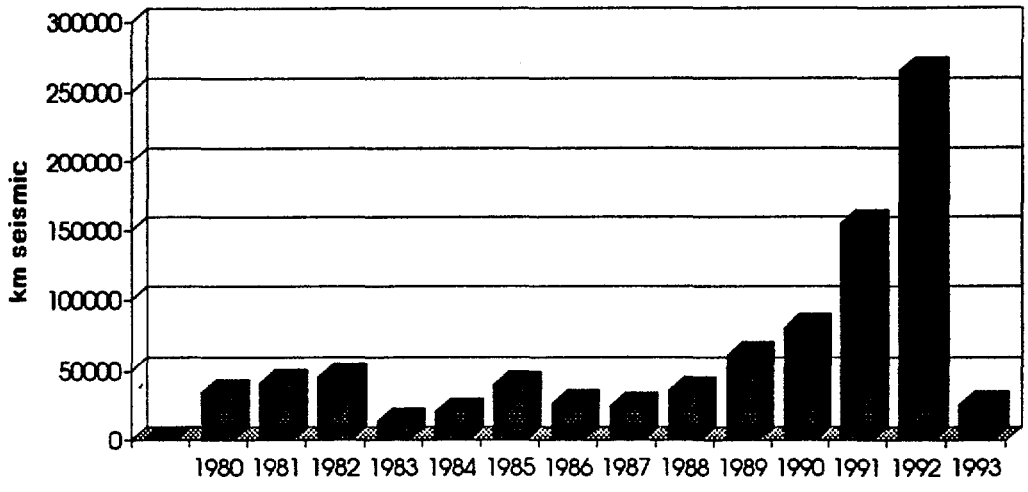
  Assume CMP outputs result in the drilling of two exploration wells per year
  Value of benefit is about $5.33 million p.a.

  Assumptions: Average offshore well costs about $8 million based on calculations from a variety of sources. Assume profit amounts to 1/3 of well cost giving a financial benefit to drilling contractor of about $2.67 million per well.

- **Seismic data.**

Offshore seismic activity in terms of line kilometres shot from 1980 to 1992, is shown in Fig. 13.

Figure 13. Offshore exploration seismic



- Shows dramatically increasing seismic acquisition from a low of 24873 km in 1987 to a high of 265000 km in 1992. A large component of this increase in 1991 and 1992 was undoubtedly due to major 3D seismic surveys on the southern NW Shelf. Interestingly, APEA's forecast is for a big drop-off in seismic acquisition in 1993. This may reflect the decision of some companies to hold off on further seismic shooting until the results of interpretation of the massive 3D data sets are known. Clearly the large increase in the level of seismic acquisition is in response to the general increase in exploration activity to 1990, and as argued earlier, the CMP contributed to this increase. The continuation of this trend through 1991/92, when other activity indicators were falling, may be the response to 3D survey activity. That is, there were fewer surveys, but more data were collected on each survey at a lower cost per km.

- ***CMP outputs have stimulated exploration through increased acreage take-up, leading to increased exploration expenditure and activity. Undoubtedly, some of this extra activity will have resulted in increased seismic acquisition, and thus financial benefit for seismic contractors.***

- **Value of benefit to service companies through influence of CMP outputs on seismic acquisition:**

Assume that CMP outputs encourage the collection of three extra 1000 km seismic surveys per year i.e. a total of 3000 km of data per year. This is only about 3% of total 2D seismic data collected in recent years, or about 0.9% of total seismic data, including 3D surveys.

Value of benefit to seismic acquisition companies is about $1 million p.a.

Assumptions: *One 1000 km seismic survey at $800/km costs $800,000. This is figure given in Coopers & Lybrand Benefit Cost Analysis and according to them is unlikely to include positioning, mobilisation, demobilisation and standby charges. If we assume these charges are levied at $25,000*

per day and amount to some 8 days per 1000 km survey the total extra cost is about $200,000 per survey. That is, total cost of 1000 km survey is about $1 million. Assume profit on survey is 1/3 of cost, the financial benefit to the seismic contractor is about $0.33 million per survey.

Annual value or benefit to government is estimated at 10% of annual profit or $0.1 million.

3. THE DEEP SEA FISHING INDUSTRY

The value of the Australian commercial fishing catch is about $1100 million per year. Fishing in shallow water is relatively well supported by navigation and bathymetric charts from the RAN Hydrographic Program, and past seafloor mapping programs conducted by the then National Mapping Organisation. However, the same level of seafloor information is not available to support the growing deep sea fishing industry. The CMP is the only group that routinely collects bathymetric information over the poorly surveyed, deep water parts of Australia's margin. It is in the process of producing the Offshore Resource Map series (ORMS) in co-operation with the Bureau of Resource Sciences and the Royal Australian Navy Hydrographic Service. These maps provide fundamental bathymetric and sediment-type information in support of fisheries and petroleum resource exploration and development, and environmental monitoring on the shelf and adjacent waters. Such maps are only possible to produce through the CMP, as it is the only group that collects such data throughout the whole of Australia's maritime jurisdiction.

The outputs from the ORMS project will be of great assistance to the deep sea fishing industry.

- Commercial fishing boats presently spend much time and money searching for trawlable ground in Australia's developing fisheries. Commercial vessel operators enter local detail on their own charts from data which they collect during fishing operations, but in most cases owners obviously treat this information as confidential. Thus, many operators are now constantly 're-inventing the wheel'. ***Generally available bathymetric and seabed information will improve the efficiency of deep sea trawling operations.***

- In 1988 the industry expressed its support and need for a detailed bathymetric map series over Commonwealth developing fisheries. ***It believed that the production of such maps would promote exploration in deep waters and save costs searching for trawlable ground.***

- The ORMS output is a clear public good aspect of the CMP.

- **Value of benefit to deep sea fishing industry from CMP outputs - bathymetric maps:**

  It is difficult to quantify benefit to the whole deep sea fishing industry but some idea can be gained by examining the Orange Roughy fishery.

Costs: - charter of fishing vessel is $3000 per day.
- can fill vessel in 2 days if all goes well; total charter cost is $60
- 40 tonnes of Orange Roughy @ $ 2000 per tonne is $80,000 for full vessel.
- total profit for 2 days is $74,000 or about $37,000 per day.
- the above figures are based on discussions with Bureau of Resource Sciences Fisheries Group.

Assume 20 vessels get an extra two full hauls of fish per year as result of CMP products i.e. $20x2x74,000 extra profit per year is obtained by the industry.

Annual value of benefit to industry is about $2.96 million.
Annual value to government is estimated at 10% of profit or $0.3 million.

Benefits to Government programs through cost savings

The following category of benefits are predicated on two assumptions:

- that CMP data exists and is able to be used in decision making and the provision of advice
- that CMP staff are available to provide advice as required based on their knowledge of Australia's continental margin.

In the counter-factual case, that is if the CMP did not exist, these new data would have to be collected, or decisions made or advice given based on lesser quality and lesser quantities of data.

These advisory functions, currently carried out by CMP staff, would cost far more to the Government agencies to either collect the data or have consultants familiarise themselves with pre-existing data on the area in question available through the P(SL)A etc.

The cost savings, provided to Government agencies by the CMP, and referred to in the following paragraphs are therefore absolute minima

4. COMMONWEALTH GOVERNMENT DEPARTMENTS - LONG TERM ENERGY POLICY

CMP scientists provide advice and information to various Government Departments (mainly DPIE) to help them in the development of long term energy policy. Benefits accrue to the departments through cost savings by CMP providing a more cost effective way of acquiring data and providing advice.

❑ Amount of Australia's offshore territory covered by CMP data

An important factor in the provision of information to departments to aid long-term energy policy formulation is extent of coverage by the basic data sets. Clearly, policy relating to Australia's full offshore jurisdiction requires adequate coverage of the full zone. Past assessments of the prospectivity of offshore Australia have never

considered the full zone, and can never therefore purport to represent the total picture.

- Roughly 40-45% of the continental margin around Australia and its territories has been covered by CMP seismic data. (See map - Fig. 14 for coverage adjacent to Australian continent). Obviously the level of coverage changes dramatically from one area to another, and from shallow to deep water. This estimate includes areas of the margin where the coverage might be as sparse as a line every 100-200 km, to areas on the shelf where lines may be only 10 km apart.

- Roughly 50-55% of Australia's margin has been covered by some form of CMP surveying and data collection - this estimate includes dredging stations, coring, DHD etc.

❑ Interaction with Commonwealth departments concerned with long-term energy policy.

CMP staff frequently provide advice to Commonwealth Departments at no charge. If charged at consultancy rates the 1992 figures of time provided on energy policy issues would be:

2 people for 10 days = 20 days

Cost savings costed @ $1000 per day ⇒ $20 000

Assumptions: Total cost per day is about $1000 including annual salary of $65,000 and overhead multiplier of 2.61 (from DOF).

5. COMMONWEALTH/STATE GOVERNMENT DEPARTMENTS - ADMINISTRATION AND REGULATION OF PETROLEUM EXPLORATION AND DEVELOPMENT

Provision of advice and information to support planning and regulation of onshore petroleum exploration and development activities is the joint function of state geological surveys and AGSO. However, offshore in the Commonwealth jurisdiction beyond 3 nautical miles, the responsibility lies largely with AGSO's CMP. The CMP is the only government group with the resources and facilities to be able to take on this task.

❑ Level of permit bidding.

The number of offshore permits and area under exploration for the period 1988 to 1991, is shown in Fig. 3.

- There was a substantial increase in both the number of permits and the offshore area under exploration. This corresponds with a big increase in offshore exploration expenditure as shown in Fig. 4.

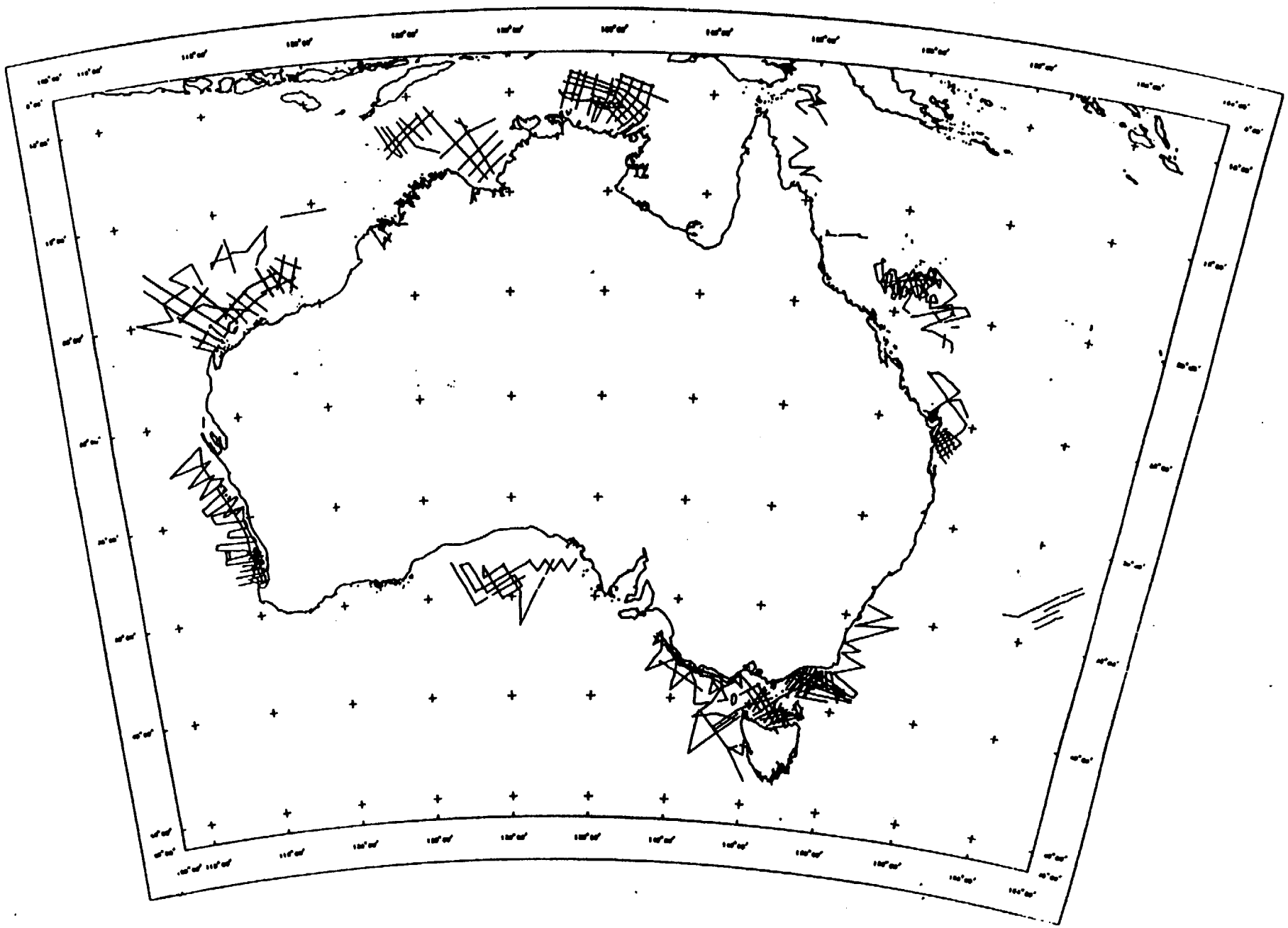


Fig. 04. Distribution of the 53,000 km of AGSO regional data acquired on the Australian continental margin from early 1982 to mid 1992. High-resolution seismic lines not shown.

- Renewed interest by industry, as measured by increased bidding and take-up of petroleum leases, was in part prompted by new tectonic models and play concepts developed by the CMP (for example, in the Perth Basin, Otway Basin, Bass Basin, Eyre Sub-basin, King Island Sub-basin, Polda Basin, Duntroon Basin, Strahan Sub-basin, and Vulcan Sub-basin).

❑ **Interaction with Commonwealth departments concerned with planning and regulation of petroleum exploration and development.**

CMP staff frequently provide advice to other Commonwealth Departments at no charge.

- The CMP was actively involved in the development of the DPIE document "Offshore Strategy - promoting petroleum exploration offshore Australia" through formulation of the regional release program, and integration and coordination of the strategy with the CMP future survey program.

