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Record Number

AGSO RECORD 1992/89

CENTRAL OFFICER BASIN
SOUTH AUSTRALIA

SEISMIC DATA ACQUISITION
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SEISMIC DATA ACQUISITION 1993

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SUMMARY

The Officer Basin Project is a five year basin study program developed co-operatively between the Australian Geological Survey Organisation and the South Australian Department of Mines and Energy as part of the National Geoscience Mapping Accord. The main AGSO objective is to:

1. Promote petroleum exploration in the central Officer Basin.

2. Evaluate the resource potential of the region.

3. Develop a depositional and post-depositional model of the Officer Basin and to compare it with other Australian intracratonic basins.

4. Understand the processes controlling hydrocarbon systems.

These objectives will be accomplished by means of an integrated basin analysis involving the reassessment of existing seismic, well and potential field data and the gathering of approximately 600 km of new seismic data. This record outlines the scientific rationale for the selection of the proposed seismic lines.

The proposed study area in the cental Officer Basin is limited to the south by the platform carbonates, and bounded to the north by the Musgrave Block and the south-east by the Gawler Block. The Namungarintja Conservation Park in the centre of the basin splits the study area in two. We are thus proposing two connected but potentially independent survey areas: one to the north of the conservation park, predominantly in Pitjantjatjara lands; and one to the south and east of the park in Maralinga lands. Negotiations to gain access for these seismic lines are ongoing and their outcome will decide the final survey network.

INTRODUCTION

The Officer Basin underlies one of the most arid and inaccessible regions of the Australian continent and for that reason is perhaps the most poorly understood of the continent's intracratonic basins (Fig. 1). The basin is very poorly exposed due largely to a widespread Pleistocene and Holocene sand-dune cover. As is the case in many intracratonic basins in Australia, hydrocarbon prospectivity is perceived to be relatively limited and in combination with access and logistical problems the basin has been seen as a high risk prospect. As a consequence only 30 wells have been drilled to depths greater than 500 m in the South Australian part of the basin. Most are to the extreme east with only one well drilled close to Western Australian border (Birksgate #1). Only 7200 km of seismic data are available, mostly in the east. In light of these problems, the Officer Basin Project was developed to broaden our understanding of the basin and encourage economic activity in the area.

AIMS OF THE PROJECT

The aims of this project are to undertake an integrated basin analysis of the South Australian portion of the Officer Basin (Lindsay & others, 1991) and compare the basin with other related Australian intracratonic basins (Lindsay & others, 1987). The study will emphasise the basin's evolution through an evaluation of its sedimentary fill, structure, morphology, tectonic and thermal history. The program will consist of two major components (1) synthesis of existing well, seismic and potential field data and (2) acquisition of seismic reflection data in the central Officer Basin which will be used to investigate specific problems. The South Australian Department of Mines and Energy will carry out a regional field mapping program and an extensive drilling and coring project along the AGSO seismic lines. The seismic acquisition aims to provide information in the third dimension to complement the geological mapping, as well as providing a regional network as an encouragement towards, and a basis for, future hydrocarbon exploration in the central portion of the basin.

This record outlines the scientific and logistic rationale for the proposed seismic network.

GEOLOGY OF THE OFFICER BASIN

The Officer Basin extends west to east from longitude 125°E in Western Australia to longitude 132° 30'E in South Australia, a distance of more than 1100 km. From north to south it extends from latitudes 27°S to 32°S, a distance of 550 km, and covers an area of 375,000 km^2 (Palfreyman, 1981). To the north the basin terminates against the older (Early to Middle Proterozoic) Musgrave Block whereas to the south it is onlapped by the younger sediments (Cretaceous to Tertiary) of the Eucla Basin. The Archaean to Middle Proterozoic Gawler Block forms the basin margin to the southeast.

The South Australian part of the basin can be subdivided into several distinct morphological features (Fig. 2). Magnetic (Gerdes, 1982) and gravity data indicate major sub-basins along the northern margin of the basin (Birksgate Sub-basin and Munyarai Trough) which are separated from each other by the Nurrai Ridge (Fig. 3). The sub-basins are in turn separated from a much larger platform area (beneath the Nullarbor Platform of the Eucla Basin) to the south by a shallow ramp or a low ridge. The basin contains a complex Late Proterozoic to Cretaceous depositional succession much of which is either shallow marine or sub-aerial (Pitt & others, 1980; Brewer, & others, 1987) (Fig. 4). The stratigraphy of the eastern Officer Basin is summarised by Pitt & others (1980) and Brewer & others (1987) and more recently Gravestock & Hibburt (1991) have looked at sequence stratigraphic models for the Cambrian succession.

