Bureau of Mineral Resources, Geology & Geophysics

RECORD

RECORD 1991/19

RESEARCH CURISE PROPOSAL

BONAPARTE BASIN: DEEP CRUSTAL ARCHITECTURE AND HYDROCARBON MIGRATION

PROJECT 121.22

PROGRAM MANAGER:- G.W. O'BRIEN

SCHEDULE:- APRIL-MAY, 1991

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EXECUTIVE SUMMARY

Objective:-To understand the deep crustal architecture and the mechanisms of hydrocarbon generation, migration and entrapment within the Sahul Syncline, Malita Graben and Petrel Sub-Basin, Timor Sea, northwestern Australia.

In order to further stimulate and assist the exploration effort in the Timor Sea, the Marine Geoscience and Petroleum Geology Division (Bureau of Mineral Resources) is, as part of its Continental Margins Program, carrying out a 30 day research program within the Petrel Sub-Basin, the Malita Graben, the Sahul Syncline and the Sahul Platform in April-May 1991 using R.V. *Rig Seismic*. This program will assist in the assessment of the area's prospectivity by acquiring deep crustal seismic reflection and remote sensing (direct hydrocarbon detection (DHD)) geochemical data. This research program will provide an improved understanding of:-

i.)The deep crustal architecture and the mechanism of basin evolution of the Bonaparte Basin.
ii.The structural relationships between the Petrel Sub-Basin, the Malita Graben and the Sahul Syncline and Platform.
iii.)The control that the deep crustal architecture has played during the structural reactivation processes.
iv.)The timing and relationship between structural reactivation and hydrocarbon generation and migration.
v.)The usefulness of underway geochemical profiling as a remote sensing tool in this area.

The BMR has considerable in-house geological and geophysical expertise concerning the Timor Sea region and presently has an active research program within the area. Consequently, the results of this survey will be rapidly and fully integrated with previously completed BMR Timor Sea programs, which would lead to a much better understanding of the area's geology and petroleum prospectivity. Data from the proposed program would be integrated with:

a.)Deep crustal, high resolution seismic and water column

geochemical (DHD) data which were collected within the Vulcan Graben during October-December 1990.

b.)High resolution seismic and DHD data which were collected within the Sahul Syncline, the Malita Graben and Petrel Sub-Basin during February-March 1991.

c.)Deep crustal seismic and DHD geochemical data to collected within the Joint Development Zone (Sahul Platform) in the near future.

d.)Deep crustal seismic and DHD data collected within the Arafura Sea by BMR in 1990.

While the proposed deep crustal seismic reflection data will be designed to determine the principal structural elements and image the crust and upper mantle, it will also provide regional stratigraphic ties, both between exploration wells and between the adjacent tectonic elements in the area.

The survey itself focusses on three areas, which are, in decreasing emphasis, the Petrel Sub-Basin, the Malita Graben, the Sahul Syncline and the Sahul Platform. The total program will consist of approximately 3000 km of simultaneously collected deep crustal seismic reflection and DHD data. The general survey area is shown in Figure 1.

1. BACKGROUND

The Australian Bureau of Mineral Resources has an ongoing Continental Margins Program which is investigating the structural development and petroleum prospectivity of Australia's continental shelf and slope. A considerable part of this program has been focussed on obtaining deep crustal seismic data around the margin so that the deep crustal architecture of the shelf and slope can be determined. These studies allow the actual mechanisms of basin formation to be established and also provide the key to understanding how the deep structures have been reactivated. Structural reactivation is proving to be a vital facet of hydrocarbon entrapment on the Australian margin.

In the past year, the focus of BMR's program has switched to the northern Australian margin. Deep crustal programs have been conducted in the Arafura Basin and the Vulcan Graben. Within the next twelve months, further deep crustal surveys are programmed for the Zone Of Cooperation, the Browse Basin and the southern Northwest Shelf, including the offshore Canning Basin. All of these programs will link directly into the previously collected data sets. Following acquisition of this data, the BMR will have a unique and consistent data set which will allow the deep crustal architecture of the entire northern Australian margin to be characterised.