If departments were charged at consultancy rates, the 1992 figures of time provided on petroleum exploration planning and regulation issues would be:

- Exploration permit definition: 4 people for 5 days
  Cost savings @ $1000 per day ⇒ $20 000

- Bidding interviews: 6 people for 0.5 days
  Cost savings @ $1000 per day ⇒ $3 000

- General interaction with DPIE Petroleum Division, BRS etc:
  5 people for 2 days
  Cost savings @ $1000 per day ⇒ $10 000

- Review of permit bids: 3 people for 5days
  Cost savings @ $1000 per day ⇒ $15 000

- **Total value of cost savings from CMP involvement:** **$48 000**

6. COMMONWEALTH GOVERNMENT DEPARTMENTS - FAVOURABLE INTERNATIONAL OUTCOMES FOR AUSTRALIA IN INTER-GOVERNMENT SEABED BOUNDARY NEGOTIATIONS AND CONTINENTAL SHELF DEFINITION

The CMP has an important responsibility in relation to the establishment and management of Australia's seabed jurisdiction by providing government with technical advice, information and expertise on seabed morphology, geology and resource potential. This responsibility has two main aspects:

1. Areas involved in seabed boundary negotiations and delimitation with

adjacent coastal states (as discussed previously).

2. Definition of the `legal' continental shelf around Australia and its territories.

- There can be little that is more fundamental to a national government than knowing the limits of its legal jurisdiction and responsibilities. In the case of the island continent of Australia this limit will necessarily involve defining a boundary at sea according to internationally agreed principles.

- The CMP's **Rig Seismic** is the only available government research vessel capable of cost-effectively acquiring the full range and quality of data necessary to fully advise government on the morphology, geology, and petroleum and mineral potential in these areas.

Seabed boundary negotiations

Australia still has to finalise seabed boundary negotiations with Indonesia - between Christmas Island and Java, and in the western Timor Trough/northern Scott Plateau area; and with New Zealand - between Lord Howe Island and New Zealand on the southern Lord Howe Rise, Norfolk Island and New Zealand on the West Norfolk Ridge, Macquarie Island and New Zealand on the northern Macquarie Ridge, and Macquarie Island and Campbell Island on the southwestern Campbell Plateau. Regional surveys and framework studies will be required in some of the areas to be negotiated, to ensure that the Australian Government can be provided with appropriate and timely information and advice on their morphology and resource potential. It is difficult to predict when these data sets will be required; however, it seems likely that some negotiations with both Indonesia and New Zealand will occur during 1993, and it is possible that the delimitations could be finalised as early as 1994. Once full negotiations commence they can be expected to proceed to completion quite rapidly.

Past negotiations that have used CMP data were the boundary with Indonesia along Australia's northern margin, in particular adjacent to Timor; the resolution of the so-called Timor Gap and establishment of a Zone of Co-operation with Indonesia; boundary with France in the New Caledonia/ northern Lord Howe Rise area and on the Kerguelen Plateau.

❑ Counterfactual argument.

An interesting question to consider is what would have been the result of these negotiations if geological information, particularly CMP data, had not been available?

- *Australia/Indonesia boundary adjacent to Timor:* Marine geoscientific information was critical to Australia's stand in these negotiations. Australia argued that the Timor Trough is a major bathymetric feature which separates the continental shelves of Australia and Indonesia, and is a fundamental geological boundary which marks the natural prolongation of the Australian continent. Indonesia argued that geology and

morphology were unimportant and that a normal median line was more appropriate. The geological information used mainly pre-dated the CMP (although it was acquired during BMR's first Continental Margins Survey), but the geological understanding of these data sets was provided from expertise within CMP. If Australia had been forced to accept the median line argument it would have lost large areas of shallow water shelf adjacent to Timor containing sub-basins of the Bonaparte Basin and Sahul Platform' including the highly prospective Kelp (Dome) Structure. The resource potential of this large structure has been estimated to average 70 million kilolitres of crude oil (Forman, 1992), a little less than half the potential of the entire Bonaparte Basin (155 million kilolites).

Indonesia initially accepted Australia's geology/morphology based argument to some extent, and early segments of seabed boundary were a compromise between the centre of the Timor Trough and the median line. Indonesia did not place any weight on these arguments during later negotiations and a stalemate was reached. Eventually the boundary in the Timor Gap area was left unresolved but a Zone of Co-operation was established so that both Australia and Indonesia could benefit from the exploitation of any petroleum resources in the area. Leases have now been let, and a massive and expensive exploration programme is underway. Australia's boundary negotiation stance, based partly on CMP input, has opened up the possibility of considerable benefit flowing to Australia should discoveries be made in the area. ***Certainly the geology/morphology arguments used allowed Australia to maximise its claim.***

- *Australia/PNG seabed boundary in Gulf of Papua region:* These negotiations finished in 1978, and highlight what can happen when geological information is not given much weight in developing negotiation strategies. The original boundary with PNG in the Gulf of Papua area was considerably further north then the present boundary - about 80 nautical miles north. During negotiations Australian territory was given up in the Portlock Reef area. In 1989, International Petroleum Corporation discovered the huge Pandora gas field, which is a buried reef on the same structural high as the modern Portlock Reef. Original estimates of dry gas reserves were about 3 trillion cubic feet, although apparently this has now been reduced somewhat. IPC mapped several other drillable reefal prospects in the vicinity of Pandora.

  If more weight had been given to geology and resource potential during the PNG/Australia negotiations, a strategy could have been adopted in which Australia attempted to retain this area. By not doing so it lost a substantial gas reserve, along with other similar undrilled prospects in the immediate area.

- **Interaction with Commonwealth departments concerned with negotiating Australia's seabed boundaries.**

  CMP staff frequently provide advice to other Commonwealth Departments at no charge. If charged at consultancy rates the 1992 figures of time provided on seabed boundary issues would be:

  - 2 people for 1 month or 30 days
    Cost savings from CMP involvement @ $1000 per day ⇒ $60 000

- Once-off special ***Rig Seismic*** surveys conducted for the purpose of collecting data to aid seabed boundary negotiations. The CMP has carried out two such surveys - one in the Christmas Is area in early 1992 and one over the Australia/New Zealand seabed boundary zone in late 1992.
  Cost savings from data collection using Rig Seismic on 2 surveys is $1.56 million.

Assumptions: ***Cost of acquisition and processing using Rig Seismic.*** *Coopers & Lybrand costed a Rig Seismic seismic survey at $607 per km. 3000 km survey cost $1.82 million CMP's seismic data processing costs recently estimated as $115 per km. Total cost for acquisition and processing of 3000 km Rig Seismic survey is $2.17 million.*
Cost of acquisition and processing using commercial contractor. *Seismic survey costs about $800/km. This is figure given in Coopers & Lybrand Benefit Cost Analysis and according to them is unlikely to include positioning, mobilisation, demobilisation and standby charges. If we assume these charges are levied at $25,000 per day and amount to some10 days per 3000 km survey the total extra cost is about $250,000 per survey. That is, total cost of 3000 km survey is about $2.65 million. Assume commercial processing cost of $100 per km - 3000 km = $300,000. Total cost for commercial acquisition and processing of 3000 km of seismic data is about $2.95 million.*
Cost savings by using Rig Seismic for 3000 km survey are about $0.78 million.

Definition of Legal Continental Shelf

- The concept of a legal continental shelf (LCS) defined by a series of rules or formulae is quite distinct and different from the morphologically defined continental shelf of a geographer. In the past, Australian offshore legislation has been linked to the 1958 Geneva Convention on the Continental Shelf. The Australian Government recently approved the adoption of new and revised maritime zones with the LCS now being defined according to the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Australia has signed but not yet ratified the 1982 Convention. UNCLOS is now not far off the number of ratifications required to bring it into force internationally and, following the co-operation shown at recent UNCLOS meetings, it is possible that this could happen in the next few years. If Australia does ratify UNCLOS it has up to 10 years, from entry into force of the Convention, in which to submit particulars and data to support its claim to a LCS beyond 200 nm.

- The 1982 LCS definition, as contained in Article 76 of the Convention, basically adopts a geomorphological view of a continental margin beyond the 200 nm line, and it provides a series of rules to arrive at a `legal' outer limit for the LCS. ***Full application of these rules requires location of the foot-of-continental-slope, knowledge of sediment thickness to at least the edge of the continental rise, and good bathymetric information defining the 2500 m isobath.*** The outer limit of the LCS must be defined at least every 60 nm around parts of margin extending beyond 200 nm, and thus a considerable technical data base is needed in these areas, consisting of high quality seismic reflection data, and associated bathymetric, gravity and magnetic information. These same data are also required for an assesssment of the resource potential of the margin.

- The area of the Australian LCS is approximately 12 million km^2, and eight regions of this LCS, totalling more than 3 million km^2, extend beyond the 200 nm line.

- A precise foot-of-continental-slope line (based on echo sounder or seismic profiles rather then contoured bathymetry) can only be defined for about 15-20% of these regions, and an outer edge-of- margin line based on the sediment thickness formula cannot be constructed for any of them.

- Regional bathymetric and seismic profiles at a spacing of 60 nm or less are required across the areas of margin extending beyond 200 nm where a precise foot-of-slope and sediment thickness line cannot be constructed. Although the collection of seismic data may not result in an increase in the area of LCS that can be claimed, with the possible exception of the Great Australian Bight, it will allow an assessment to be made of the resource potential of these remote regions.

- Regional bathymetric and seismic data for LCS definition purposes is required in the following regions - the northern, northwestern and southwestern margins of the Exmouth Plateau; the northern and western margins of the Wallaby (Cuvier Plateau) and probably around the adjacent Zenith Seamount (outer Wallaby Plateau); central Great Australian Bight south of the Ceduna Terrace; around much of the southern two-thirds of the South Tasman Rise; the southwestern and western margins of the Lord Howe Rise; the northwestern and northeastern margins of the West Norfolk Ridge; and around much of the southern Kerguelen Plateau .

- The collection of data for this purpose will probably need at least 8 normal **Rig Seismic** cruises (about 3000 line km of data per cruise). The use of a high-speed seismic streamer would speed up the data collection and reduce the number of cruises required in very remote, poorly known areas such as the Kerguelen Plateau.

- **Cost savings from use of CMP (Rig Seismic) to acquire and process 3000 km of seismic data for LCS definition based on one such survey per year:**

  Savings derived from use of Rig Seismic rather than a commercial contract vessel. **Cost savings are about $0.78 million per year**

The above serves to illustrate the magnitude of the task in front of Australia if it is to adequately define its legal maritime jurisdiction and ensure that maximum benefit accrues to. Clearly the collection of data to support such a task is in the nature of a **public good,** although benefits may spin-off to other client groups. For example, the petroleum exploration industry will benefit from a better assessment of Australia's undiscovered petroleum resources in the remote, deep water parts of the margin; the fisheries industry will benefit from improved bathymetric maps etc.

.. COMMONWEALTH GOVERNMENT DEPARTMENTS CONCERNED WITH FAVOURABLE INTERNATIONAL OUTCOMES - *"WAVING THE FLAG"*

- **CMP surveys of Australia's remote island territories.**

The CMP conducts surveys around Australia's remote island territories for the purposes of seabed boundary (legal continental shelf) definition and assessment of long-term resource potential. The CMP has carried out four such surveys - the central Lord Howe Rise Survey 46; the Heard Is./ Kerguelen Plateau Survey 47; the Christmas Island Survey 107; and the southern Lord Howe Rise Survey 114. Further surveys are planned for this purpose over the next few years. Apart from the scientific benefits arising from these surveys, they also serve an important 'flag-waving' role around Australia's remote territories.

- **Cost of CMP surveys carried out for this purpose:**

3.5 seismic surveys (1 survey every 2 years) have so far been conducted for this purpose (survey 46 was a relatively short survey) at average cost saving of $0.78 million per survey.
Annual cost saving by using Rig Seismic is about $0.39 million.

- **International development assistance and co-operation.**

Rig Seismic has been a very high-profile platform for projecting Australian scientific and technological capabilities through the S.E. Asian and S.W. Pacific region. The AIDAB funded Philippines survey carried out in early 1992 resulted in development assistance money being kept in Australia that could easily have gone to an overseas contractor if the facilities of the CMP had not existed.

The total AIDAB funding for this project is $4.85 million of which about $3.3 million is for data acquisition and processing - both of these activities were conducted using CMP facilities (Rig Seismic and AGSO seismic processing centre) and staff. There is also a substantial training and interpretation component involved in the Philippines project, and this is forming stronger scientific and technical ties between Australian and Philippine colleagues. Such interaction has long-term benefit to Australia, as it forms the basis for harmonious relationships with our Asian neighbours in the important area of resource exploration and exploitation.

8. COMMONWEALTH GOVERNMENT DEPARTMENTS CONCERNED WITH MANAGEMENT OF AUSTRALIA'S MARITIME JURISDICTION

During all of its surveys around Australia the CMP routinely collects bathymetric information over the poorly surveyed, deep water parts of Australia's margin. This, along with all other available information is being compiled around Australia by the CMP to form a series of thirty three 1:1 million map sheets called the Offshore Resource Map series (ORMS), which will be progressively updated as required.

- The ORMS project is being conducted in co-operation with the Bureau of Resource Sciences and the Royal Australian Navy Hydrographic Service.

- The ORMS maps provide fundamental bathymetric and sediment-type information in support of fisheries and petroleum resource exploration and development, and environmental monitoring on the shelf and adjacent waters.

- There are already quite detailed maps and charts available for large parts of the shelf and upper slope in less than 300 m of water produced by National Mapping (AUSLIG) and the RAN Hydrographic Service. However, there was no equivalent systematic coverage, at a reasonable scale, of the deeper water parts of Australia's margin. All that has been available are the 1:1million GEBCO sounding sheets, which only compile ocean sounding depth data as numbers on sheets, and are not contoured for easy interpretation and immediate visual impact; and contoured compilations at various scales produced for research purposes.

- The ORMS map series is only possible to produce and update through the CMP, as it is the only group that routinely collects such data throughout the whole of Australia's maritime jurisdiction. Many of the available compilations are based on extremely old data, some dating back to soundings made by Cook and Flinders (1802-03).

- The maps will support all management, research, defence, environmental and jurisdiction issues in the continental shelf around Australia and its territories.

- The ORMS series is a clear public good output from the CMP.

- Because the CMP often operates in areas of Australia's maritime jurisdiction that are rarely visited, it occasionally contributes to chart updates and modifications, which can have a significant influence on safety. For example, during surveys off northeast Australia the locations of major reef complexes were accurately determined. Lihou Reef was found to be out of position, as was the reef front of the Great Barrier Reef between east of Mackay, and numerous reef complexes at the northern end of the Great Barrier Reef. Accurately positioning such features is clearly of great importance to shipping traffic, and the safety of vessels and the protection of human life. It has been estimated that the minimum cost of a death to the Australian community is in the region of $0.7 million ("An Economic Analysis of the Benefits of the RAN Hydrographic Program" by Coochy, 1992). Loss of human life related to poorly located shipping hazards, such as reefs, is both a tragic and expensive outcome.

- During its 1992 survey in the Christmas Island area CMP's vessel ***Rig Seismic*** rescued six Indonesian fishermen.