STRUCTURAL SETTING OF THE OFFICER BASIN

Relatively little is known of tectonic structure in the central Officer Basin, because Pleistocene sand dunes obscure the surface geology, and there is a dearth of any modern seismic data in the area. However, discontinuous, patch outcrops along the northern margin indicate strong deformation of sedimentary rocks at the contact with the Musgrave Block. The underlying tectonic structure can only be inferred from an interpretation of the potential field data.

Within South Australia, two deep sub-basins which are evident from both the gravity and total magnetic intensity (TMI) datasets wrap around the southern boundary of the Musgrave Block. The Birksgate sub-basin (Fig. 2) trends east-southeast and Munyarai sub-basin trends east-northeast. These two troughs are separated by the Nurrai Ridge, a north northeasterly trending linear feature that appears on both the gravity and TMI images. Southeast of the Munyarai trough, the Officer Basin thins onto the edge of the Gawler Craton, with a series of troughs and ridges that parallel the craton's boundary.

South of the major sub-basins, the basin hinges onto the Murnaroo Platform. The TMI image of the basin shows linear anomalies which appear to fan out to north from Coompana Block in the southwestern corner of the State. This fan structure is cross-cut by a series of northwest trending linear anomalies south of latitude 29°S

PETROLEUM POTENTIAL

In determining the priority of the seismic traverses, the petroleum potential of the basin must be considered. Both Comalco and Amoco have explored in the eastern Officer Basin, with some encouraging shows, but no success. We therefore need to investigate why the exploration in the eastern Officer Basin has been unsuccessful, and question whether the prospects in the central Officer are better.