In addition to the deep crustal program, the BMR has been acquiring underway water column geochemical data around the Australian margin. This remote sensing tool continuously measures the hydrocarbon content and composition in seawater which is pumped to the ship from near the sea bottom (see Appendix 2). This tool has proven effective in delineating the most prospective parts of sedimentary basins and can potentially discriminate between oil and gas-prone areas. Very interesting results have been obtained recently in the Vulcan Graben, the Sahul Syncline, the Malita Graben and the Petrel Sub-Basin.

As part of our ongoing research program in northern Australia, BMR will conduct a 30 day survey within the Bonaparte Basin in April-May 1991 (see Figure 1).

2. PROJECT OBJECTIVES AND RATIONALE

TECHNICAL AND SCIENTIFIC OBJECTIVES

i.)Deep Crustal Seismic Reflection Data: To acquire, in and around the Bonaparte Basin, approximately 3000 line km of deep crustal seismic reflection data.

The deep crustal study has the objective of defining the three dimensional basinal architecture of the offshore Bonaparte Basin, specifically the Petrel Sub-Basin, the Malita Graben, the Sahul Syncline and the Sahul Platform. These tectonic elements will be then linked into the adjacent structural elements which have been, or soon will, be defined by BMR deep crustal seismic programs. The survey will be sufficiently detailed to allow the definition of the major structural features in the region and to allow an understanding of the complex relationships between the Palaeozoic (eg Petrel Sub-Basin) and the Mesozoic overprinted structures such as the Malita Graben. This will, in turn, provide an understanding of how these major structures have controlled basin development, sedimentation history, petroleum trap formation (including via reactivation), source rock accumulation, and the migration of hydrocarbons within the offshore Bonaparte Basin. The data will also provide regional stratigraphic ties, both between exploration wells and between the adjacent tectonic elements in the area.

The geological structures within the Bonaparte Basin reflect multiple periods of rifting and extension which relate to the formation of the initial Paleozoic rift, later Mesozoic rifting, and finally, continental margin formation. In addition, geologically recent structural reactivation, due to the interaction between the major Tertiary compressional pulse (associated with collision along the northern margin of Australia and