COMMONWEALTH/STATE GOVERNMENT AGENCIES CONCERNED WITH MANAGING THE MARINE ENVIRONMENT

The CMP is involved in aiding understanding and management of Australia's marine environment in a variety of ways: through fundamental research into the marine geoscientific aspects of global change, which can establish baselines for monitoring modern, man-induced change; environmental monitoring using unique, specialist techniques only available on **Rig Seismic**; and through the provision of morphological, geological and resource information during the process of establishing special environmental zones, such as marine parks and reserves.

- **Global change.**

The CMP has carried out extensive research programmes in environmentally sensitive areas such as the Great Barrier Reef, to understand the various environmental factors, such as climate, oceanography and sealevel change, that have affected the growth of the reef. Such information is vital to long-term management of the region as it provides a baseline by which we can judge and predict the effects of future global (both natural and man-induced) change. Through its interaction with the Great Barrier Reef Marine Park Authority and AIMS, the CMP has contributed to management and preservation of the GBR - an important national asset. A 1990-91 estimate of the financial value accruing to the GBR-related community placed it at a minimum of $1110 million per year (Coochy, 1992).

- **Environmental monitoring.**

Recently the CMP has been involved in environmental monitoring programmes with state government agencies as part of its Marine Processes and Environment Program.

- **Development and testing of new techniques.**

CMP has modified its DHD ('sniffer') technology for use in water pollution off Australia's major cities and ports. Several tests have been conducted in Bass Strait and off Sydney, and culminated in a recent (late 1992) survey of the Sydney shelf to monitor pollutants from the Sydney sewerage outfalls. This study was conducted in co-operation with the Sydney water Board, NSW Geological Survey and Sydney University. The study demonstrated the validity of the technique and consideration is being given to miniaturising it for use on smaller vessels. This may open up new opportunities for environmental service groups.

- **External contributions to 'sniffing' studies.**

  - The Sydney Water board contributed $330 000 to the 2 week survey, plus 7 scientists and technical officers. The CMP contributed the other $330 000 plus 19 CMP scientists and technicians.

  - Cost savings to Sydney Water Board through use of Rig Seismic:
    Estimates of costs for operating a contract vessel for geological surveys is

provided by R. Whitworth in Appendix F to CMP Evaluation Report. A 15 day contract survey could cost about $0.74 million, where as ***Rig Seismic*** would cost about $0.45 million. Sydney Water Board contribute $0.3 million to the survey.
Cost saving to Sydney Water Board for the 15 day survey was $0.44 million.

-As a result of test surveys, and the Sydney water board study, further possibilities for the use of the technique are under discussion with the Melbourne Water Authority and the Geelong Water Board.
This is not included in cost savings in Table 2 as it is a one-off survey and may not be repeated.

❑ **Marine parks and reserves.**

THE CMP has a role to play in providing technical advice, information and expertise on seabed morphology, geology and resource potential for areas that are under consideration for marine parks and reserves. Such information should help to ensure that balanced decisions are made within a framework of sustainable development.

- The CMP has not as yet conducted any dedicated surveys for this purpose; however, it is has, through its data bases and expertise, contributed to decisions related to the GBR Marine Park, and parks/reserves around Middleton and Elizabeth Reefs, Lord Howe Island, head of Great Australian Bight, and Shark Bay.

- It is conceivable that, at some time in the future, framework studies of the margin adjacent to the Australian Antarctic Territory may be necessary, prior to declaration of protected zones etc.

- Advice on the morphology and resource potential of areas under consideration for national parks and reserves has normally been based on existing data, although a more pro-active role may need to be played in the future.

❑ **Cost savings by using Rig Seismic for environmental surveys:**

Average of one cruise every 2 years for this purpose, but not necessarily all at one time. An estimate of cost for a contract geological survey is given by R. Whitworth (AGSO) in Appendix F to CMP Evaluation Report.
- 30 day contract geological survey costs about $1.48 million.
- 30 day ***Rig Seismic*** geological survey costs about $0.9 million.
Cost saving on one such survey is $0.58 million, thereafter annual saving of $0.29 million

COMMONWEALTH GOVERNMENT DEPARTMENTS CONCERNED WITH DEEP SEA FISHERIES MANAGEMENT

As mentioned previously, the CMP is the only group that routinely collects bathymetric information over the poorly surveyed, deep water parts of Australia's margin. It is in the process of producing the Offshore Resource Map series (ORMS) in co-operation with the Bureau of Resource Sciences and the Royal Australian Navy Hydrographic Service. These maps provide fundamental bathymetric and sediment-type information in support of fisheries and petroleum resource exploration and development, and environmental monitoring on the shelf and adjacent waters. There are already quite detailed maps and charts available for large parts of the shallow shelf, but there is no systematic coverage at a reasonable scale of the deeper water parts of Australia's margin. Such maps are only possible to produce through the CMP, as it is the only group that collects such data throughout the whole of Australia's maritime jurisdiction.

- Current deep water maps/charts do not show sufficient detail (100 m isobath contours) in most areas to permit ready planning of demersal trawl survey work which is envisaged by or on behalf of the Australian Fisheries Service, the Bureau of Rural Resources, and other research organisations such as the CSIRO. This was recently demonstrated during a scientific survey of fish resources in the Great Australian Bight, when vessels had to search large areas for trawlable ground. ***Thus the ORMS maps will help fisheries managers define and investigate fishing grounds and stocks.***

- ***The ORMS maps help in the management of Australia's $1100 million fishing industry.*** The benefit to this industry is reflected in the support for the project by the various fisheries agencies throughout DPIE.

- ORMS maps can be use to identify new deep sea fishing grounds, such as for the much sought after Orange Roughy (deep sea perch). This fish is obtained from 500-1200 m of water off southern Australia in specific habitats such as canyons, troughs and channels. This fishery alone had a 1991 commercial value of $45 million. This species is a slow growing long-lived fish and will take a long time to recover from any overfishing. ***Careful management of the resource is necessary and will be greatly helped by the ORMS series.***

- The CMP currently has a contract scientist devoted solely to the task of collating, checking and contouring data for ORMS, as well as other scientists and technicians on a part time basis.

- **Cost savings to Government programs concerned with deep sea fisheries management:**

  The savings can arise through better definition of appropriate trawlable ground. Research and management agencies conduct surveys of deep sea fish resources on a fairly regular basis, and in order to save time they need to be able to readily locate trawlable seafloor with characteristics appropriate to the species being studied. For example, the Orange Roughy's habitat is deep channels and canyons in

500-1500 m of water. CMP bathymetric outputs, such as the ORMS maps, can dramatically improve the efficiency of such surveys.

Assume appropriate survey vessels cost about $10,000 per day to run and two are used on each survey of say 30 days duration. If 6 days survey time are lost for each vessel due to inadequate bathymetric information, the cost per survey is about $0.12 million.
Annual cost savings based on one such survey every 2 years could amount to $0.06 million.

Other benefits

11. THE SCIENTIFIC COMMUNITY

The CMP has established the only 'blue water' geoscience research program in Australia, and this has produced significant spin-offs to the general scientific community, both within industry and academia, through the collection of new data, the output of new ideas and approaches, training facilities, and the attraction of further resources and opportunities through co-operative studies with other countries and programs, such as the Ocean Drilling Program (ODP). The CMP has carried out a considerable body of research on fundamental issues such as the marine geoscientific aspects of global change, and the basic processes and concepts involved in the evolution of Australia's continental margin.

❑ The data

- The CMP has produced an enormous amount of data from its surveys since 1985. For example up until about mid-1992:
  75747 km of seismic data
  163578 km of bathymetric data
  170287 km of gravity data
  99681 km of magnetic data
  20335 km of DHD data
  926 geochemical samples
  444 seafloor grab samples
  267 dredge samples
  2314 cores
  108 heatflow stations

  These data form a vast resource for future studies of offshore Australia. In the area of seafloor sampling the CMP has produced a quantum leap in the amount of data available. These data sets are an invaluable aid to higher degree studies and training in the marine geoscience discipline.

❑ Reports and publications

- The CMP has produced a large volume of reports and publications on the results of its studies. For example, up until mid-1992:
  68 AGSO Records

9 AGSO Reports
4 AGSO Folios
103 scientific papers

❑ **Use of CMP outputs**

- The direct contribution of CMP studies to the petroleum exploration industry can be gauged by examining CMP author citation in industry-oriented journals such as the APEA Journal and the PESA Journal. ***From 1985 to 1992 CMP scientists totaled 654 citations in these journals*** - that is about 82 per year, and this includes the first few years of the program during which projects were only gaining momentum. Also it does not include publications in international petroleum journals such as the AAPG Bulletin.

❑ **Training and collaboration**

The CMP has been involved in substantial training programs with Australian and overseas universities and institutes through participation on Rig Seismic cruises, and analytical work in CMP's various laboratories.

- Four students participated on the recent Sydney Shelf study carried out in co-operation with the NSW Geological Survey and the University of Sydney. The University of Sydney has allocated $100 000 over the next 5 years to ensure that students can be involved in CMP programs.

- Over 12 students have completed higher degrees based on CMP data or using CMP expertise.

- Over 100 scientists representing more than 50 organisations from Australia and overseas have collaborated on various studies within the CMP.

❑ **Co-operative studies and additional resources.**

Major co-operative studies/ventures leading to substantial external funding and/or resources have been carried out with:

The Cooperative Centre for Antarctica and Southern Ocean Environment
Technical research Centre of Japan National Oil Corporation
Sydney University
Sydney Water Board
NSW Geological Survey
Ocean Drilling Program, through Australia's membership of a consortium with Canada
NOPEC
AIDAB
Philippines Office of Energy Affairs

- **Value of benefit to the scientific community:**

  The benefit arises through the collection of data, and the provision of opportunities for co-operative studies and training as a result of CMP surveys on ***Rig Seismic.*** Universities in Australia do not have the money available to fully fund a research cruise on this vessel, so the benefit provided by CMP is the full cost of a cruises. Assume, as a minimum case, that only one cruise every 2 years is run for the purpose of providing data to the general scientific community. The cost of one seismic survey plus processing is estimated at $2.17 million for 3000 km of data, and the cost of one 30 day geological cruise is estimated as $0.9 million. Assuming the research cruise is made up of half seismic and half geological acquisition, the cost would be about $1.54 million.
  Value of benefit of one mixed (seismic/geological) research cruise to the scientific community is about $1.54 million, this equates to $0.77 million annually.

CONCLUSION

This study has shown that there are a substantial number and variety of benefits arising from the CMP to both industry (through returns on investment), and Government (through taxation) from the expected production of marketable products, such as petroleum; to Government programs through cost savings associated with data collection and advice; and to the general scientific community through advancement of knowledge, data and training. An attempt has been made to quantify some of these benefits, but it needs to be stressed that the analysis is a simple one, and only examines first-stage effects. Issues such as flow-on effects and other spin-offs throughout the economy are not assessed, and therefore the full economic benefit of the CMP would be considerably larger than portrayed here.

The value of benefits from the CMP, in each of the categories mentioned above, is summarised in Table 2.

P.A. Symonds
MGPG
March 1993 (final version)

Table 2: Categories and value of benefit from AGSO's Continental Margins Program

Nature of benefit	Value of benefit		
	To Industry ($m p.a.)	Tc Government ($m p.a.)	Total ($m p.a.)
Benefits that directly relate to the expected production of a marketable product including Government revenue etc.			
• **Petroleum** - increased exploration expenditure in 1988-89 (assume CMP produced 20% of increase)	5.06	24.50	29.56
• **Petroleum** - influence CMP on bidding (assume CMP produced 20% of increase exploration expenditure)	7.85	19.50	27.35
• **Petroleum** - influence CMP on undiscovered resources	16.46	40.89	57.35
• **Petroleum** - CMP definition of non-prospective areas - improved exploration efficiency	0.75	3	3.75
• **Exploration techniques** - CMP development of new techniques/approaches	0.11	0.01	0.12
• **Exploration techniques** - CMP influence on drilling	5.33	0.53	5.87
• **Exploration techniques** - CMP influence on seismic acquisition	1	0.10	1.10
• **Deep sea fisheries** - CMP bathymetric data/maps	2.96	0.30	3.26
	39.53	**88.83**	**128.36**
Benefits to Government programs via cost savings			
• **Long-term energy policy**		CMP advice - 0.02	0.02
• **Administration/regulation resource exploration & production**		CMP advice - 0.05	0.05
• **Seabed boundary negotiations**		CMP advice - 0.06 CMP survey - 0.78	0.84
• **Definition of legal continental shelf**		CMP survey - 0.78	0.78
• **Favourable international outcomes - "waving flag"**		CMP survey - 0.39	0.39
• **Management of maritime jurisdiction**		0.29	0.29
• **Deep sea fisheries management**		CMP data 0.06	0.06
	0.00	**2.43**	**2.43**
Other benefits			
• **Scientific community - data, co-operation, and training**		CMP survey - 0.77	0.77
	0.00	0.77	0.77
sub total benefits	**39.53**	**91.26**	**0.77**
TOTAL BENEFITS			**131.55**

APPENDIX 4
11

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

29 January 1993

The Chairman
Review of the Australian Geological Survey Organisation
Department of Primary Industries and Energy

ATTENTION: Mr Geoff Gorrie

Dear Dr Richards

"RIG SEISMIC" AND THE CONTINENTAL MARGINS PROGRAM

I understand from the Executive Director, AGSO, that during your meeting with the AGSO Advisory Council on Friday 21 January, concern was expressed that current arrangements to charter and operate "Rig Seismic" were inappropriate, and that AGSO's Continental Margins Program (CMP) is now behind, and will slip further behind, industry standards for seismic acquisition. A question has therefore been raised that the Review might consider a recommendation that the "Rig Seismic" charter could be terminated and AGSO move to contract operations for both seismic and geological acquisitions offshore. This submission seeks to clarify the background to AGSO's decisions in these matters.

The option of moving to contract operations has been raised on several previous occasions, and is currently being examined in the AGSO Advisory Council Evaluation of the CMP being undertaken with the assistance of the Department of Finance. There are compelling arguments, however, for both continuing with "Rig Seismic" and planning for an eventual replacement, rather than contracting out. It should be noted that the largest single component of marine operations is already "out-sourced" - namely ship charter and maritime (ie non-scientific) operations. The cost of this component, $5.4 million in 1992/93, is the main "discretionary" element of the CMP budget allocation from which the cost of contracting and the costs and penalties of decommissioning "Rig Seismic" could be found.

Current Scope of the CMP

There are three elements of the Marine Program which form the objectives of the Continental Margins Program:

Australian Geological Survey Organisation
A research bureau of the Department of
Primary Industries and Energy

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- Petroleum - regional basin studies in areas of direct relevance to exploration (including impending gazettals) and frontier areas (60%).

  Offshore Minerals and Environment - studies of surficial sediments of economic potential and significance in terms of their role in the modern marine environment (20%).

- Law of the Sea - definition of the extent of Australia's maritime jurisdiction under the convention, and the long term economic potential of such areas and areas where bilateral delimitation may be required (20%).