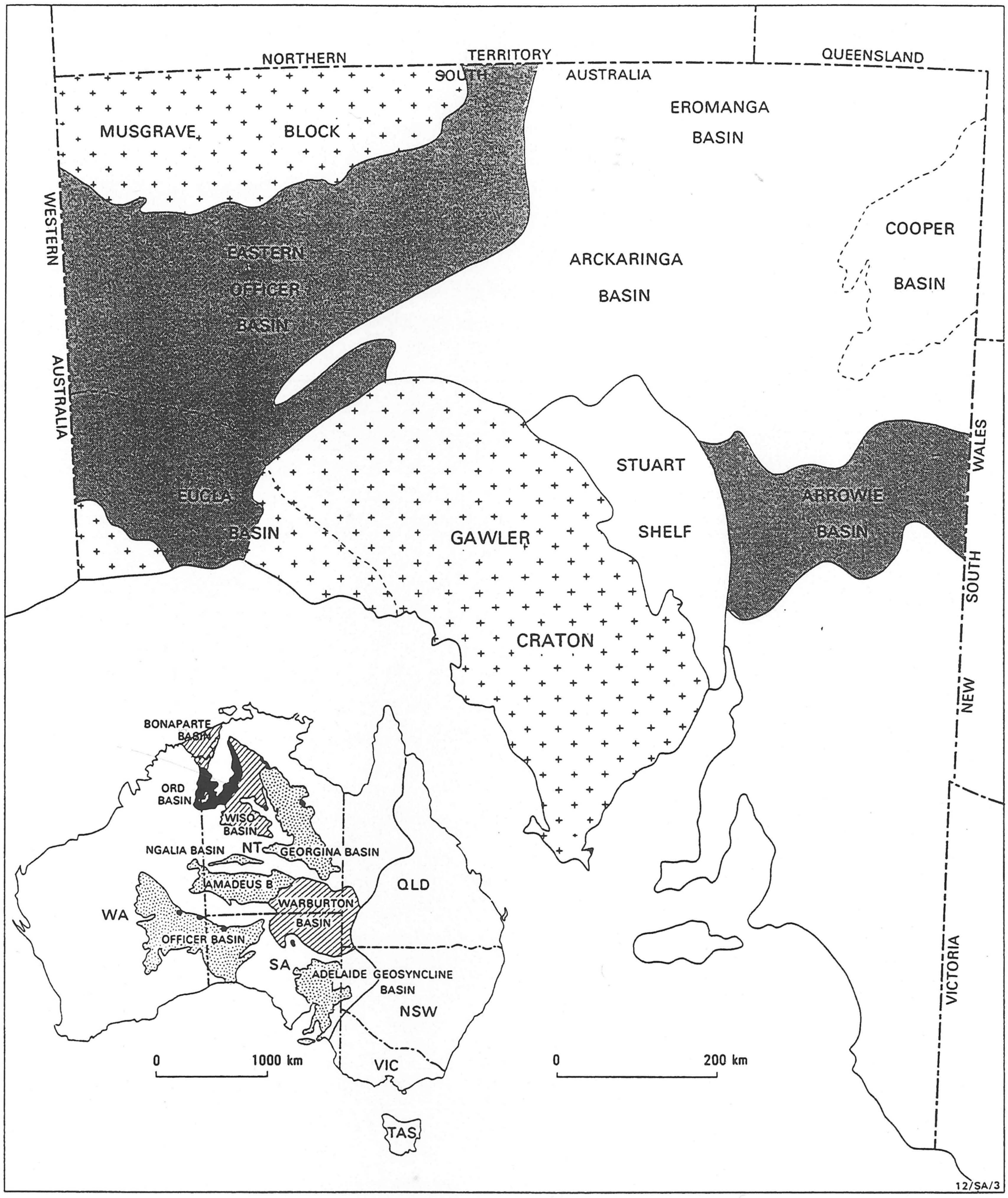

Figure 1. Location map of the Officer Basin and the study area. The inset map shows related intracratonic basins. Stippled basins were initiated about 900 Ma; the cross hatched basins were initiated about 600 Ma (see Lindsay & Korsch, 1989, 1991).

In spite of the upper Proterozoic to lower Palaeozoic age of this basin, its petroleum prospectivity should not be dismissed. Strata of equivalent age and very similar geology in the Amadeus Basin are hosts to the Dingo gas field (Lindsay & Gorter, in press). The Proterozoic oil and gas fields in the U.S.S.R. (Meyerhoff, 1980) indicate the potential of these older basins, and Karajas (1982) has compiled hydrocarbon indications in Australian Proterozoic Basins. Comalco reports (Stainton & others, 1988) indicate that Cambrian source rocks in the eastern Officer Basin are still within the mature oil window.

Source Rocks

Four units within the upper Proterozoic to Cambrian strata of the Officer Basin are identified as the most likely potential source rocks. These are the Observatory Hill Formation and the Rodda beds.

1. Observatory Hill Formation

The Observatory Hill Formation (Wopfner, 1969; Amoco, 1987; White & Youngs, 1980; Weste & others, 1984, Lambert & others, 1986; Farrand & Gatehouse, 1985; Brewer & others, 1987) consists of non-marine early Cambrian calcareous siltstones and shales interbedded with minor greywackes and thin carbonate and chert beds, and is up to 300 m thick. Within the Parakeelya Alkali Member, the presence of gypsum and chemically precipitated minerals indicates deposition in an evaporitic environment, and suggests a playa lake facies for this member, and a non-marine lacustrine environment.

The formation has TOC around 1%, but appears confined to the eastern portion of the basin. Comalco interpreted this unit as mature source rocks, and encountered good shows of oil, including bleeding from vugs in cores of the Observatory Hill Formation.

2. Rodda beds

The Rodda beds (Amoco, 1987; Krieg, 1969; Stainton & others, 1988; Thomas, 1990; Preiss & Krieg, 1991) consist of laminated calcareous and dolomitic siltstones with minor limestone and sandstone beds, and are interpreted as deep water marine. Although these beds have relatively low TOC values (Jenkins & others, 1992), the thickness of more than 3000 m in the northern sub-basins compensates. These beds contain bacterial mats, and currently appear to be in the mature oil window.

3. Browne Beds

Liquid hydrocarbons have been described as oozing from a core of Corehole NJD #1; a coarse sandstone thought to be Browne Beds - Middle Proterozoic Bangemall Basin equivalents (Townson 1985). Analysis indicates that these sandstones are not the source of the hydrocarbons. However, this show may demonstrate the presence of oil source rocks below the Browne Beds (Townson 1985), possibly from the Townsend Quartzite sequence. In the South Australia, the equivalent sequence is the Pindyin Beds, and this unit appears to be extensive in eastern Officer Basin. It may therefore represent a significant source unit if it is extensively preserved in the central Officer Basin.

4. Ouldburra Formation

The Ouldburra Formation (Brewer et al., 1987) is a chronostratigraphic equivalent to the Relief Sandstone. It comprises marine carbonates and evaporites containing ooid shoals, algal mud mounds, algal bioherms, and was deposited in a shallow water marine environment. Its thickness is variable, but in places reaches over 1000 m. Although organically lean, it may represent an important source unit because it interfingers with the Relief Sandstone.