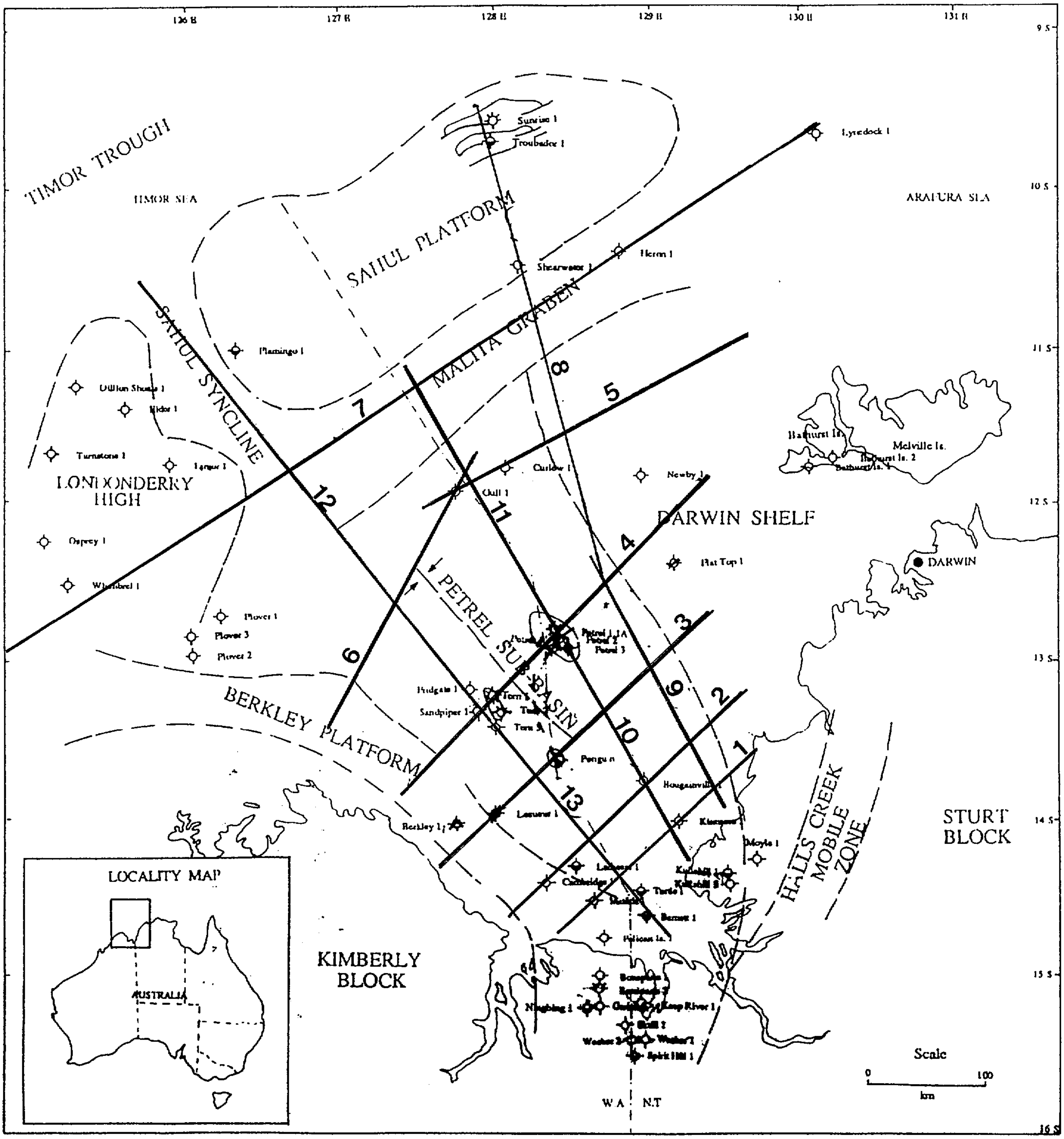

Figure 1. Location map showing proposed survey tracks for the deep crustal seismic and water column geochemical program within the Bonaparte Basin, Timor Sea. Schedule April-May, 1991. Map reproduced from Bradshaw (1990: BMR Record 1990/72).

Timor) and the underlying architecture of the Bonaparte Basin, was probably instrumental in providing Mesozoic structural traps and, importantly, expulsion and migration pathways for hydrocarbons, particularly in the northern Bonaparte Basin. Our proposed deep crustal data set potentially provides an understanding of which (and how) the deep-seated Palaeozoic and Mesozoic structural features were reactivated during the Tertiary, and consequently, which trends are most likely to be productive.

The program will consist of a maximum of 13 lines: 7 NE-SW lines and 8 NW-SE lines. The details of the lines are given in Table 1. Seismic refraction and wide angle reflection data will be collected using sonobuoys utilising shots fired during the seismic reflection survey, to provide velocity control to facilitate interpretation of the reflection data.

Table 1. Line lengths and orientation for the proposed BMR survey in the Bonaparte Basin, Timor Sea.

Line Number	Line Length (kms)	Orientation	Priority
1	165	NE-SW	High
2	185	NE-SW	High
3	270	NE-SW	High
4	300	NE-SW	High
5	195	NE-SW	High
6	230	NE-SW	High
7	550	NE-SW	High
8	260	NW-SE	Low
9	230	NW-SE	Medium
10	190	NW-SE	High
11	230	NW-SE	High
12	270	NW-SE	Medium
13	300	NW-SE	High

Total Line Kilometres:	**All Lines: 3375 km**
	NE-SW Lines: 1895km
	NW-SE Lines: 1480kms

Petrel Sub-Basin

The actual mechanism of formation for the Petrel Sub-Basin is not well understood. Some workers (Lee & Gunn, 1988; Gunn, 1988) have proposed that the Petrel Sub-Basin formed via rifting around a 'pivot-type' opening centred about the Bonaparte Gulf. Extension was progressively greater from south to north, and these workers proposed that oceanic crust actually formed within the northern Petrel Sub-Basin. In addition, they suggest that a major axial intrusion of upper mantle material was injected along the Sub-Basin as a precursor to 'crustal splitting'. These features, which would significantly affect the heat flow history of the area, presently lay below the available conventional seismic data but should be clearly resolvable (if present) on BMR's deep crustal data. Interestingly, Gunn (1988) has also proposed that the Petrel Sub-Basin is sub-divided into a series of compartments which are separated by transfer faults. Again, deep crustal seismic will be able to test this model. The proposed program consists of a series of NW-SE and NE-SW oriented lines across the Sub-Basin, linking the Petrel Sub-Basin into both the Sahul Syncline and Malita Graben.