Current Scope of Operations:

These program elements define specific operational systems and methods:

- Multichannel seismic acquisition - long, regional lines tying existing wells where possible; extending into very deep water; involving extended record lengths of up to 16 seconds, and an energy source designed to give deep penetration.

- High-resolution multichannel seismic acquisition - focussing on the "post-breakup" sedimentary cover; stratigraphic relationships and evolution; definition of geological/geochemical sampling targets; involving 0.5 to 1 millisecond sampling and short record lengths of 1 to 2 seconds. The high-resolution energy source is changed to suit the problem.

- Underway geophysics/geochemistry - routine gravity, magnetics and bathymetric data acquisition, contributing to the national database; targeted trace hydrocarbon anomaly detection ("sniffing").

- Seabed sampling - coring, dredging and heatflow measurements in water depths of up to 7000 m.

The overall program could keep one research vessel fully occupied. Apart from "Rig Seismic" there is no single vessel of any kind in Australia, or the region, set up for such multidisciplinary operations. There is no other vessel in Australia or the region specifically configured for the deep seismic acquisition mode, although several contractors could presumably meet these specifications at a price.

There is no vessel in Australia or the region currently configured for high resolution seismic acquisition and geological/geochemical sampling. I believe that a key factor is that the CMP does not require 3-D acquisition or intermediate resolution 2-D acquisition, where the focus is prospect definition in the 1 to 4 second depth range.

Current Data Acquisition Standards and Costs

There is a misunderstanding of the quality of seismic data collected by "Rig Seismic". Following the Woods Review, there has been a major effort to bring the equipment up to a level comparable to that needed by industry. This upgrade is now essentially complete and includes:

- A commercial differential GPS navigation system that provides 5 - 10 metre accuracy anywhere around the Australian Continental margin; this offers accuracy approaching that of radio navigation, at a fraction of the price, and is gradually being accepted worldwide.

- Sleeve gun arrays - these use the types of air gun that have become almost the industry standard because of their reliability and efficiency in the use of high-pressure air.

- A transformerless seismic streamer cable with 288 seismic channels. This top-end analog cable is now giving noise levels comparable to those of digital cables costing at least twice the price. The best deep seismic penetration in Australia has been obtained by "Rig Seismic".

- Compass units and an active tailbuoy to accurately position the cable, to make its output compatible with the 3D seismic data collected by industry.

The current CMP Program Evaluation has found that our deep multichannel seismic acquisition costs in 1991/92 were around $A600 per km. This is arguably below comparable commercial data acquisition costs in Australian waters, and on the low end of the commercial range in Southeast Asia, despite the vessel being geared to multi-purpose operations which necessarily carries a premium.

The quality of current AGSO deep regional seismic data must be judged against its purpose for basin (not prospect) analysis. Over the last 12 months, AGSO has been highly praised by industry for the quality of its data (particularly surveys 101 and 110) and this has been reflected in data sales (AGSO share) of $383,000 in the first half of 1992/93. We were recently asked to tender for regional seismic acquisition in Vietnam by both PetroVietnam and Nopec on a commercial basis. Our Philippines data have been acknowledged as the best in the region surveyed.

It is important to differentiate between 2-D and 3-D seismic acquisition and the overheads involved. The equipment now used is essentially identical, but the intensity of acquisition is different. "Rig Seismic" could shoot 3-D seismic, albeit inefficiently. A 3-D boat could shoot 2-D seismic but because of the huge investment of equipment (4 seismic cables and up to 8 airgun arrays worth $20 - $50 million compared to $5 - $10 million for 2D), the overheads would make it uneconomic. To our knowledge, all seismic vessels in the Australian region have been converted to 3D operation because of the lack of a viable market for commercial 2-D operations.

Geological acquisition of the type required under the CMP can only be done on a specialised vessel. Comparison with international geoscience agencies shows "Rig Seismic" costs to be comparable with vessel operating costs in France and the United States, and markedly cheaper than those in Japan. Our productivity is considered very high.

Cost of Contracting Out

The one-off costs of decommissioning "Rig Seismic", re-delivery of the vessel to Norway, and paying the penalty for mid-term termination of the charter, are still being estimated in the context of the CMP Program Evaluation. A preliminary estimate is around A$3-4 million.

The smaller CSIRO vessel, "Franklin" (length 55 m), is not currently equipped to carry out the high-resolution seismic and geological/geochemical role. Recently CSIRO sought (unsuccessfully) some $A4 million to extend its oceanographic role through major refit and "stretching". It is clear that funds of this magnitude would be required just to modify it to provide a platform equivalent to "Rig Seismic". In addition, several million dollars extra would be required to install "Rig Seismic's" existing deep sea winch and at least 2 compressors, and permanently equip a geophysical and geochemical laboratory. Additional costs would be incurred in working up the vessel to the performance level currently available in "Rig Seismic". At the end of the day, the best advice available to us casts doubt on the operational viability of such a refit. The nearest comparable vessel worldwide is the "Moana Wave" (Hawaii Institute of Geophysics, length 64 m), a vessel fundamentally more robust and flexible than "Franklin" could ever be.

It is also worth noting that "Franklin's" day costs are only slightly less than "Rig Seismic's", and that it carries the same number of crew but has much less room for scientists.

A preferable option, and one that could potentially carry out some of "Rig Seismic's" activities in the longer term, is a new vessel that the Australian Marine Safety Authority (AMSA) is considering buying and fitting out in Europe. This vessel would be of comparable size to "Rig Seismic", and could be made available by AMSA for several months each year. This vessel has not yet however been purchased, and would not be as efficient as "Rig Seismic" without substantial "working up".

In summary, current indications are that one-off costs to AGSO of contracting out offshore seismic and related data acquisition could run between $A8 and $10 million. Without additional funds this would require suspension of the program for 2 years, and provide program platforms of uncertain or lesser capability and possibly higher cost.

Responsiveness of Rig Seismic vs Contracting Out

Every other major marine geoscientific agency (USA, Canada, Japan, France, Germany and UK) operates one or more dedicated multirole geoscience vessels. he principle reasons are an ability to fine tune an institutional platform to institutional program needs, and to schedule a complex formal scientific program with confidence.

An additional 2 to 3 months' cruise operations per year on "Franklin" would inevitably be dictated by the requirements of the existing 6 months of oceanographic program. The use of 3 to 4 months' ship time on a seismic contractor vessel (or vessels) would have to fit in between exploration contracts. Experience suggests there could be problems if AGSO sought to occupy a commercial contract time slot when critical permit obligations were at stake. It is likely, therefore, that AGSO contracts will be an occasionally uncertain second priority for the contractor.

In terms of Australia's foreign development assistance objectives, "Rig Seismic" has been a very high profile platform for projecting Australian scientific and technological capabilities. I do not believe AIDAB will be as enthusiastic about future Philippine-type regional programs if the platform is a US, French or Norwegian contractor.

"Rig Seismic" occupies a niche in the market that would be difficult to service by using a seismic contractor and another vessel to provide the geological capabilities. There are other benefits, in that the money spent and the expertise developed is retained within Australia, even when undertaking foreign operations such as the Philippines project.

It also provides a mechanism for training Australian scientists and technicians that gradually spreads out to the industry. Exposure to training and operations by foreign nationals influences them in our favour, and opens up opportunities for Australian industry to penetrate foreign markets again such as in the Philippines project.

"National Facility" concept

The Australian Science and Technology Council (ASTEC) has supported the present mode of operation by AGSO since 1979. The Woods Review did not challenge the use of "Rig Seismic" for delivery of the CMP. Last year an ASTEC report on Major Scientific Facilities recommended replacement of "Rig Seismic" by a similar vessel at the end of the current charter in 1998. In addition, ASTEC recommended allocation of funds to AGSO to provide additional ship time as a "national facility" to university and other agency bidders, on a scientifically competitive basis. If AGSO is forced into contracting out, this facility will not be available in any foreseeable timeframe.

Efficient Operation

AGSO believe that "Rig Seismic" would operate most efficiently on the basis of 240 days effective data collection per year. Of these, 180 days should be dedicated to the CMP (the original scope of operations established in 1983 and renewed in 1988, but more than can be managed with present funding and staff); 30 days as a "national facility"; and 30 days for other contracts, including AIDAB. The remaining time will be spent in major transits, refit in a ship yard, and trials which are essential for a research vessel with continually changing demands, plus the necessary time in port for crew change and minor repairs. (For more details see attachment). On this basis, cost would be minimised and quality maintained into the foreseeable future.

I would be happy to meet again with the Review Team to clarify any further points you may wish to raise.

Yours sincerely

for

Dr D A Falvey
Associate Director, Petroleum

Attachment: Optimum use of "Rig Seismic"

		Days	Total
6 cruises	30 days at sea	180	180
	5 days in port	30	210
1 Trials	30 days at sea	30	240
	5 days in port	5	245
1 Refit	30 days in yard	30	275
	5 days in port	5	280
3 transits	7 days average	21	301
1 external	30 days at sea	30	331
	5 days in port	5	336
1 external	30 days at sea	30	366

Effectively 240 days at sea.

review.01

REVIEW OF COST-BENEFIT ANALYSIS OF THE MARINE PROGRAM

Coopers & Lybrand are to be congratulated upon their analysis of the costs of the Continental Margins Program. They have managed to uncover more about the costs of the program than we have succeeded in doing ourselves. It does suggest the value in having a qualified accountant within the organisation to keep adequate track of expenditure of funds.

From studying the copious tables and explanations of how they have gone about the assessment, I certainly have a better understanding of the impact of the corporate body upon our operating costs. However, from my perspective there are a few key points that should be updated to better represent the actual costs that the various activities incur. These primarily flow on from allocating salaries closer to home; ensuring that the corporate overheads are distributed according to the background operating costs which is roughly proportional to the number of people involved; and distributing the depreciation costs in proportion to the value of the equipment held.

(1) Salaries and labour on-costs

This represents about one quarter of Marine's costs. Because of the twenty-four-hour operation of the ship and the support this requires, ship operations take a larger proportion of salaries money than might otherwise have been thought. In particular all ESU effort is spent in support of the ship with only minor exceptions that are not worth separating out. However, there are some other factors that have not been considering by C&L that do need to be taken into account:

- Effectively all the AILOT and other on-costs like shift penalties and marine allowances ($521,000) are chargeable to ship operations.

- All ESU on-costs ($344,000) are also to the account of ship operations.

- The Marine on-costs exclude ESU staff and so apply to 76 staff in all, of whom only 16 are costed against Operations ($115,000 from $546,000).

This increases Operation's salaries by some $462,000 to $2,379,000 or almost half of the salary costs overall, but reduces office costs.

(2) Operating expenditure

For clarity and for reasons explained elsewhere, the operating costs associated with RIG SEISMIC should be kept separate. This is roughly one half of our budget. No cost savings exist here except those that can be made by increased efficiency.

(3) Overhead expenditure

These are very high, and are mainly attributable to cross-subsidisation of other Programs by an inappropriate method of calculating the pro-rata distribution of corporate overheads. The reasoning is as follows:

- All applicable overheads associated with the ship contract are included with the monthly payments made to AMSA. The only internal BMR costs are those involved with making the payments, which are now made directly by warrant and are trivial.

Should the arrangement with AMSA be cancelled, apart from the operating costs for the ship itself, the savings in overheads would be negligible. There would be some savings in Marine operations perhaps, but these are included in the operational not the corporate budget.

Hence ship operation costs payable to AMSA should be quarantined from being used in distributing overheads around the Programs. A similar approach is perhaps also applicable in the case of aircraft operations. In this case, the Offshore Petroleum Geology costs fall from $11,480,000 to $6,280,000 in a total BMR expenditure that reduces from $30,935,000 to $25,735,000.

As a result, the proportion of overheads chargeable to Marine falls from 37.1% to 24.5% with commensurate increases elswhere in BMR. There is a significant impact both on direct overheads from the Executive, MSB and so on, and also on all the Direct and Indirect Property operating costs. Assuming that direct costs consist of a pro-rata share of the BMR building (previously at 37% and now at 25%) this falls by $136,000, while it seems logical that the buildings only Marine use are charged at 100% ($159,000).

Indirect Property costs are a little harder to calculate. Assuming that these costs are allocated to the corporate body on a pro-rata basis from their expenditure, then using the percentages tabulated, we get indirect costs of $1,800,000 averaging 34% which reduces to 27%, saving $135,000.

This represents a very significant saving overall of some $1,240,000.

(4) Depreciation of equipment

The appropriate figure to use for depreciation is a matter of some debate. From a rapid review of our purchasing ever since we have had RIG SEISMIC, I suggest that the value of 33.3% is overly cautious, at least in the case of shipboard equipment. Some items currently in use pre-date arrival of the ship by several years, while others date from 1984:

- The EPC recorders and echo sounders with a replacement value of perhaps $475,000 are mainly ten or more years old

- The gravity meter ($500,000) and sonar dopplers ($150,000) were bought and installed on the ship in 1984 when it first arrived, as were the large coring winch and hydrographic winch ($500,000)

- The first long seismic cable from Teledyne ($1,000,000) lasted about 5 years before it was lost at sea while still in reasonable condition.

- Our new seismic cable (worth $2,000,000) is expected to have a lifetime of about 5 years before digital cable technology will have stabilised and it will be cost-effective for us to move into this field

- Similarly, the new sleeve gun arrays (worth $650,000) would be kept operational for around five years before later developments overtake them and adequate funding is available for their replacement

There is perhaps some confusion on our part between depreciation and the lifetime we expect in the water, which we tend to use interchangeably. Damage in the water can be considerable, and a towfish operated close to the sea floor has high risk of damage. The cost of maintenance, including repair and/or replacement depending upon the items, is allowed for within our operating budget.

making reasonable allowance for the various types of equipment, and the risks they face under operational conditions, a depreciation period of 5 years is considered the most appropriate interval. A 3 year period is definitely too short based, upon available information.

For simplicity and to be consistent with the C&L report, the shipborne equipment is valued at $5,000,000. Based upon the figures given above, quite a significant fraction of the equipment will have been written off. Notionally perhaps $3,000,000 of items identified are left on the books. But with the known inadequacies in the asset register and our continuing efforts to upgrade equipment, we probably do have around $5,000,000 of items that are depreciating at any one time.

Despite rapidly changing technology, a similar period is thought to be more sensible for office equipment also. Money for upgrades to keep equipment functioning over the 5 years is included in our budget. Even furniture should be included at this level. With rapidly evolving OH&S standards and the need for ergonomic desks and chairs, much of our office furniture is being replaced more frequently than in the past.

In summary, some changes need to be made to the costing algorithms used. These will reduce the total actual cost for the Marine Program by close to $2,200,000 which then needs to be distributed amongst the various activities. Because of the highly variable nature of the activities, the savings are distributed erratically. Operations reduce by roughly $1,500,000, Processing by $100,000, Projects by $500,000 and Management by $100,000.