Reservoirs

Two potential reservoir units are identified: the Murnaroo Formation and the Relief Sandstone. Both have recorded oil staining in cores (Thomas, 1990).

1. Murnaroo Formation

The Murnaroo Formation (Amoco, 1987; Gatehouse & others, 1986; Thomas, 1990) consists of moderately well sorted sands, often containing chert, quartzite, mafic volcanic with locally interbedded with evaporites, and is interpreted as marginal marine. In the eastern Officer Basin it has poor reservoir potential due to heavy cementation. However, it is believed to be regionally extensive.

2. Relief Sandstone

The Relief Sandstone (Gaughan & Warren, 1990) is interpreted to have been deposited in an aeolian or braided fluvial environment with some tidal to shallow marine deposition in the west. It is early Cambrian in age, and interfingers with Ouldburra Formation. The Relief Sandstone has excellent porosity and permeability, with porosity up to 26% and permeability up to 4839 mD. Most of the porosity is secondary - a result of the dissolution of cement and matrix.

Play Concepts

Perhaps the most compelling reason for the continued exploration of the Officer Basin lies in its similarities with the Amadeus Basin, one of the most productive of Australia's onshore basins. The Officer Basin is one of a number of similar intracratonic basins that evolved on the Australian craton in the Late Proterozoic and early Palaeozoic (Fig. 1). These basins appear to have evolved as a response to two major tectonic events and in some cases to a third compressive event. Because of recent detailed studies, the Amadeus Basin can be used as an analogue to evaluate these intracratonic settings (Lindsay & Korsch 1989, 1991, Lindsay & others, 1987).

The Amadeus Basin has a series of sub-basins along its northern margin that appear to have been initiated in the original extension and reactivated in the second extensional event. Hydrocarbons occur in broad gentle structure along the southern margin of these sub-basins. This presumably occurs because there are thick source rocks to the north and there is a good migration path to the southern margin. The hydrocarbon traps all have cores of late Proterozoic salt from the Bitter Springs Formation and appear to be ancient structures which began to evolve in the Proterozoic but which grew most rapidly during the final compressional event, the Alice Springs Orogeny.

The Officer Basin has a very similar history to that of the Amadeus Basin (Lindsay & others, 1987) so we would expect a similar stratigraphy and perhaps some overall similarities in petroleum potential and play concepts. Like the Amadeus the Officer Basin has a series of major sub-basins along its northern margin which shallow to the south to a broad platform (Fig. 2). Hydrocarbon shows have been encountered along the southern margin of the sub-basins towards the eastern end of the basin. However, there are no wells in this setting in the central part of the basin and only the broad features of the region are known, in large part from potential field data. Compressional anticlines and fault traps associated with the thrusting of the Alice Spring Orogeny are the most likely structural traps. Diapiric structures and anticlines associated with salt movement are another possibility, if these salt structures persist into the central Officer Basin. The most likely source rocks in the region are the Rodda Beds and any trapping structures would potentially have access to hydrocarbons from a very large area of the sub-basin. By analogy with the Dingo Field in the Amadeus Basin the Rodda Beds are most likely to be gas prone.

Another play that the proposed regional seismic lines should investigate is the Relief Sandstone. Its excellent reservoir potential and close association with the possible source rocks of the Ouldburra Formation means that it could be an important fairway if it persists into the central Officer Basin.