Sahul Syncline

The work program within the Sahul Syncline has one principal objective. This is to obtain a deep crustal line from the Australia-Indonesia border, along the centre of the Sahul Syncline, across the western extremity of the Malita Graben, and into the northern Petrel Sub-Basin (see Figure 1). This line will assist in understanding the structural development of the Sahul Syncline and the relationship of the Syncline to the adjacent tectonic elements. The data will also be used to study the processes of structural reactivation associated with collision and foreland basin development along the northern margin of the Australian craton. The line is positioned so that it will tie two previously acquired BMR strike lines within the northern Vulcan Graben (lines 98/005 and 009).

Malita Graben
The Malita Graben program consists of two strike lines linking the Londonderry High, the Sahul Syncline, the Malita Graben and Darwin Shelf.

Sahul Platform
One dip line will be run from the Australia-Indonesia border (Sahul Platform), through the Sunrise and Troubadour gas/condensate discoveries to the Shearwater 1 well, through the Malita Graben and into the Petrel Sub-Basin. This line will link with a proposed BIRPS deep crustal line which will be soon be collected across the Timor Trench.

ii.)Remote Sensing Geochemical Data: To acquire, in and around the Bonaparte Basin, approximately 3000 line km of direct hydrocarbon detection (C_1-C_8^+) water column data

The Direct Hydrocarbon Detection data (DHD) data will be collected simultaneously with the deep crustal seismic data, thereby allowing geochemical anomalies to be related to sub-seafloor geology. The DHD data will help to establish the nature (and migration pathways) of the hydrocarbon charge emanating from the Sahul Syncline and Malita Graben at the present day (see Appendix 2). This objective may be particularly important because of the possibility of flushing oil from reservoirs along the margins of the Sahul Syncline (and Malita Graben) with gas generated from source rocks which are now overmature. The DHD program will also potentially provide information on the probable type (i.e. gas versus oil) and distribution of hydrocarbon accumulations within the Malita and Sahul Synclines and their margins. The survey will also investigate the northeastern Sahul Platform (Sunrise/Troubadour gas condensate discoveries) and thereby hopefully provide further information on the likely nature of the reservoired hydrocarbons within Area "A" of the Zone of Cooperation.

In addition, the survey will collect DHD data between the southern oil-prone part of the Petrel Sub-Basin (Barnett 1,2; Turtle 1,2) and the northern gas-prone area (Petrel/Turn gas discoveries).

3. EXPECTED PRODUCTS FROM PROJECT 121.22

The following products can be expected to result from this project:-

- Regional deep crustal seismic sections showing the main structural elements of the offshore Bonaparte Basin and their relationship to the surrounding structural elements.

- Revised regional tectonic elements maps and structural sections.

- Regional seismic stratigraphic ties, both between exploration wells and between the adjacent tectonic elements in the area.

- Regional maps of the distribution of light hydrocarbons in the water column the relationship of any detected geochemical anomalies to sub-seafloor geology.

- Basin-wide burial and thermal geohistory analyses of relevant exploration wells (and synthetically-generated locations) to constrain the timing of hydrocarbon generation and likely migration pathways.

4. REFERENCES

Gunn, P.J. (1988). **Bonaparte Basin: Evolution and Structural Framework**. In: The North West Shelf Australia. PESA Volume, P.G. & R.R. Purcell, Editors.

Lee, R.J. & Gunn, P.J. (1988). **The Bonaparte Basin**: In Petroleum in Australia. The First Century. APEA Publication, 252-269.

MacDaniel, R.P. (1988). The geological evolution and hydrocarbon potential of the western Timor Sea region. In: **'Petroleum In Australia, The First Century'. APEA**, 270-284.

APPENDIX 1

GENERAL DETAILS:-RESEARCH VESSEL RIG SEISMIC

R/V Rig Seismic is a seismic research vessel with dynamic positioning capability, chartered and equipped by BMR to carry out the Continental Margins Program. The ship was built in Norway in 1982 and arrived in Australia to be fitted out for geoscientific research in October 1984. It is registered in Newcastle, New South Wales, and is operated for BMR by the Federal Department Of Transport and Communications.