The overalll Operations costs of $12,012,000 must then be distributed between seismic and non-seismic acquisition. Using the ratio of 0.66 computed by C&L, seismic acquisition for 12,540 kms of data costs $7,940,000 or $632 per km. Note that this includes <u>all</u> overheads, including mobilisation and transits, plus management of operations.

<u>NOTE:</u>

Should acquisition be done by contract, a cost that must be included is that of managing the contracts. Based upon previous experience, a major seismic job of say 3000 kms would take not less than 6 months effort to set up and then administer the contract. At $40,000 per year for a suitably qualified person and allowing 50% overheads, this would add at least $360,000 a year to our salaries bill. A more realistic figure would be closer to 12 months for a seismic cruise of which there would be four a year, and perhaps 6 months for a geological cruise with two each year, making a total of $600,000 a year.

review.02

MARINE PROGRAM TOTAL ACTUAL COSTS BY ACTIVITY

in thousands of Dollars

- With redistributed salary costs
- Corporate overheads adjusted to 25%
- Depreciation proportioned to equipment held

	Operations	Processing	Science	Management	Total	
Total salaries+ESU	1,399	932	1,282	272	3,885	(1)
On-costs (excl AILOT)	115	201	187	43	546	(2)
AILOT plus other	521	---	---	---	521	
ESU on-costs (100%)	344	---	---	---	344	
AMSA ship costs	5,200	---	---	---	5,200	
Operating costs	2,136	1,076	308	316	3,836	(3)
Depreciation	1,000	459	25	25	1,509	(4)
Corporate overheads	1,297	865	1,189	252	3,604	(5)
Total Activity costs	12,012	3,533	2,991	908	19,445	
ODP membership					518	
Total program cost					19,963	

(1) Distributed according to C&L Table E2 percentages

(2) Used number of people; 16 excl ESU, 28, 26, 6 out of 76

(3) As per C&L Appendix F summary

(4) Equipment as per C&L Appendix H at 20% with Office costs shared

(5) Property costs as per C&L Appendix G with 25% adjustment

CONCERN OVER QUALITY OF DATA COLLECTED BY RIG SEISMIC

When operations started with RIG SEISMIC in 1984, the demands of the regional geophysical and geological survey work were fairly low key. Over the years, the capability of the vessel has been built up to better meet the changing requirements. In particular, the impetus of the Woods Review has resulted in a major effort to bring the equipment up to a level comparable to that used in the exploration industry.

Any concern over the quality of seismic data has been laid to rest with the upgrade which is now essentially complete. Adverse comments on data standards presumably come from assessment of published seismic data which was collected largely before the Review, which while adequate for many of the scientific objectives, did not necessarily reach industry standards.

The present status can be summarised as:

(1) A commercial differential GPS navigation service is now being leased from Racal Survey in Perth. This system was adopted after a lengthy evaluation of units from the major equipment suppliers. Primarily as a result of AGSO support and seed funding, Racal have installed six shore reference stations around the Australian coastline such that a survey vessel will generally be within 1000 kms of a reference station.

An accuracy of 5-10 metres can be obtained anywhere around the Australian Continental margin. By strategically locating the reference stations, key exploration areas are rarely more than 500 kms away so resulting in positioning accuracies of around 5 metres. The system offers accuracies approaching that of radio navigation at only a fraction of the price. Differential GPS is gradually becoming accepted world-wide because it is a system that is little affected by difficulty of access or remoteness and the significant cost advantages.

(2) The guns in the arrays on the ship have been replaced with sleeve guns. This type of gun has become almost an industry standard because of its reliability which improves productivity and lowers costs. The increased output pulse for the air consumed means that the demand for high pressure air is reduced hence saving on compressor capacity or conversely greater output power can be achieved with existing units.

The arrays were designed by Halliburton Geophysical Services specifically taking into account space constraints on the multi-purpose RIG SEISMIC and a realistic appraisal of the support available in a research group. The success of the several compromises inevitable in any design can be measured by the excellent results obtained in several of our deep seismic cruises that have drawn positive responses from the exploration industry.

(3) The compressor capacity has been expanded from four to six 300 scfm units to allow us to shoot industry-type surveys on the continental shelf at a 10-second interval with volumes up to 3000 cubic inches. Yet we can still execute a variety of tasks from high-resolution surveys that demand little air through intermediate arrays to the largest volumes required. The choice of several intermediate size compressors rather than large specialised units has proven to be an effective and flexible choice.

(4) After a careful market survey, a transformerless seismic streamer cable was chosen rather than one of the latest digital cables. This occurred after lengthy negotiations with Fjord Instruments (GECO of Norway) to arrive at a flexible cable that can provide group lengths from 6.25 to 25 metres or longer if required. The basic design was varied to provide a 288-channel capability and innovative noise reduction features at a price significantly lower than that of a digital cable.

Regardless of the type of cable, the success of a cable design is largely measured by the tow noise levels that can be achieved. An analog cable typically generates about 3 uBars of noise while digital cables can be as low as 1 uBar. After a lengthy working up period, our cable gives noise levels around 1-2 uBars, and the low frequency noise rejection features have yet to be activated. The best deep seismic penetration achieved in Australia has been with our Fjord cable and HGS sleeve gun arrays.

(5) The effort put into accurate location of the gun arrays and seismic cable required for the latest 3D seismic work is both considerable and expensive. Such accuracy is not needed for 2D seismic work, particularly for regional and deep seismic data. However, our data can be put to better use if it is of comparable quality. Compass units and an active tailbuoy have been introduced to accurately position the cable to make our data compatible with the 3D seismic work collected by industry.

To protect our considerable investment in the cable, we have introduced methods to track the cable if it should be lost at sea. There is an ARGOS satellite transmitter on the tailbuoy to periodically monitor its position regardless of range from the ship, and another one on the cable that only releases if the cable breaks. Improvements have been developed by ARGOS Australia at our instigation which are now being sold worldwide.

(6) The seismic acquisition system used on RIG SEISMIC has been developed within AGSO partly because of the limited capabilities of existing analog systems when compared to those of the digital cable systems. The aging DSS-V charge-coupled interface and DFS-V recording system are limited in their QC capabilities in particular. With the high cost of acquisition, it is important that every effort is made to check data quality as it is being collected and not wait until it gets to the processing centre.

The AGSO system integrates the DSS-V and DFS-V into a single unit that is directly controlled by computer. Data is written in SEG-Y format onto 3480 cartridge tapes with considerable savings in cost and storage volume. QC analyses are made from computation of RMS signal and cable noise values with hard-copy displays to spectral analysis and thorough analysis of instrumental performance.

Over the years, considerable assistance has been willingly provided by several major equipment suppliers. The active cooperation of Teledyne Exploration, Halliburton Geophysical Services and GECO has helped us ensure that the vessel is fitted out to best advantage. The involvement of or advice from other companies such as Syntron and Western Geophysical has also been of benefit.

It is generally considered that it takes about five years to bring a boat up to a level where it produces quality results. By utilising the resources and expertise of these companies, our path has been smoothed considerably and RIG SEISMIC now produces data of a comparable quality to industry.

RW
9 Feb '93

GENERAL BENEFITS OF OPERATION OF RIG SEISMIC

When RIG SEISMIC was first chartered and commissioned in 1984, it was intended to provide a multi-purpose platform for geological and geophysical research aimed at achieving the objectives of the Continental Margins Program in a cost-effective manner. The main reasons for the multi-purpose approach were the assessment that there was only enough work for a single research vessel of this type, and the availability of funding for analysis, research and publications of the findings.

Over the years, the equipment has been upgraded to a level comparable to that of industry in the seismic and geophysical field, and unique within Australia in the geological field. Because of the emphasis and relevance of the seismic work to the exploration industry, it is important to identify the capability of the vessel and compare it to equivalent industry vessels.

RIG SEISMIC is set up for a range of seismic acquisition activities from high resolution sub-bottom profiling through near surface studies to deep seismic studies down to basement and below. But it is set up for 2D not 3D seismic work. It is important to differentiate between 2D and 3D acquisition and the overheads involved. The equipment now used is essentially identical, but the intensity of work is different. If required, RIG SEISMIC could shoot 3D seismic data, albeit inefficiently because we would need to shoot along parallel lines at close intervals of 25 to 100 metres with a single cable.

A modern super-boat designed for 3D work could shoot 2D seismic data but because of the huge investment in equipment and the size of the vessel to carry it (up to 4 cables and up to 8 arrays worth $20-50 million on a boat costing perhaps $50 million), the overheads would make it uneconomic. This should be contrasted with $5-10 million on a $10 million 2D boat.

To our knowledge, the last commercial seismic vessel in Australia has been converted to 3D operation because of the lack of a viable market for 2D operations. Industry now routinely demands 3D seismic work to solve the increasingly complex geological problems around current drilling targets.

As a result, RIG SEISMIC now occupies a niche in the market that would be difficult to service using a seismic contractor. It would be uneconomic for a 3D boat to do the work, and there is probably insufficient demand for a dedicated 2D boat. Should a contract boat be used, a realistic appraisal must be made of timeliness of availability at an acceptable acquisition cost.

With the erratic demand for their services, contractors must often take those jobs on offer as they come up. They cannot wait for the large jobs with the comfortable profit margins. To get work done exactly when required usually costs a premium, such as to bring a vessel in to meet the time constraints. Otherwise, one waits in the queue. We not infrequently have demands arising at short notice to meet government priorities to which we able to respond by rescheduling cruises. It would be difficult to do this commercially.

There are several other benefits to maintaining an independent capability:

(1) The commercial market is still largely driven by multi-national companies. If in its wisdom, a large company considers it better to invest its money elsewhere in the world, the seismic contractors will necessarily respond. Not long ago, Australia had only one contractor operating in its waters. Timeliness, availability and cost will all suffer as a consequence if the market closes down.

(2) .ith a genuine Australian operator (ie AGSO), the money will stay largely in the country and employment will continue to be available to Australians. HGS is an Australian company, but it is still controlled from the USA. GECO, Western Geophysical and Digicon are all foreign-owned companies. Many contractors use expatriates and much of the money goes overseas.

(3) Maintaining a AGSO capability has several advantages. The expertise that is developed is retained largely within Australia, even when undertaking foreign operations such as the AIDAB Philippines project. Experience circulates between AGSO and the industry to everyone's general benefit as people move on in their careers. Keeping expertise above the critical mass is most difficult unless there is a genuine long term commitment. The government needs to play a key role if sustainable development is to be adequately supported.

(4) There is considerable benefit in the government retaining an independent view to that of the exploration industry. For this to be done effectively, sufficient expertise must be retained to be able to adequately assess any exploration and production proposals and conclusions. Self regulation is a highly debatable way of ensuring the country's future when an overseas investor's interests are at stake.

(5) Training of the next generation of experts should not be left to chance. An organisation that has a vested interest in the future and the resources to assist the universities in this aim is needed. Considering the limited population and funding available, there is only room for one organisation which should operate at the national level. The operational and logistic support required does not sit well with a university. A government agency is more appropriate.

(6) Involvement in overseas aid projects has spin-offs to Australia's benefit. It opens up opportunities for Australian industry to penetrate foreign markets, again such as in the Philippines project which gave Australian companies guaranteed access and first choise on further exploration. Exposure to training and operations by foreign nationals will help to influence them in our favour indirectly. People tend to turn naturally to an area or group with whom they are familiar for further advice.

Turning to the geological aspects of the Continental Margins Program, there is not enough work or funding to support a dedicated geological research vessel. A parallel case can be developed for an independent role within government for marine geological research that is oriented towards sustainable development and other aspects such as environmental and pollution problems.

Without a significant increase in funding, a single vessel to meet both the geological and geophysical demands is a cost effective solution. The overheads of mobilisation and commissioning of a vessel for limited periods each year would drain the slender resources, both financial and manpower, away from the research efforts into non-productive support activities.

review.05

RW
9 Feb '93

COST EFFECTIVENESS OF MARINE OPERATIONS USING RIG SEISMIC

The cost analyses given here are based upon the following premise:

> *There is not a sufficiently large demand for data acquisition in support of the Continental Margins Program to justify full-time operation of separate geological and geophysical survey vessels, whether this be done by contract or using RIG SEISMIC or by some other combination. Necessarily therefore, there is a premium that must be paid to support both functions.*

Any cost analysis relies heavily upon comparison between the cost of acquiring seismic data using a commercial vessel and the cost of running RIG SEISMIC. It is much harder to evaluate the cost and value of acquiring geological data. Therefore to make a fair cost comparison between options, it is appropriate to first calculate the cost of efficiently providing seismic data acquisition, and then estimate the premium to cover both ends of the research spectrum.

The most recent assessment of the cost of supporting the CMP using RIG SEISMIC has been the Coopers & Lybrand report. The following uses that analysis with some corrections for operating costs and rate of depreciation (see attachment).

Cost of seismic operations on RIG SEISMIC

The adjusted cost of running the ship is $12,000,000 for six cruises on which acquisition takes place. All other costs are considered as overheads that are distributed against the cruises. There is a modest difference in cost between seismic and non-seismic cruises primarily caused by somewhat higher consumables and maintenance costs. Accepting the C&L figure that a seismic cruise costs 1.12 times a geological cruise, then a seismic cruise actually costs $2,070,000 and a geological cruise costs $1,850,000 if there were four of the former and two of the latter types of cruises respectively.

The number of kilometres of seismic data shot in a cruise is highly variable. It is greatly affected by weather and remoteness of the work area for example. That combined with a cruise profile that includes an erratic number of seismic and geological cruises a year will result in a fluctuating cost per kilometre.

With improved equipment and greater experience, our coverage per cruise is rising. Last year we routinely collected about 3000 kms per cruise and this year we expect that to rise to around 3500 kms. Our longer term aim is to approach 4000 kms per cruise. This would give rates of $690, $590 and $520/km respectively. The rate includes all overheads such as any mobilisation costs, bad weather standby, equipment depreciation, management and leave allowances. Costs for comparable industry work is given in C&L as $800/km, to which must be added the cost of contract management and field supervision of $20-$30/km.

To assess the effectiveness of seismic operations on RIG SEISMIC, it is useful to estimate the overall cost of using the ship for full-time seismic operations. Making a reasonable allowance for major transits, refit and equipment tests, plus time in port for minor maintenance, 240 operational days are available. The marginal cost of <u>adding</u> a further cruise dedicated to seismic work is about $530,000 (see attachment) while the additional cost of shooting seismic rather than doing geological work is $220,000 (see above).

Hence the total cost of running the ship this way is estimated at $13,480,000. Adopting a production rate towards the conservative end of 3000 kms per cruise, the cost per kilometre falls to $560. Making a reasonable allowance for profit, this would equate well with industry charges. Hence the seismic operations on RIG SEISMIC are run at an equivalent level of efficiency to that of industry.