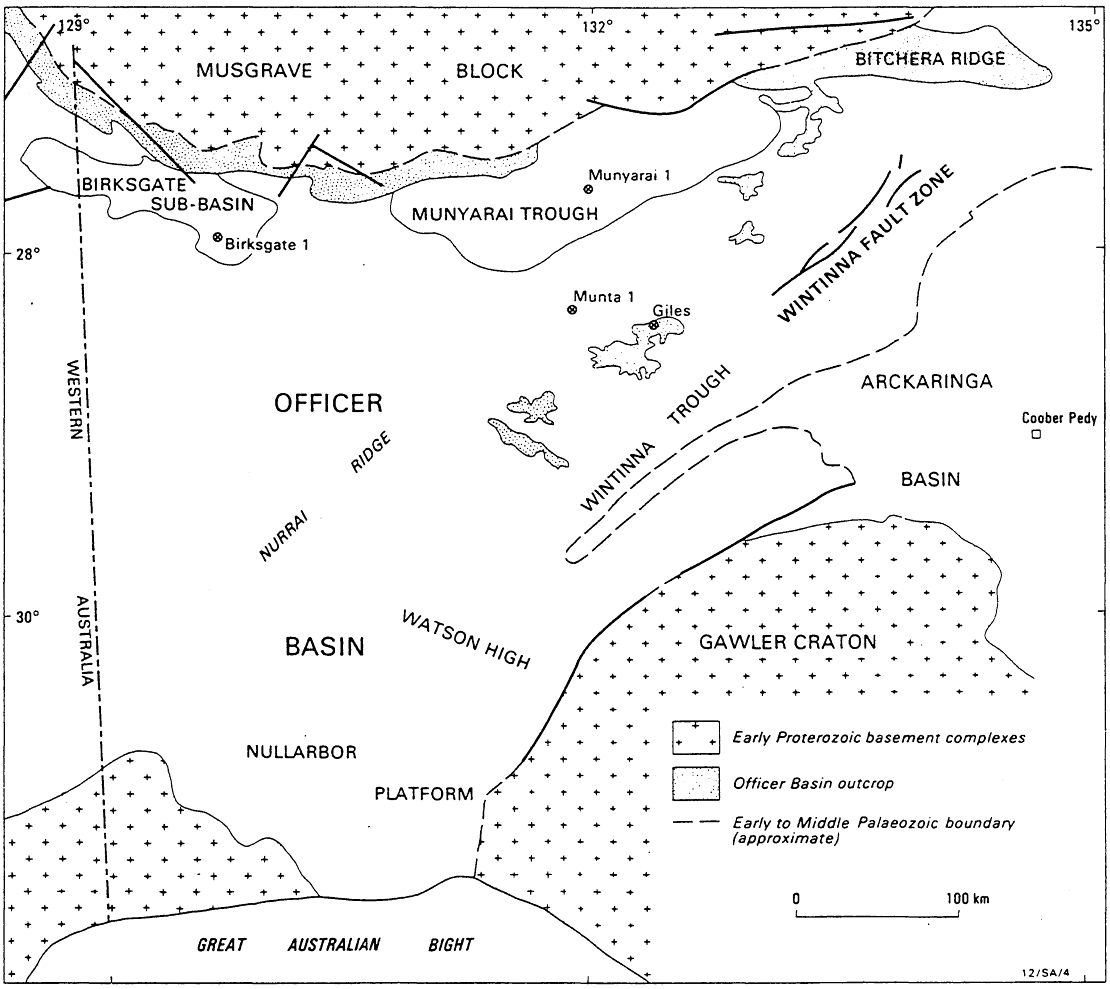

Figure 2. Map of the eastern Officer Basin showing the main morphologic and tectonic features as currently understood.