Gross Registered Tonnage:	1545 tonnes	
Length, overall:	72.5 m	
Breadth:	13.8 m	
Draft:	6.0 m	
Engines:	Main: Norma KVMB-12	2640 HP/825 rpm
	Aux: 3x Caterpillar	564 HP/482 KVA
	1x Mercedes	78 HP/56 KVA
	Shaft generator:	AVK 1000KVA; 440 V/60 Hz
Side Thrusters:		2 forward, 1 aft, each 600 HP
Helicopter Deck:		20 m diameter
Accommodation:		39 single cabins and hospital

APPENDIX 2

SCIENTIFIC EQUIPMENT

GEOPHYSICAL SCIENTIFIC EQUIPMENT

NON-SEISMIC SYSTEMS

General
Raytheon echo sounders: 3.5 Khz (2 KW) and 12 Khz (2 KW)
Geometrics G801/803 magnetometer/gradiometer
Bodenseewerk Geosystem KSS-31 marine gravity meter

E.G. & G. model 990 side scan sonar
Nichiyu Giken Kogyo model NTS-11Au heatflow probe

Navigation
Differential GPS System
Magnavox T-set Global Positioning System
Magnavox MX 1107RS and MX 1142 transit satellite receivers
Magnavox MX 610D and Raytheon DSN 450 dual axis sonar dopplers
Magnavox Differential GPS System
Arma Brown and Robertson gyro-compasses; plus Ben paddle log
Decca HIFIX-6 radio-navigation system, modified for long range operations

SEISMIC SYSTEM CONFIGURATION FOR DEEP CRUSTAL SEISMIC REFLECTION PROGRAM IN THE BONAPARTE BASIN, TIMOR SEA

The anticipated recording parameters to be used on the deep crustal seismic survey in the Bonaparte Basin are as follows.

SEISMIC SYSTEM

Streamer
Fjord Instruments transformerless.
3600 to 4800 m seismic cable.
144 to 192 seismic channels.
group interval 25 m.
depth 10m nominal.

Field Data
8 hz - 256 hz passband
2 ms demultiplexed
up to 15 sec record length
nominal 18.5 to 20 second shot rate

Seismic data supplied in SEG-Y format, special floating point format, 4 bit binary exponent, 12 bit mantissa. Conversion routines supplied.

Energy Source:
16 x 150 cu.in. HGS sleeve gun array (2 arrays)
16 x 160 cu.in. HGS Mod III airgun array (2 arrays)
Gun depths 5 to 15 metres, spacing 0.5 metres

SEISMIC ACQUISITION SYSTEM (GENERAL)

Seismic cable:
Fjord Instruments, transformerless coupling
Maximum of 288 seismic channels, 12 auxiliary channels
10 Teledyne T-1 hydrophones per 6.25 metre group
Nominal sensitivity 20 Volts/Bar for standard group
Oil blocks to reduce low frequency noise
6.25, 12.5, (18.75), and 25.0 metre groups available
192 seismic channels,
Maximum towable length 6000 metres,
4800 m available

Energy Source:
5 x 80 cu.in. SSI S-80 watergun array
Gun depths 3 to 5 metres, spacing 2.5 metres
16 x 150 cu.in. HGS sleeve gun array (2 arrays)
16 x 160 cu.in. HGS Mod III airgun array (2 arrays)
Gun depths 5 to 15 metres, spacing 0.5 metres
Gun groups separated by 2.5 metres
Various gun groupings available
Configured as 6, 5, 3, and 2-gun groups
Usually fired as 4, 3, 2, and l-gun groups
Compressor capacity 1200 scfm nominal at 2000 psi

RecordingParameters:
Low noise charge-coupled preamplifiers
Preamplifier gain from 1 to 128 in 6 dB steps
Maximum of 320 channels including seismic and auxiliaries
LC filters 4, 8, 16, and 32 Hertz at 18 dB/octave
HC filters 90, 180, 360 and 720 Hertz at 140 dB/octave
Sampling rates of 0.5, 1, 2, and 4 millisecs
Record lengths from 2 secs to 20 secs
SEG-Y recording format with extension
IFP operating at 200 khz with special floating point format
Data recorded as 4-bit binary exponent and 12-bit mantissa