Alternatives to using RIG SEISMIC for geological work

It must be stated clearly that there is no vessel within Australia at the present time capable of providing the service required apart from RIG SEISMIC. A ship with large A-frame and suitable work decks, dynamic positioning and a length of not less than 70 metres for stability is not available on the coast. Apart from AGSO, no other market exists.

With current and likely funding levels, there is not enough work to occupy a suitably fitted out vessel for more than a few cruises a year. Unless this type of work can be time-shared with some other activity, mobilisation of any vessel must necessarily carry a heavy penalty in overheads. The specialised winches, hydraulic power packs, A-frame and coring cradle and the several other pieces of equipment needed to cover the suite of sampling techniques required are not easy items to install on a ship on a temporary basis.

An attempt has been made to estimate the cost of mobilisation/demobilisation and operation of a vessel chartered on short-term lease for this purpose. Two scenarios are envisaged. The first is a cruise at a time, which though much closer to the desired requirement, imposes very high penalties indeed. The second is to run two cruises back-to-back, thus halving overheads but constraining flexibility and placing greater pressure on specialist staff.

Assuming a ship positioning cost of $15,000/day, mobilisation will cost some $600,000 and demobilisation about $280,000. With an daily operating cost of $20,000, the total cost of a 30-day cruise is a very expensive $1,480,000. Running two cruises in a row with a 5 day transit in between costs $2,180,000. Note that this covers only the basic maritime costs; the scientific costs have to be funded in addition.

The equivalent maritime costs for RIG SEISMIC based upon the current 180 days operation a year is $30,000 including mobilisation, positioning and overheads. Hence a single cruise costs $900,000 and two cruises $1,800,000. The cost differential is extreme for single cruises and significant for double cruises. There is an additional burden of organising repeated commissioning of a ship to do the geological work that is difficult to quantify. With greater use of RIG SEISMIC, this differential will increase further. Fully utilising the ship for 240 days reduces RIG SEISMIC costs to $660,000 per 30-day cruise.

There is no doubt that using RIG SEISMIC as a multi-purpose vessel offers very substantial cost savings for geological work when this is compared to a short term charter arrangement.

Use of AMSA vessel for geological work

Another alternative in the future is the possible use of the proposed AMSA ship. While the vessel will be more economic to run than RIG SEISMIC, the higher impost of servicing its capital cost will effectively offset any savings. A budgetary indication from AMSA is that the basic vessel cost will be perhaps $500,000 higher at $2,000,000 while its operating cost will hopefully be some $500,000 lower. Hence no major cash savings are envisaged.

Ther. are perhaps some operational advantages worth considering:

(1) Better utilisation can be made of RIG SEISMIC for seismic work improving its cost effectiveness by about 20% if extra funds can be made available.

(2) Facilities not available or technically feasible on RIG SEISMIC such as the SEABEAM swath mapping system or the GLORIA long range sidescan sonar could be deployed off the AMSA vessel.

(3) The greater flexibility could lead to more effective cooperation with outside organisations such as the universities and industry.

(4) If sufficient income-generating work can be found for the AMSA ship of a similar nature to that required by AGSO, then the commissioning costs can be largely eliminated. This would probably require outside funding from the ARGC or other bodies.

Decommissioning costs for RIG SEISMIC

Before any alternative ways of obtaining the data required for the Continental Margins Program are considered, it is useful to estimate the cost penalties in terminating the charter for RIG SEISMIC. Some of these are clearly spelt out in the charter document, but other costs are harder to quantify.

(a) If the charter is terminated in 1993, we would pay a penalty of about $930,000 plus redelivery costs of perhaps $360,000 and a further charge of $50,000 to make good the vessel.

(b) We would need to remove our equipment and make any necessary repairs which could be as high as $500,000, plus pay the charter during decommissioning of say $140,000 for 30 days.

(c) DNV and agency fees to cover any changes and approvals for certification of the vessel is estimated at perhaps $40,000

(d) Redundancy payments for AMSA crew as there would be no further use for their services is difficult to predict; $1,500,000 might be appropriate.

(e) Superannuation payouts to AMSA crew could cost as much as $2,000,000 considering the length of service of the crew members.

(f) The marginal cost savings will be inadequate to cover alternative ways of obtaining the data required without reducing AGSO staff numbers. Even then, it is unlikely that the cost of external contracting can be covered by the savings obtained. The number of people involved in marine operations within AGSO is roughly equal to those in AMSA. Redundancy and superannuation costs will presumably be of a similar magnitude.

review.06

RW

10 Feb '93

COST OF OPERATING A CONTRACT BOAT FOR GEOLOGICAL ACQUISITION

Mobilisation		
AGSO mobilisation	50,000	
Outfit in yard	250,000	
Time charter (10 days @ $15,000)	150,000	
Positioning (10 days @ $15,000)	150,000	
Total cost of mobilisation	600,000	
Demobilisation		
AGSO demobilisation	50,000	
Stripping ship	50,000	
Time charter (2 days @ $15,000)	30,000	
Return of vessel (10 days @ $15,000)	150,000	
Total cost of demobilisation	280,000	
Cruise (30 days @ $20,000)	600,000	
One cruise at a time	1,480,000	
RIG SEISMIC(30 days @ $30,000)	900,000	
Cost saving for one cruise	580,000	(1,160,000 overall)
Two cruises back to back	2,080,000	
Transit between cruises (5 days @ $20,000)	100,000	
RIG SEISMIC (60 days @ $30,000)	1,800,000	
Cost saving for two cruises	380,000	

review.07

RW
10 Feb '93

COSTS OF OPERATING RIG SEISMIC FOR SEISMIC ACQUISITION

Cost of normal cruises

Four seismic cruises (weight 1.12)	4.48
Two geological cruise (weight 1.00)	2.00
Total weight of cruises	6.48
Total cost of cruises	12,000,000
Cost of seismic cruise	2,070,000
Cost of geological cruise	1,850,000

Cost of extra seismic cruises

Consumables, all cruises	100,000
Seismic cruise consumables	220,000
Fuel for cruise	50,000
AILOT for AGSO staff	90,000
Miscellaneous	40,000
Fares T/A etc	30,000
Marginal cost of extra cruise	530,000
Cost of six seismic cruises	12,420,000
Cost of extra two seismic cruises	1,060,000
Total cost of eight seismic cruises	13,480,000

Acquisition rates for seismic cruises

Cost of standard seismic cruise	2,070,000
Acquisition of 3,000 km/cruise	690/km
Acquisition of 3,500 km/cruise	590/km
Acquisition of 4,000 km/cruise	520/km
Cost of extended program cruise	1,685,000
Acquisition of 3,000 km/cruise	560/km

review.08

RW
10Feb'93

DECOMMISSIONING COSTS FOR RIG SEISMIC

Penalty payment in 1993	930,000
Redelivery costs	360,000
Making good vessel	50,000
Removal of equipment	500,000 ?
Charter while decomm'g (30 days)	140,000 ?
DNV and agency fees	40,000 ??
AMSA redundancy payments	1,500,000 ??
AMSA superannuation payout	2,000,000 ??
Total penaty costs for AMSA	5,520,000
AGSO redundancy payments	1,500,000 ???
AGSO superannuation payout	2,000,000 ???
Total AGSO penalty costs	3,500,000

review.09

RW
10 Feb '93

APPENDIX G

Australian Maritime Safety Authority

Eastern Region

Fax No: 062 574 614. Two Pages Faxed.

AGSO Marine.
Canberra.

Attention: Dr D. Falvey.

Decommissioning Costs R/S Rig Seismic

Redundancy and Superannuation costs are additional to the decommissioning costs, addressed below.

The Charter Party and in particular Addendum No III addresses the obligations of the Commonwealth of Australia with regard to redelivery of the vessel to her Owners.

The Charter Party is written in Norwegian Kroner (Nok).
Daily Charter rate is Nok19,500 per day.

1. If the Charter is terminated in 1993, you are obligated to give the Owner six months notice of termination, a one off payment of Nok3,900,000, (Aust $848,000\$975,000).
   The exchange rates this financial year have been exceedingly volatile ranging from Nok4 to Nok4.6 to the Australian Dollar.

2. You have the option to redeliver the vessel in Australia or Bergen range (Norway). Redilvery Australia represents the cheaper option, requiring a one off payment of Nok1,500,000, (Aust $326,000\$375,000).

3. The Owner will accept the vessel back without requiring her to be restored structurally to the state she was in when we took delivery.
   We are obligated to terminate all electrical wiring and piping in a proper manner at the nearest bulkhead\deck.
   You will recall that the vessel was redelivered to us in an immaculate condition, we are required to return her in the same state, fair wear and tear accepted.
   An allowance of at least $50,000 should be made for this purpose.

4. The removal of AGSO equipment and the transporting of it to Canberra is difficult to estimate both in time and money.

   There are three components:

Removal of AGSO equipment	$450,000\$500,000.
Transportation to Canberra	$50,000
30 day Charter payment	$109,000\$125,000.

It is likely that removal and restoration of the vessel will take longer than 30 days, resulting in extra charter payments.

5. Classification Society, AMSA Survey, Agency Costs and incidentals will amount to $40,000\$50,000.

Regards,

Colin Chappell
Manager\Ship Operations

17 February 1993.

APPENDIX H

Seismic Data Processing in AGSO - Options for the Future

Frank Brassil
Data Processing Manager, Marine Program

It is inappropriate to cease seismic data processing within AGSO at this time for the following reasons:

1. The recent installation of the CONVEX computer had created a situation where it would be very uneconomic to attempt to cease processing at this time. To meet current processing requirements, additional cash outlays of $690,000 per year would be required.

2. The cost of AGSO processing is estimated to be about $115 per km at present. This compares with the current contract price of $85 per km. However, under contract processing, AGSO would still require the equivalent of $20 per km to supervise and manage contracts and the data handling between AGSO and the contractors.

3. Substantial gains have been made in the productivity of the AGSO seismic processing operation and the quality of the product has improved markedly. There are still improvements which can be made, but considering the cost situation it is more logical to allow the in-house group the opportunity to continue to improve.

4. The group has completed processing of the equivalent of over 6000 kms of conventional seismic data since the CONVEX was installed. This is approaching the required productivity and is indicative that the data can be processed in a reasonable time.

5. The first major production deadline for the Philippines project (Ragay Gulf) was met to the satisfaction of the external consultant supervising the processing. This further supports our ability to meet required processing deadlines.

6. Significant steps are being taken with external organisations including NOPEC, Digital Exploration Ltd and COVNEX, to reduce costs of processing. NOPEC have expressed a willingness to invest up to $300,000 in the processing centre. This will be a significant contribution and bring AGSO much closer to commercial costs. DEL are interested in a proposal to share excess capacity between both sites. CONVEX are under pressure to reduce their hardware maintenance charges.

7. There has been considerable work put into upgrading processing streams and training staff. Use has been made of external consultants to improve and verify processing parameter definition. This has meant that many of the timeliness and quality problems have been addressed and are still being worked on.

8. Investigations to evaluate interactive seismic processing for parameter analysis are proceeding. Installation of this facility will further improve productivity and quality of processing.

9. Disposal of the CONVEX at this time would cause substantial losses.

10. Realisation of staff costs would be a slow and expensive process, with the need for additional funds to cover salaries and contract costs at the same time.

It is proposed that performance of the AGSO in-house seismic processing be monitored regularly to ensure that the requirements of the program are being met and that standards of quality and timeliness are being achieved.

Given that so much as been and is being done to improve the operation of the processing centre, and that the cost differential is not nearly as great as was suggested by the Coopers and Lybrand study, it is premature to dismiss AGSO in-house seismic processing at this point, and it would result in considerable losses.

Frank Brassil
8 February 1992

Seismic Data Processing in AGSO - Options for the Future

Frank Brassil
Data Processing Manager, Marine Program

INTRODUCTION

In the preliminary report of the CMP Review Panel, the issue of the viability, performance and appropriateness of AGSO processing its seismic data in-house was closely scrutinised. In this paper, the issues, as perceived from the processing staff perspective, are presented, and the alternatives considered.

The present state and costs of seismic processing in AGSO are reviewed, followed by a hopefully fair comparison between the options of continued internal processing and external processing.

The position is put that it is inappropriate to cease data processing within AGSO at this time, but that the continued efficiency and effectiveness of the processing operation be monitored independently to ensure that the arrangements continue to be effective.

Recent Developments in Seismic Processing IN AGSO

Since the installation of the CONVEX, we have re-structured our seismic processing operation to address the problems we were aware of and which were drawn out by the report of the CMP review panel. We believe that we have made significant progress in that time, though not without some difficulties.

We have been processing the data from the Philippines cruise. This has proved to be a very difficult data area, and has been a challenging exercise. In line with the recommendations of the review panel, we have used an external consultant to assist with the parameter definition phase, and this has been very successful. We have processed the data to the satisfaction of the external client, and met the first production deadline.

We re-processed the High Resolution Survey in offshore Queensland for JNOC. This work was the equivalent data volume to over 1800 kms of conventional data.

We completed processing of the Arafura Survey, and fully processed the 1900 km of the Triassic Reefs survey. We have processed more of the high resolution data from the Vulcan Graben, equivalent to about another 1000 kms of conventional data.

In that time we have effectively processed the equivalent of 6200 kms of conventional seismic data, over a period of about 7 months. This is close to our required production rate, and not unreasonable considering that we started with an entirely new system, including a beta test version of DISCO, and

incorporated conversion of data, including conversion of the entire 3200 tape library, from the previous system. The summary of our processing since July 1992 is in Appendix 1.

We have, however, done considerably more than this and it is these improvements in our management and methods that we consider to be at least as important.

We have established a project to correct our existing processed data set to eliminate those problems that have arisen from inadequate quality control in the past. This is possible now because we have sufficient staff available to do this work. There are two phases to this task. The first is to check all the data for correct annotation, display, and navigation. This is about 20% complete. It has been done in a less orderly way than we would have preferred because of a very high number of requests from our marketing section, arising substantially but not entirely from the NOPEC agreement, which has required relatively short period responses and doing parts of surveys. Further, responses for the needs of external clients have significantly diluted the manpower available for this work. However, we are on the way to completion of this stage and will continue as quickly as practicable.

The second stage of this project is to review all the data to improve the presentation of the data by application of more advanced post stack processing. NOPEC have done this to some of the data already, and to good effect. We would naturally prefer to do it ourselves now that we have sufficient computer power and software to do it. We are considering NOPEC involvement in this project at present.

We have re-built, virtually from scratch, our basic processing sequence, particularly to enhance the quality control aspects of our processing, partly to take advantage of the significantly improved amount and quality of information recorded on RIG SEISMIC, and partly as training for our new scientists, so that they will fully understand the processes we are applying.

We have substantially improved the co-ordination between our seismic and non-seismic processing groups with the specific intention of obtaining greater efficiency and focus of the activities of both groups. This has worked well in the Philippines project.