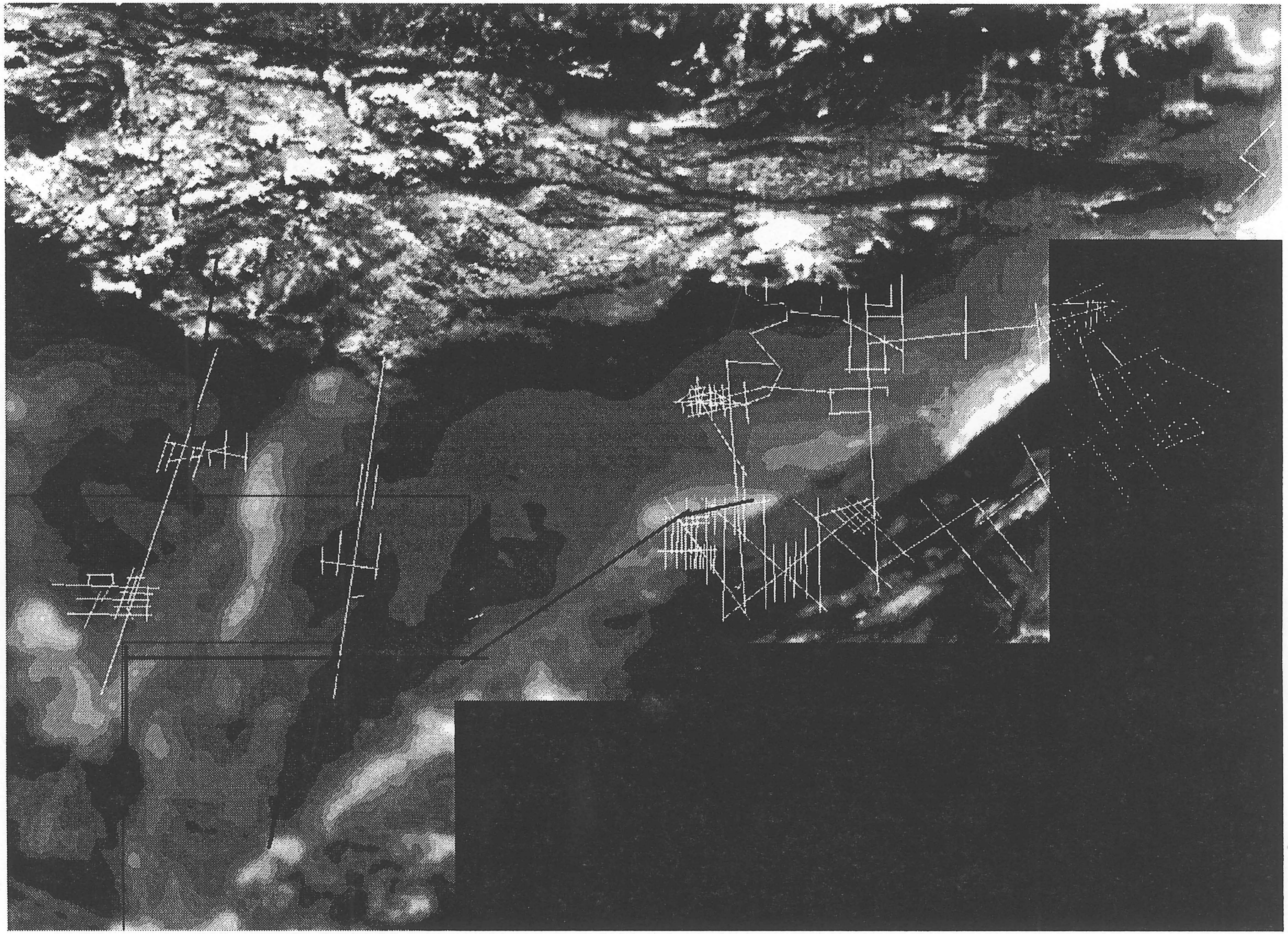

Figure 3. Total magnetic intensity image of the eastern Officer Basin. Note the faulted northern margin, the sub-basins and the clearly defined Nurrai Ridge. Heavy black lines show the proposed seismic survey while the white lines show existing seismic lines.