Other:
Reftek receiver and sonobuoys
Yaesu sonobuoy receiver and Spartan SSQ-57A sonobuoys
Raytheon echo sounders: 3.5 Khz (2 KW) and 12 Khz (2 KW)
Geometrics G801/803 magnetometer/gradiometer

GEOCHEMICAL SCIENTIFIC EQUIPMENT

Water Column Geochemistry

The Direct Hydrocarbon Detection (DHD) method continuously analyzes C_1-C_8 hydrocarbons within seawater. Thermogenic hydrocarbons migrating up faults from source rocks and/or hydrocarbon reservoirs debouch into the seawater at the seafloor, producing higher concentrations of light hydrocarbons within the water column. These seep gases have molecular compositions that are distinctively different from that of the biogenically-produced hydrocarbons which are mainly produced by *in situ* processes in seawater. If the hydrocarbons are present in sufficient amounts, the molecular composition of the thermogenic hydrocarbons may be used to infer whether the primary source of the seep was oil, condensate or dry gas.

The method used on the RV `Rig Seismic' is as follows. Seawater is continuously delivered into the geochemical laboratory onboard the ship via a submersible fish (which is towed approximately 10 m above the seafloor). The seawater is degassed in a vacuum chamber and the resulting headspace gas is injected into three gas chromatographs which sequentially sample the flowing gas stream and measure a variety of light hydrocarbons. Total hydrocarbons (THC) are measured every thirty seconds, light hydrocarbons (C_1-C_4) are measured every two minutes and C_5 to C_8 are measured every 8 minutes. These data, as well as fish altitude (above the seafloor), the depth of the fish, hydrographic (temperature and salinity) and navigation data are recorded on computer. All these data are recorded and displayed continuously so that any hydrocarbon anomalies in the water column can be quickly recognised and additional measurements can be made when appropriate. Detection sensitivity is approximately 10 parts per billion in the stripped headspace sample. At a ship speed of 4 knots, the measurement of THC is made every 70 m, C_1-C_4 every 250 m and C_5 to C_8 every 1400 m.

GEOLOGICAL SCIENTIFIC EQUIPMENT

Geological and geochemical equipment which could be used during contingency geological coring operations:

Australian Winch and Haulage deep-sea winch with 10,000 m of 18 mm wire rope and a hydrographic winch with 4000 m of 6 mm wire rope
Gravity, piston, box and vibracores
Grab sampler
Pipe and rock dredges
Niskin bottle water samplers
Underwater camera

Sediment And Porewater Geochemistry

Flow injection analyser

UV-VIS spectophotometer

Gas chromatographs

APPENDIX 3

WELLS DRILLED IN THE TIMOR SEA

WELL NAME	LATITUDE	LONGITUDE
Allaru 1	12.093406	124.798173
Allaru 1 ST 1	12.093406	124.798173
Allaru 1 ST 2	12.093406	124.798173
Anderdon 1	12.646416	124.796593
Anson 1	12.502971	124.8035
Arunta 1	11.975496	124.951508
Ashmore Reef 1	12.180472	123.086277
Asterias 1	13.152305	124.119998
Augustus 1	11.683611	124.970276
Avocet 1	11.373053	125.755
Avocet 1A	11.372813	125.755001
Avocet 2	11.364093	125.757075
Barcoo 1 (Woodside)	15.343611	120.636721
Barita 1	11.443318	125.728054
Barnett 1	14.530556	129.0611
Barnett 2	14.532361	129.052138
Barnett 3	14.534238	129.050336
Barossa 1	12.020833	124.261111