We have built software links to our PETROSEIS mapping system and enhanced parts of the DISCO software enabling features such as location maps on side panels and seismic line intersections to be generated automatically, avoiding the manual methods of the past and gaining significantly in efficiency and reliability. We have built links to our internal non-seismic processing software system to enable data such as water depths, and potential field data to be incorporated into seismic sections. This is a significant enhancement that is not often available from contractors.

We have put considerable effort into improvement of organisational culture and staff morale. We have taken time to get staff involvement in and commitment to

the improvements in quality and productivity that we require. This is not an assumed factor. We have put considerable management effort into cultivating the necessary commitment and understanding by staff of the importance of the changes we have been trying to implement.

We have, particularly in the Philippines Project, spent considerable time training new scientific staff. This is our investment in our future productive capacity. We have very good young scientific staff who will become first rate geophysicists.

Our current projects are to complete the Philippines project on schedule, complete the High Resolution study in the Vulcan Graben and to start processing the recent survey in the Tasman Sea.

Our biggest problems at present are that we lack an interactive parameter analysis capability. This is being addressed at present and currently available systems including the three major vendors are being closely assessed at present. The analysis is complex because the connection between interactive and batch processing must be carefully evaluated. Despite some views to the contrary, batch processing for marine seismic data is here for a considerable time yet, and large systems such as the CONVEX remain the principal processing platforms in this industry.

We have some way to go in bringing our staff and methods to the point of maximum efficiency. As mentioned, we have significantly improved our data handling methods since the acquisition of the CONVEX. The attached seismic section from the Philippines survey is an example of what we can produce. Note that the section contains highly processed seismic data together with bathometry, gravity and magnetic data. This integrated product is the combination of the efforts of the processing staff.

We need to expand somewhat the disc space on the CONVEX, but this is a purely budgetary limitation. It will assist in improving operational efficiency.

Costs of AGSO Seismic Processing

As is typical when costing complex operations, a costing model is used to define budgetary costs, and variances are accounted for as they occur. The model used for costing seismic processing is a "typical" AGSO marine survey comprising 3000 kms of 16 second data recorded with a 12.5 m group interval and shot every 25 metres. The data is 192 channel 48 fold up to 240 channel 60 fold. The processing sequence comprises a modern sequence including shot domain FK and designature, DMO, multiple attenuation, high resolution velocity analysis, stack, migration, post processing, film display and SEG-Y tape production.

The table below shows current costs of processing seismic data for a year. These costs are based on current budgetary allocations, not historical costs as are shown in the Coopers & Lybrand analysis. Given the changes that have

occurred within the previous 9 months, it is not meaningful to use historical costs to estimate the current or future costs or performance. I also differ with that analysis because it depreciated the capital equipment over 3 years, whereas the anticipated life of the equipment is 5 years, and I prefer to follow the requirements of the Accounting Standards and depreciate equipment over the anticipated life of the equipment. There is room for debate concerning depreciation of software licences since they could theoretically be sold for their present value, but for simplicity I have depreciated the licences in line with the hardware.

The cost of processing 12,000 kms of seismic data per year in AGSO under the present budgetary arrangements is $114 per km. That cost is broken down as follows:

FIXED COSTS:	
Depreciation	$23
Hardware Maintenance	$11
Software Maintenance	$8
VARIABLE COSTS	$18
MANAGEMENT OVERHEAD	$9
VARIABLE LABOUR	$45
TOTAL	**$114**

There is some scope for lowering in cost in a number of areas. Fixed costs ($42) are a significant component and negotiations are presently under way with a number of organisations with a view to lowering them. These include:

1. We are presently negotiating a Memorandum of Agreement between DIGITAL Exploration Limited of Brisbane, to make arrangements whereby, given the compatibility of our facilities, we can by mutual agreement share excess capacity on either system. This has attractions for both parties, and can, from AGSO's position, enable our excess capacity to be used to raise additional revenue. On the other hand, where we have short term peaks in demand, some work could be off-loaded if there is surplus capacity in Brisbane. In addition, we could have ready access to their film display capability, which is a significant deficiency of our existing facility.

2. We are presently negotiating with NOPEC an arrangement whereby they will add money in the region of $200,000 to $300,000 to our seismic processing facility as part of their involvement in some of our projects. This is an alternative to their processing data outside AGSO, and shows that they have confidence that we now have the ability to meet their requirements.

3. We are negotiating with CONVEX to reduce the fixed cost of hardware maintenance, which we consider to be high. We note that since they tendered for our facility, there have been three more CONVEX systems installed in Australia, with no increase in staff on their part. It seems unlikely that there has been any increase in parts supply either, as these system are very reliable. Therefore, we believe that CONVEX ought be in a position to be flexible in this area and are pursuing the matter with them.

The variable costs include consumables, sundry expenses and operator costs. Our computer operators are provided by a contractor, and we adjust the work required to the demand for the system from time to time. The cost to AGSO of this service is significantly lower than using AGSO permanent staff, and we are able to have a more flexible operation. We are presently in the process of establishing a full seismic tape copying and transcription facility which we will use to provide a tape copy service for our own data and for other users when required. This will provide us with the opportunity to obtain some revenue to offset the operator costs. There is little scope for significant reduction in the other variable costs without compromising the processing.

Staff overhead ($9) is Group Management and Systems Support, and is not high nor open to much lowering.

Variable staff ($45) is a significant cost. This represents in part that we tend to have more highly qualified staff than contractors frequently employ, and partly that our batch oriented system is somewhat less efficient in its use of staff than those systems with ready access to interactive facilities. We are presently evaluating options for interactive seismic processing, but the cost is going to be of the order of $300,000 total capital investment. This will add $5 per km to depreciation, but will hopefully be offset by improved staff efficiency. As far as our staff is concerned, It must be emphasised that many of our people are of low experience, and that productivity is expected to rise significantly as we gain more experience.

COSTS OF EXTERNAL PROCESSING

This is a somewhat contentious topic because there is a lot of anecdotal information about the current prices of seismic processing, which accords only partially with experience. Prices as low as $50 per km are mentioned in discussions, but without a clear statement of what would be received for that price. AGSO's arrangements with NOPEC have given us a recent opportunity to assess the present prices of contract processing in Australia, and access to some independent view on the nature of costs in Australia and the rest of the world, and the following is based in information supplied by Mr Jan Otsby of NOPEC.

The present price being paid for processing AGSO's marine seismic data is about $85 per km. This is for full processing in a "conventional" manner, excluding very intensive processing such as Tau-P. Such "advanced" processing is sometimes sold at very low prices to gain market penetration,

and we have had the benefit of this on at least one occasion. The company which did so has since shut down. However, in the present market, $85 per km is a reasonable expectation.

NOPEC advises that the price for seismic processing in Australia is the lowest in the world and that this is related to an over supply in the market. Further, in Europe, typically acquisition and processing are sold as a bundle, with the effect that true processing costs are often not seen explicitly by customers. However, they expect that in Australia the price will rise significantly when the supply reduces or the demand increases. Their estimate of the possible increase in prices is up to 50%, which would take prices to over $125 per km.

In budgeting for contract seismic processing, a figure of $100 per km would be the minimum realistic figure when planning expenditure on a typical project.

When considering the price of external processing, the AGSO costs which would be incurred in managing and supervising contracts and in handling the processed data must be taken into account. The costs of this is an estimate, but we believe that it will be of the order of $20 per km. This allows for one full time senior scientist, 50% of a senior scientific manager, and a technical officer to manage the physical data. Additional costs will include travel and allowances for specialist processing staff and for project staff to visit contractors.

COST OF AGSO DISCONTINUING SEISMIC PROCESSING

Unfortunately, AGSO cannot cease processing its own seismic data at no cost. At the least current projects would need to be completed, and a lead time of about 6 months would be required, during which at least one and possible two projects would also be processed externally.

The CONVEX system would be sold at a loss. The selling price of the CONVEX is a matter of considerable speculation. Experience is that second hand computers sell at a considerable discount, and this is a very specialised machine. Given the nature of the seismic processing industry in Australia, it in unlikely that any existing processing house would take it at anything like its presently depreciated value because they have access to lower cost (but lower power) systems from their overseas branches at considerable discounts. There are few other users of these systems in Australia outside CSIRO, Universities and other research institutes. Few of these can raise the necessary capital. It would be very likely to be sold overseas, and this is also a difficult market to sell into without sustaining considerable losses when the equipment was acquired so recently. It is possible that it would sell for as little as $500,000, incurring a loss on depreciated value of $700,000.

The hardware and software maintenance cost would be saved, recovering about $250,000 per year.

The second major exit cost is that of the existing processing staff. Allowing for staff to continue to supervise contracts, three professional and three technical staff, with a total employment cost including overheads of $365,000 pa, would be redundant. Under the APS employment conditions, it is not possible to make these staff redundant without protracted processes. These are expensive and time consuming. Further, most of the staff could readily be used by other areas of the Marine Program, particularly in the projects area. The program as a whole is understaffed and re-deployment of processing staff to assist with projects would be welcomed by many people and would add significantly to the productivity of the Marine Program. However, such a re-deployment is not a saving, and its ready availability would make redundancy very difficult. In reality the only way we would shed the staff cost is by natural wastage.

The consumables cost would mostly be saved, but some minor on-going cost would be incurred to support the much diminished system which would be retained.

The staff overhead cost would be transferred to the cost of managing contracts.

Total savings on relinquishment of the seismic processing facility in a year are, therefore:

Sale of the CONVEX	$500,000
Maintenance	$250,000
Staff Costs	$365,000
Variable Costs	$200,000

While the sale of the CONVEX may generate revenue which can be fed back into contract processing, it is a "one-off" receipt. The staff costs would only be realised over a long period.

If AGSO were to use external processing for its conventional data, then we would not in fact eliminate all seismic processing capability. Rather, we would scale down the operation to provide the following facilities:

1. The ability to process further and display our existing data sets. This is an important aspect of our existing facility which is difficult to cost explicitly. The cost is hidden within the overall costs of our major production processing.

2. Processing of tests from RIG SEISMIC to assess the performance of the ship board systems and experimental acquisition systems.

3. Parameter analysis and testing of our new data sets to provide independent analysis when working with contractors.

4. Access to a research and development facility.

It is considered to be an unacceptable position for AGSO to relinquish all direct access to a seismic processing facility in-house, even though it would not be used for volume production processing. The form of this facility would be much reduced from the present system, principally because the present system is very expensive to own and maintain. A modern powerful workstation facility would probably meet this requirement. Such a facility would cost approximately the same as implementation of a sufficiently configured interactive parameter analysis facility, so the cost would be offset in that sense.

EVALUATION OF ALTERNATIVES

Internal Processing

Reasons that might be advanced for doing seismic processing internally are:

1. That it is cost effective.
   AGSO seismic processing is at present about $20 per km more expensive than external processing. This converts to a cost difference of $360,000 per year. This is in the context of the lowest contract prices in the world. Further, clearly the costs basis of AGSO seismic processing is different from that of contractors. It is argued that the cost of AGSO seismic processing is sufficiently close to the market rate and within reasonable expectation of likely increases in processing costs if the market improves. It is further the case that by implementation of some of the cost offset proposals being negotiated at present, this cost difference can be ameliorated considerably. For example the NOPEC injection of $300,000 for two surveys will bring the cost down to a negligible difference for the coming year.

   Further, if implementation of improved processing methods gives returns in improved efficiency the difference is likely to diminish.

   In summary, the AGSO seismic processing operation is sufficiently comparable to the present and likely future costs of seismic processing that this ought not be the major consideration when deciding the strategic direction of seismic processing.

2. That it is more efficient.
   It is arguable that this is the area where we have most to prove. However, we are coming from behind - attempting to recover from the deficiencies of the past at the same time as meeting present demands. We have the batch processing technology, and are planning for the necessary interactive technology. Clearly the solution to our productivity is in bringing our staff to a high level of performance. We have invested considerable effort in this, and have come a long way, but admit we have scope for further improvement, and we expect that this will be demonstrable within the present year if we are given the opportunity.

3. That it provides a higher level of scientific content.

The AGSO system in its present form provides an opportunity to undertake significant research into seismic processing in Australia. It is the most powerful CPU of its type in Australia, and, having replaced the VAX and array processor based systems, the programming headaches of the older systems are eliminated. A good example arises from the Geodynamics CRC which has involvement of AGSO, CSIRO, a number of universities and major exploration companies. AGSO can offer a very powerful seismic research environment with fully developed software and operational infrastructure within which major research into seismic problems specific to Australia can be undertaken.

A second aspect of this is that by having direct control over our system we have much more opportunity to control how our data is processed in detail. For conventional problems this is not critical. However, given that we do work which is not always conventional, there are considerable advantages in having our own facilities for this work

4. That there are intangible benefits of a substantial nature.
   Intangible benefits have been suggested above - the opportunity for advanced research and better control over unconventional processes. Another intangible benefit is the maintenance of Australian expertise in this important technology for petroleum exploration. Without AGSO's system there is no significant body of expertise which is not controlled by foreign interests.

However, the issue of whether AGSO should continue to process internally raises the question:

Are the advantages of external processing more cost effective given the exit costs of changing the existing situation?

The discussion above leads to the position that the present cost of contract processing is $85 per km, but for budgeting purposes, $100 per km would have to be allowed for possible price rises and costs of special processing. If AGSO supervision and management overheads are considered, the cost of processing our data by contract are in the range of $105 to $125 per km. This compares with $115 per km for internal processing. Therefore, converting to contract processing would, at best, save $120,000 per year, and at could easily lead to a loss of about the same amount. In other words we have a "line ball" situation when considering the comparative costs.

However, when the actual realisable savings are considered, the situation is less attractive. The immediately realisable savings are $450,000 from maintenance and variable costs. This equates to $37 per km. The staff costs would take at least one year to recover and might never be entirely recovered if staff are re-deployed permanently to other areas of the program. Assuming that they are realised, the saving will be $30 per km, the remaining $15 being required to support contract processing. The depreciation cost ($23) is not realisable, and the sale of the CONVEX is a "one-off" return at a considerable loss. The remaining cost are on-going support for a reduced system ($5) and

the cost of managing and supervising contracts ($5). Thus, of the $115 per km it costs us to process our data, a maximum of $67. per km is realisable and could be offset against contract cost. On this basis, on-going contract processing would require an additional $696,000 actual cash in the budget each year.

On the other hand, there are disadvantages with internal processing, and these are not trivial:

1. The overhead of management.
   It takes a considerable management time to look after major facilities. This includes the major administrative efforts in acquisition of systems, dealing with operational crises on a seven day a week basis, and the overhead of managing a group of processing staff. This seriously restricts the ability of senior professional staff to work as professional geophysicists, and distracts from specific processing and project goals.