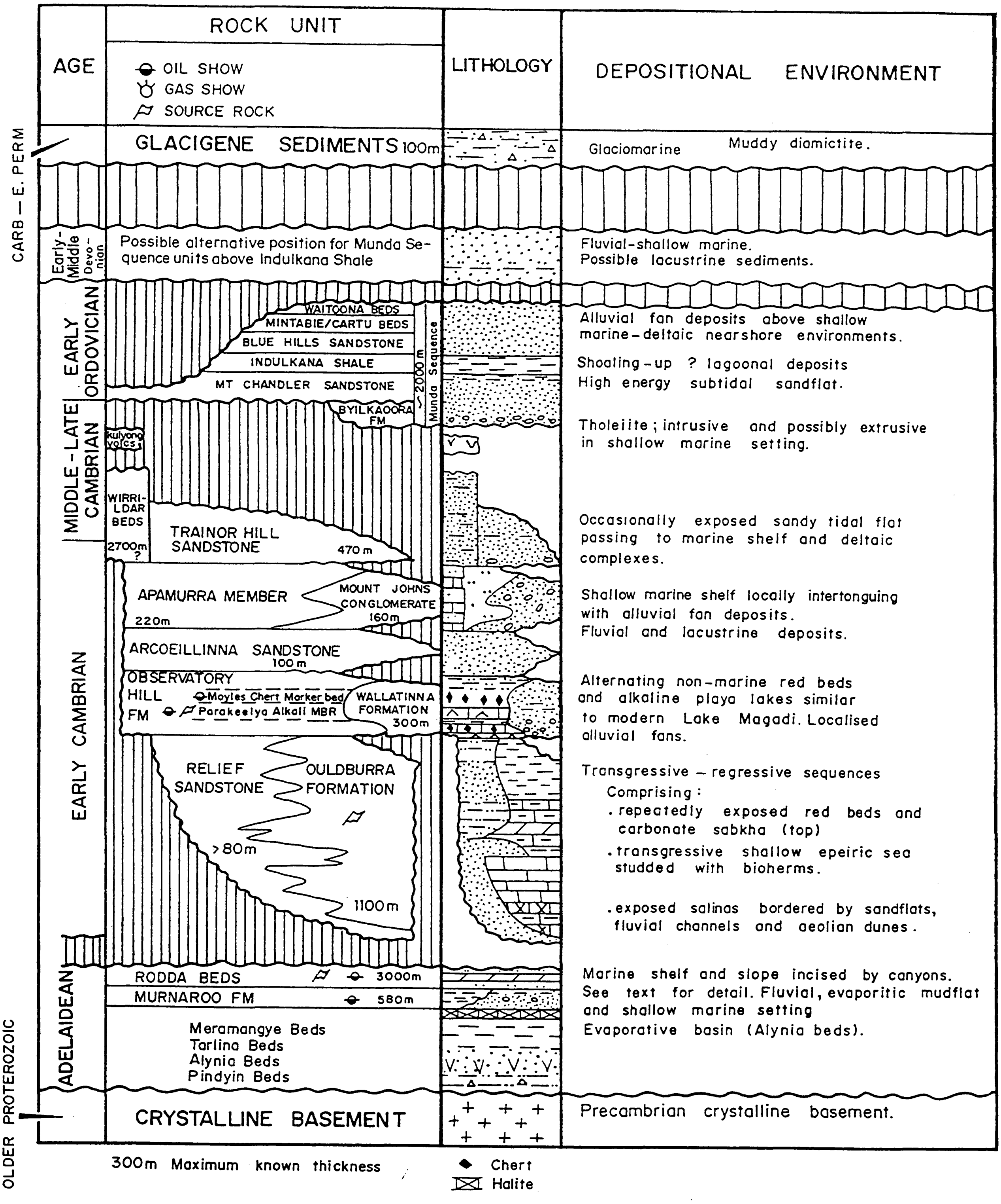

Figure 4. Stratigraphy and geological summary for the Officer Basin (after Thomas, 1990).

With these regional concepts in mind we have designed the survey grid to provide information over the southern margin of the Birksgate sub-basin where there is the best hydrocarbon potential. A seismic traverse extending across the Birksgate sub-basin to the north of the conservation park will provide information to aid in understanding potential source rocks and the basin geometry.

GOALS OF THE SEISMIC ACQUISITION

A major seismic reflection survey is proposed in the central Officer Basin in South Australia, with a primary objective of developing an improved understanding of the structure and stratigraphy of this portion of the basin to encourage petroleum exploration.

The goals of the seismic survey in the Officer Basin are outlined below:

1. A regional seismic survey of quality seismic data is required to develop a cross section and to evaluate basin morphology. The emphasis of the seismic acquisition will be on the basin fill.

2. To investigate the subsidence history of the central Officer Basin and evaluate its petroleum potential, the regional seismic reflection data is required to tie into the available well data.

3. The stratigraphy of the central Officer Basin needs to be defined in terms of modern concepts of sequence stratigraphy. The seismic traverses should tie the existing seismic and well data in the eastern Officer Basin to the central Officer Basin. Ties will also be made to the early Serpentine Lakes seismic Lines 1 and 2 (Fig. 5) and to wells providing stratigraphic control in the eastern Officer Basin.

4. The project will investigate the nature and relationships of the post-depositional structuring of the Officer Basin to the Central Australian Orogens. In particular, Milton & Parker (1973) interpreted seismic data and anomalies in magnetic data along the northern boundary of the Officer Basin as major overthrusting of the Musgrave Block. This project will investigate the influence this interpreted thrusting of the Musgrave Block has had on the post-depositional tectonic development of the basin.

Ideally, a regional seismic survey of the South Australian part of the Officer Basin would extend from the Musgrave Block on the basin's northern margin across the main depocentre (the Birksgate or Munyarai Sub-basins) onto the Murnaroo Platformal Region which is now onlapped by the Eucla Basin. However, logistic and scientific factors impact on the survey design.

CONSTRAINTS ON POSITIONING OF SEISMIC TRAVERSES

The gathering of seismic data across this part of the basin is constrained by several factors other than scientific objectives. The major constraints are:

1. Access to the Namungarintja Conservation Park which extends across the most direct potential north-south seismic line (Fig. 6). Discussion with the National Parks and Wildlife Service and the State Government suggests that it is unlikely that permission will be granted for seismic acquisition within the conservation zone.

2. Access to Aboriginal lands. The proposed seismic lines lie within Pitjantjatjara and Maralinga Lands (Fig. 6). Permission to operate within their land will have to be obtained from the relevant land-owners before seismic program can begin.