Bassett 1	13.31111	123.42667
Bassett 1A	13.311583	123.425222
Bedout 1	18.244444	119.389611
Berkley 1	14.004721	127.831111
Berri 1	11.486111	124.563888
Bilyara 1	12.684654	124.505886
Bilyara 1 ST 1	12.684654	124.505886
Birch 1	12.460841	124.495348
Bougainville 1	13.773583	129.04181
Brecknock 1	14.436964	121.6725
Brewster 1	13.91361	123.2595
Brewster 1A	13.913706	123.259511
Brown Gannet 1	12.108056	123.856111
Buccaneer 1	13.616666	124.016666
Buffon 1	13.393869	122.183228
Cambridge 1	14.290431	128.432639
Cartier 1	12.244166	123.940276
Cassini 1	12.146501	124.968138
Cassini 1 ST 1	12.146498	124.968136
Cassini 2	12.148551	124.949416
Casuarina 1	12.052446	125.098658
Caswell 1	14.241306	122.4675
Caswell 2	14.242528	122.469522
Challis 1	12.123753	125.00446
Challis 2	12.121666	125.018333
Challis 2A	12.121286	125.018568
Challis 3	12.115125	125.022888
Challis 4	12.129268	124.995086
Challis 5	12.122263	124.996666
Challis 6	12.109661	125.034593
Challis 7	12.105366	125.040561
Challis 8	12.102161	125.047823
Challis 9	12.1091	125.035398
Challis 10	12.126736	125.017348
Challis 11	12.099143	125.054613
Champagny 1	12.487223	124.312601
Champagny 1 ST 1	12.487223	124.312601
Cockell 1	11.667278	125.039228
Cockell 1 ST 1	11.667278	125.039228
Coonawarra 1	12.080554	124.353333
Crane 1	12.125766	125.628168
Curlew 1	11.770556	128.263888
Cygnet 1	11.896124	125.939031
Darwinia 1	11.441854	127.934766
Darwinia 1A	11.442118	127.934921
Delamere 1	12.000475	125.304193
Delta 1	12.649066	123.970348
Dillon Shoals 1	11.239263	125.446997
Discorbis 1	12.882476	123.812796
Douglas 1	11.795833	124.946388

Drake 1	11.285013	125.835554
Dromana 1	12.274998	124.9125
East Mermaid 1	17.166944	119.822555
East Swan 1	12.301968	124.582249
East Swan 2	12.292674	124.583496
Echuca Shoals 1	13.750342	123.723617
Eclipse 1	12.271388	124.618609
Eclipse 2	12.238423	124.643611
Eider 1	11.389167	125.746389
Evans Shoal 1	10.081523	129.531999
Fagin 1	11.571388	125.137776
Flamingo 1	11.026111	126.481944
Flat Top 1	12.376472	129.265528
Frigate 1	13.18	127.923611
Fulica 1	11.088891	125.875276
Garganey 1	11.356596	125.916388
Garganey 1 ST 1	11.356596	125.916423
Grebe 1	12.451111	124.249444
Gryphaea 1	12.810646	123.739321
Gull 1	11.941389	127.910277
Heron 1	10.440833	128.95139
Heywood 1	13.462683	124.066725
Ibis 1	12.062021	125.346491
Jabiru 1	11.932181	125.005222
Jabiru 1A	11.933561	125.004081
Jabiru 2	11.934864	124.988837
Jabiru 3	11.925583	125.00885
Jabiru 4	11.921625	125.019882
Jabiru 5	11.940204	124.989593
Jabiru 5A	11.939861	124.990171
Jabiru 6	11.930321	125.012855
Jabiru 7	11.920548	125.017303
Jabiru 7 ST 1	11.917991	125.017401
Jabiru 8	11.936518	125.01038
Jabiru 8A	11.936526	125.010388
Jabiru 9	11.951113	124.980398
Jabiru 10	11.922358	125.026016
Jabiru 11	11.942079	124.993308
Jacaranda 1	11.470835	128.16388
Jarrah 1	11.289238	125.70328
Jarrah 1A	11.289333	125.703166
Kalyptea 1	13.032998	123.872388
Kambara 1	16.743011	122.437578
Katers 1	12.675416	124.744416
Keeling 1	12.620538	124.165036
Keraudren 1	18.907592	119.15423
Kimberley 1	12.60288	124.383086
Kinmore 1	14.033614	129.262448
Kite 1	12.067793	126.436761
Lacepede 1	17.088333	121.444721