2. Loss of Operational Flexibility.
   In having an in-house system one is thereby constrained to use it. This means that one is limited in productive capability to the power of that system. When using contractors, one simply engages another contractor if one requires additional work to be done in a given period. This means that if, for example, we run "back to back" cruises, we could have the results sooner by using two contractors than by processing it through our own centre sequentially.

3. Limitations of one vendor.
   This is principally a software problem. Contractors develop various methods at various times and at any time one or other is at the front of the pack. With an in-house system, we must wait for our supplier to produce a facility, or develop it ourselves. We have done this in the past, but lack the resources at this point in time. By using contractors, we can choose whoever has the technology to meet our needs.

4. Staff Dependency
   Running a successful processing centre requires that a significant number of staff have a high level of expertise. At present we are vulnerable because if we lose two key staff rapidly, much of our expertise is lost, and it takes a long time to recover. This is a significant component of our immediately past productivity problems. On the other hand, using contractors eliminates this problem.

5. The problem of continual uncertainty.
   It is a fact that the present trend in the Public Sector is towards contracting out of major facilities. Therefore operations such as AGSO's seismic processing facility are under perennial scrutiny with a view to closing the operation. While scrutiny and accountability are proper, the persistent focus on avoiding being contracted is a serious distraction from operational management, and a major contributor to poor morale among processing staff. If the future could be resolved for some definite period

then the process would be more effective and constructive. The appropriate time in the view of the AGSO processing staff is prior to replacement of major facilities.

External Processing

In most ways the case for external processing is the reciprocal of the case for internal processing. The perceived advantages of external processing are:

1. That it is more cost effective.
   This might be true if the decision was made before we installed the CONVEX system. It is not the case at present, but will become possible when the existing equipment comes to the end of its economic life, which is estimated to be about 5 years.

2. That it is more efficient.
   This is almost certainly true for purely conventional data processed in a conventional manner. It is particularly true when more than one cruise is needed in a short period of time. However, the AGSO processing staff have the potential to approach the productivity of contract processors and have the ability to do a job of a high scientific standard. Given that this is achieved, and that we are comparable on cost, then we gan gain by our opportunity to address special and unconventional problems. On the other hand, when we are short of staff and we have access to a small in-house facility, we could do the specialist work without the overheads of managing a major operation.

3. That it provides access to the latest processing technology independent of a particular software vendor.
   This is clearly true, and will be significant on some occasions, but it is difficult to predict when. AGSO would probably have used DMO as part of its processing sequence two years earlier if it had used contract processing. New developments in processing are occurring constantly. The present AGSO facilities give it much more opportunity to participate in this process than ever before, but we will always be behind to some extent.

4. That by use of a variety of contractors, those with the best tools for a particular job can be chosen for each project.
   This is the case, but it is difficult to quantify. It will always be a trade-off between what is required and what it costs.

The disadvantages of contract processing are also significant:

1. Budgetary Vulnerability
   Given that contract processing will require a cash allocation of $1,200,000 each year, and given the environment of public sector contraction, incremental reductions in allocations are almost inevitable, and there will come a point where project objectives will be compromised by cash flow constraints. We will run a serious risk that with a very few years, we will

sustain a minimal contract processing level, and have little or no opportunity to use new and innovative processing. This in turn will compromise the scientific quality of the Continental Margins Program.

2. Staff Vulnerability
   Using contract processing will lead to a situation where about two people spend a great deal of time with contractors, and most other people have an occasional contact. Loss of the critical people will leave the organisation seriously deficient in specialist geophysical competence.

3. Loss of Opportunity for Advanced Research
   We have better tools for this now than we have ever had. With appropriate use of mechanisms such as CRCs and other co-operative research programs, we have an opportunity to do significant and valuable research into Australian seismic exploration problems.

CONCLUSION

The case made in this paper is that the Seismic Processing operation in AGSO should be retained for the following reasons:

- Given the recent introduction of the CONVEX system, the realisable costs of closing the operation are insufficient to cover the cash requirement for contract processing, with a shortfall of the order of $690,000 per year.

- The need to improve productivity is recognised, that considerable gains have been made, and that implementation of interactive processing technology and increased staff expertise are expected to bring about further improvement.

- That significant opportunities exist to lower the costs by various arrangements with outside organisations, and these ought be pursued.

- That the opportunity for AGSO to take part in important research in application of seismic exploration to Australian conditions ought be taken, particularly in the context of CRCs.

The operation of the seismic processing centre should be looked at again in six months to monitor progress in these areas

delete appendix

Appendix 1: A Bit of History

When the then BMR chose to acquire its own seismic processing system in 1983, there were a number of reasons why the option to purchase its own system was taken:

1. It was strongly believed that it would be more cost effective to do so, based on experience with processing the Bass Strait Survey. Costs and technology were very different from now.

2. It was considered scientifically highly desirable that the processing of the data have close and direct involvement of project scientific staff.

3. It was our ambition to undertake research into seismic processing methods and applications to data processing problems in Australia.

4. The organisational culture at the time strongly favoured an independent approach to providing major operational functions. This was consistent with BMR's long history of innovation in exploration methods. Indeed the purchase grew out of a NERDDC funded attempt to develop our own capability in-house.

5. It was considered that seismic processing was an important national resource, and with the experience of the mid seventies in mind, the acquisition of a system by BMR would ensure that the capability and some expertise remained in Australia, no matter what happened.

6. There was a strongly held attitude that if we processed data by contract, the funding would be vulnerable in short term financial problems, whereas a fairly high fixed cost facility would be less easily starved of money under the allocation processes which operated at the time.

For the initial surveys, there were no specialist professional processing staff working on projects. We had up to five technical staff assisting, but each of these spent at least two cruises at sea each year, accumulating additional leave, effectively reducing the available staff to about three. We had one specialist researcher who assisted in parameter analysis, and one geophysical processing manager, who was generally pre-occupied with administration and frequently side tracked into other major IT acquisition activities.

This strategy proved to be unworkable, and more staff were gradually allocated to the processing group, although the demand for people to go to sea was constant and overriding. At no time prior to 1992 could it be said that there were sufficient staff allocated to processing seismic data. Further, the nature of the technology being used meant that production capacity was hampered by poor reliability of equipment.

However, the principal problem was insufficient numbers of staff, and those staff being diverted to other activities including time at sea, and marketing activities. There were two consequences of this - quality control and

throughput. We processed a lot of data, but had insufficient time to ensure that the best possible job was being done. This often occurred in the context of changing project priorities, and at times being directed to drop one project and start another. This led in a number of cases to project being poorly archived and insufficient QC of the final products being done. The needs of research project scientists were met by the data, but is was not of a standard which was acceptable to exploration companies. This latter requirement was imposed after the CMP was established, but no additional resources were available to do the additional work necessary to meet the external needs.

We had a lot of data, but it was being produced too slowly, and the QC and archival processing were inadequate. This problem was acknowledged within the organisation, and steps were taken to remedy it from about 1990, at the same time as funds were being obtained to upgrade the field acquisition system and the processing system.

In 1991/1992 financial year additional positions were allocated to Seismic Processing, and recruitment action was commenced. Other losses of staff meant that at the same time a new senior scientist commenced duty in September 1991. This was the first time that a senior person was available full time to supervise seismic processing. Recruitment actions were undertaken and, owing to delays in the process and the inherently long lead times in APS recruitment procedures, we finally had a full number of staff in July 1992. However, at that time, we had only two experienced processing geophysicists and two experienced non-professional staff, out of a total staff of 8.

At the same time we installed the CONVEX computer which was a substantial upgrade in our processing power. The system was a very powerful CPU, but was somewhat under configured for peripherals. I will describe what has happened since then later in this paper. Suffice it to say that this was the first time that we had sufficient computer power and sufficient numbers of staff to do the job required of us.

SEISMIC PROCESSING COST ANALYSIS

8-Feb-93

Surve, ..ze (kms)		3000		Onshore Allocation		10%
Number of Surveys per		4				
Total kms		12000				
FIXED COSTS						
					Annual Cost	
Depreciati	Capital Valu	$1,500,000	Rate	20%	$300,000	
Maintenar	Hardware	$150,000			$150,000	
	Software	$110,000			$110,000	
Total Fixed Costs		$560,000				
Allocated to Onshore		$56,000				
Marine Total Fixed Cost		$504,000				
VARIABLE COSTS						
		Budget Cost	Onshore	Marine	Per Survey	Per km Cost
Operators	Two Shifts	$130,000	$13,000	$117,000	$29,250	$10
Consumat	Four Surveys	$70,000	$10,000	$60,000	$15,000	$5
Sundry		$40,000	$0	$40,000	$10,000	$3
Total Variable Costs		$240,000	$23,000	$217,000	$54,250	$18
	Additional operator costs when km exceeds 12K pe				$6,000	$2
	Film Costs are additional					
STAFF COSTS		Staff Overhead Multiplier		2.1		
Fixed	Grade	Number	Salary	Total	Overhead	Full Cost
	SPOA	0.5	$55,000	$27,500	$30,250	$57,750
	SITOC	0.5	$45,500	$22,750	$25,025	$47,775
	TOTAL FIXED SALARY			$50,250	$55,275	$105,525
Variable	Grade	Number	Salary	Total	Overhead	Full Cost
	SPOC	1	$45,500	$45,500	$50,050	$95,550
	TO4	1	$40,000	$40,000	$44,000	$84,000
	PO1	3	$28,000	$84,000	$92,400	$176,400
	TO3	1	$34,000	$34,000	$37,400	$71,400
	TO2	2	$28,000	$56,000	$61,600	$117,600
	Total Variable Salaries			$259,500	$285,450	$544,950
	Per Survey cost			$64,875	$71,363	$136,238
	Per km cost			$22	$24	$45

Annual Production Cost Table

TOTAL COSTS

Number of Surveys	Total kms	Fixed Costs	Variable Cos	Fixed Staff	Variable Sta	Total Cost
1	3000	$504,000	$54,250	$105,525	$136,238	$800,013
2	6000	$504,000	$108,500	$105,525	$272,475	$990,500
3	9000	$504,000	$162,750	$105,525	$408,713	$1,180,988
4	*12000*	*$504,000*	*$217,000*	*$105,525*	*$544,950*	*$1,371,475*
5	15000	$504,000	$277,250	$105,525	$681,188	$1,567,963
6	18000	$504,000	$337,500	$105,525	$817,425	$1,764,450
7	21000	$504,000	$397,750	$105,525	$953,663	$1,960,938
8	24000	$504,000	$458,000	$105,525	$1,089,900	$2,157,425

Per km Costs

Number of Surveys	Total kms	Fixed Costs	Variable Cos	Fixed Staff	Variable Sta	Total Cost
1	3000	$168	$18	$35	$45	$267
2	6000	$84	$18	$18	$45	$165
3	9000	$56	$18	$12	$45	$131
4	*12000*	*$42*	*$18*	*$9*	*$45*	*$114*
5	15000	$34	$18	$7	$45	$105
6	18000	$28	$19	$6	$45	$98
7	21000	$24	$19	$5	$45	$93
8	24000	$21	$19	$4	$45	$90

INCREMENTAL TOTAL COSTS

Number of Surveys	Total kms	Fixed Costs	Variable Cos	Fixed Staff	Variable Sta	Total Cost
1	3000	$504,000	$54,250	$105,525	$136,238	$800,013
2	6000	$0	$54,250	$0	$136,238	$190,488
3	9000	$0	$54,250	$0	$136,238	$190,488
4	*12000*	*$0*	*$54,250*	*$0*	*$136,238*	*$190,488*
5	15000	$0	$60,250	$0	$136,238	$196,488
6	18000	$0	$60,250	$0	$136,238	$196,488
7	21000	$0	$60,250	$0	$136,238	$196,488
8	24000	$0	$60,250	$0	$136,238	$196,488

INCREMENTAL Per km COSTS

Number of Surveys	Total kms	Fixed Costs	Variable Cos	Fixed Staff	Variable Sta	Total Cost
1	3000	$168	$18	$35	$45	$267
2	6000	($84)	$0	($18)	$0	($102)
3	9000	($28)	$0	($6)	$0	($34)
4	*12000*	*($14)*	*$0*	*($3)*	*$0*	*($17)*
5	15000	($8)	$2	($2)	$0	($8)
6	18000	($6)	$0	($1)	$0	($7)
7	21000	($4)	$0	($1)	$0	($5)
8	24000	($3)	$0	($1)	$0	($4)

COMPARISON WITH EXERNAL COSTS

PROCESSING COSTS BY FIXED PRICE

	Number of cruise kms				
Price per k	12000	15000	18000	21000	24000
$50	$600,000	$750,000	$900,000	$1,050,000	$1,200,000
$60	$720,000	$900,000	$1,080,000	$1,260,000	$1,440,000
$70	$840,000	$1,050,000	$1,260,000	$1,470,000	$1,680,000
$80	$960,000	$1,200,000	$1,440,000	$1,680,000	$1,920,000
$90	$1,080,000	$1,350,000	$1,620,000	$1,890,000	$2,160,000
$100	$1,200,000	$1,500,000	$1,800,000	$2,100,000	$2,400,000
$110	$1,320,000	$1,650,000	$1,980,000	$2,310,000	$2,640,000
$120	$1,440,000	$1,800,000	$2,160,000	$2,520,000	$2,880,000
$130	$1,560,000	$1,950,000	$2,340,000	$2,730,000	$3,120,000
$140	$1,680,000	$2,100,000	$2,520,000	$2,940,000	$3,360,000
$160	$1,920,000	$2,400,000	$2,880,000	$3,360,000	$3,840,000
$180	$2,160,000	$2,700,000	$3,240,000	$3,780,000	$4,320,000
$200	$2,400,000	$3,000,000	$3,600,000	$4,200,000	$4,800,000

COMPARISON WITH ACTUAL COSTS

	Number of cruise kms				
Price per k	12000	15000	18000	21000	24000
$50	($771,475)	($817,963)	($864,450)	($910,938)	($957,425)
$60	($651,475)	($667,963)	($684,450)	($700,938)	($717,425)
$70	($531,475)	($517,963)	($504,450)	($490,938)	($477,425)
$80	($411,475)	($367,963)	($324,450)	($280,938)	($237,425)
$90	($291,475)	($217,963)	($144,450)	($70,938)	$2,575
$100	($171,475)	($67,963)	$35,550	$139,063	$242,575
$110	($51,475)	$82,038	$215,550	$349,063	$482,575
$120	$68,525	$232,038	$395,550	$559,063	$722,575
$130	$188,525	$382,038	$575,550	$769,063	$962,575
$140	$308,525	$532,038	$755,550	$979,063	$1,202,575
$160	$548,525	$832,038	$1,115,550	$1,399,063	$1,682,575
$180	$788,525	$1,132,038	$1,475,550	$1,819,063	$2,162,575
$200	$1,028,525	$1,432,038	$1,835,550	$2,239,063	$2,642,575