Lacepede 1A	17.088439	121.444822
Lacrosse 1	14.2975	128.58278
Lagrange 1	18.274361	119.318916
Langhorne 1	11.979638	124.365721
Lesueur 1	13.95264	128.125833
Leveque 1	15.753312	122.004906
Lombardina 1	15.288942	121.537303
Londonderry 1	13.614769	124.51183
Longleat 1	12.563693	124.742111
Lorikeet 1	11.173676	125.617996
Lucas 1	12.260361	124.133804
Lynher 1	15.9401	121.083065
Maple 1	12.019916	124.538716
Matilda 1	14.454828	128.749747
Minilya 1	18.32465	118.732426
Minjin 1	16.802153	122.379092
Montara 1	12.689346	124.531661
Mount Ashmore 1	12.560276	123.20667
Mount Ashmore 1A	12.560276	123.20639
Mount Ashmore 1B	12.560081	123.20781
Nancar 1	10.988741	125.757818
Newby 1	11.835278	129.101944
Nome 1	11.655268	125.221291
North Hibernia 1	11.671953	123.324741
North Scott Reef 1	13.948054	121.974721
North Turtle 1	18.909806	118.087776
Octavius 1	11.847221	124.910555
Oliver 1	11.644801	125.008801
Osprey 1	12.219167	125.22084
Paqualin 1	11.980638	124.5069
Parry 1	12.270646	124.337516
Pascal 1	12.203	124.221898
Pearl 1 (Home Energy)	17.851387	122.02777
Peewit 1	12.656144	126.020894
Pengana 1	11.891433	125.029043
Penguin 1	13.607778	128.468333
Perindi 1	16.828358	122.26314
Petrel 1	12.826389	128.47418
Petrel 1A	12.831112	128.47223
Petrel 2	12.853889	128.51389
Petrel 3	12.935833	128.569498
Petrel 4	12.888441	128.494751
Phoenix 1	18.635292	118.7854
Phoenix 2	18.602193	118.842526
Plover 1	12.7125	126.368611
Plover 2	12.958056	126.174444
Plover 3	12.818156	126.115833
Pokolbin 1	11.519443	124.552776
Pollard 1	11.664721	124.56889
Prion 1	12.404444	124.151944

Prudhoe 1	13.748819	123.864203
Puffin 1	12.308333	124.333611
Puffin 2	12.363056	124.275277
Puffin 3	12.288783	124.35825
Puffin 4	12.292226	124.360668
Rainbow 1	11.937958	124.331913
Rainier 1	12.062463	125.023008
Rob Roy 1	13.971	124.199194
Rowan 1	12.498298	124.393698
Rutherglen 1	11.606943	124.470833
Sahul Shoals 1	11.427221	124.54723
Sandpiper 1	13.314722	127.976388
Scott Reef 1	14.076108	121.824655
Scott Reef 2	14.101111	121.8575
Scott Reef 2A	14.101575	121.857803
Shearwater 1	10.513611	128.310278
Skua 1	12.505278	124.432777
Skua 2	12.509516	124.404346
Skua 3	12.506121	124.414663
Skua 4	12.493136	124.425766
Skua 5	12.473919	124.443666
Skua 6	12.487743	124.438568
Snowmass 1	11.994708	125.179466
Stork 1	11.491416	125.792638
Sunrise 1	9.590097	128.153789
Swan 1	12.188056	124.492777
Swan 2	12.194727	124.495677
Swift 1	12.537356	124.451507
Tahbilk 1	12.732758	124.503976
Talbot 1	12.453138	124.881616
Talbot 2	12.457133	124.870329
Taltarni 1	12.612863	124.579529
Tamar 1	11.870924	126.211144
Tancred 1	11.734743	125.323429
Tern 1	13.220833	128.064722
Tern 2	13.2789	128.132789
Tern 3	13.336026	128.104471
Troubadour 1	9.734394	128.123753
Turnstone 1	11.736944	125.295833
Turtle 1	14.476608	128.94484
Turtle 2	14.505891	128.945791
Voltaire 1	11.193351	125.331983
Vulcan 1	12.241993	124.549474
Vulcan 1A	12.242261	124.549964
Vulcan 1B	12.242642	124.550339
Wamac 1	17.240517	121.491563
Whimbrel 1	12.482778	125.378055
Willeroo 1	12.027721	124.897891
Woodbine 1	12.645206	124.147072
Yampi 1	14.558888	123.276077

Yarra 1	12.047804	124.360026
Yering 1	12.612888	124.517098