Discussion with the two Aboriginal communities is in progress and verbal agreement to gain access to their lands to record seismic data has been reached. The next phase of negotiations will investigate options in detail and select a seismic grid suitable for addressing the scientific problems.

3. Seismic data acquisition on the Nullarbor Plain (Fig. 2). In July 1991, seismic tests were carried out over the Nullarbor Limestone in the vicinity of Cook (Leven & Barton, 1991). The results of these tests indicate that absorption of the seismic energy during propagation through the platformal carbonates of the Eucla Basin (Nullarbor Limestone) would obscure the seismic image of the underlying Officer Basin sequence.

The study area is thus well defined. It is limited in the north by the basin margin with the Musgrave Block and in the south by the onlapping carbonates of the Eucla Basin. The area is cut in two by the Namungarintja Conservation Park, with Pitjantjatjara Lands to the north and Maralinga Lands to the south and east of this zone (Figs. 2,6).

PROPOSED NETWORK

For logistic reasons, we propose the survey in two parts (Table 1, Fig. 5):

1. The area north of the conservation zone (predominantly in Pitjantjatjara Lands).

2. The area south of the conservation zone (in Maralinga Lands).

Northern Area

The main objectives in the northern area include 1) developing a cross section of the deep Birksgate sub-basin and 2) attempting to correlate the section to the stratigraphy of the Birksgate #1 well in the west and the main seismic grid to the east. A secondary objective is to define the northern margin of the basin.

The northern survey proposal consists of a single line (Table 1, Fig. 5):

93AGS.L1 (120 km) is a dip line which will pass through Birksgate #1 well to provide stratigraphic control, and a cross-section of the sub-basin from the northern margin. This line, together with the reprocessed Serpentine Lakes Line 66OF-2 and 93AGS.L4, will provide a basin cross section in the western part of South Australia.

Southern Area

The southern area is of most direct interest for petroleum exploration (Fig. 5). Using the Amadeus Basin as an analogue, we could expect the greatest potential for petroleum accumulations to occur in structures along the southern margin of the deep sub-basins (Lindsay & Korsch, 1989, 1991). The survey should define the transition (hinge) from the northern sub-basins to the southern Murnaroo Platform (Figs. 2, 3). It should also provide information on structuring and tie the stratigraphy to seismic and well control data farther

Northern Area

93AGS.L1	01	27° 05'	10.8"S	129° 54'	45.6"E	
93AGS.L1	02	27° 56'	18.0"S	129° 47'	15.6"E	Birksgate #1 well
93AGS.L1	03	28° 05'	00.0"S	129° 46'	00.0"E	

Southern Area

93AGS.L2	01	28° 08'	07.3"S	132° 13'	40.2"E	
93AGS.L2	02	28° 08'	38.6"S	132° 11'	14.8"E	Ungoolya #1 well
93AGS.L2	03	28° 12'	24.5"S	131° 54'	40.2"E	
93AGS.L2	04	28° 12'	42.7"S	131° 52'	23.2"E	
93AGS.L2	05	28° 10'	49.7"S	131° 56'	49.8"E	
93AGS.L2	06	28° 12'	24.5"S	131° 54'	40.2"E	
93AGS.L2	07	28° 49'	00.0"S	131° 00'	00.0"E	
93AGS.L2	08	28° 50'	36.0"S	130° 56'	52.3"E	
93AGS.L3	01	28° 49'	00.0"S	131° 05'	00.0"E	
93AGS.L3	02	28° 49'	00.0"S	130° 17'	40.0"E	
93AGS.L3	03	28° 49'	00.0"S	129°30'	00.0"E	
93AGS.L4	01	28° 46'	00.0"S	129° 31'	00.0"E	
93AGS.L4	02	29° 30'	00.0"S	129° 31'	00.0"E	
93AGS.L5	01	28° 46'	00.0"S	130° 31'	00.0"E	
93AGS.L5	02	29° 08'	00.0"S	130° 14'	00.0"E	
93AGS.L5	03	29° 09'	40.0"S	130° 12'	40.0"E	
93AGS.L6	01	29° 06'	40.0"S	130° 14'	00.0"E	
93AGS.L6	02	29° 08'	00.0"S	130° 14'	00.0"E	
93AGS.L6	03	29° 38'	40.0"S	130° 07'	50.0"E	

Table 1. Location of end points and key inflection points of the proposed seismic lines in the central Officer Basin, South Australia.

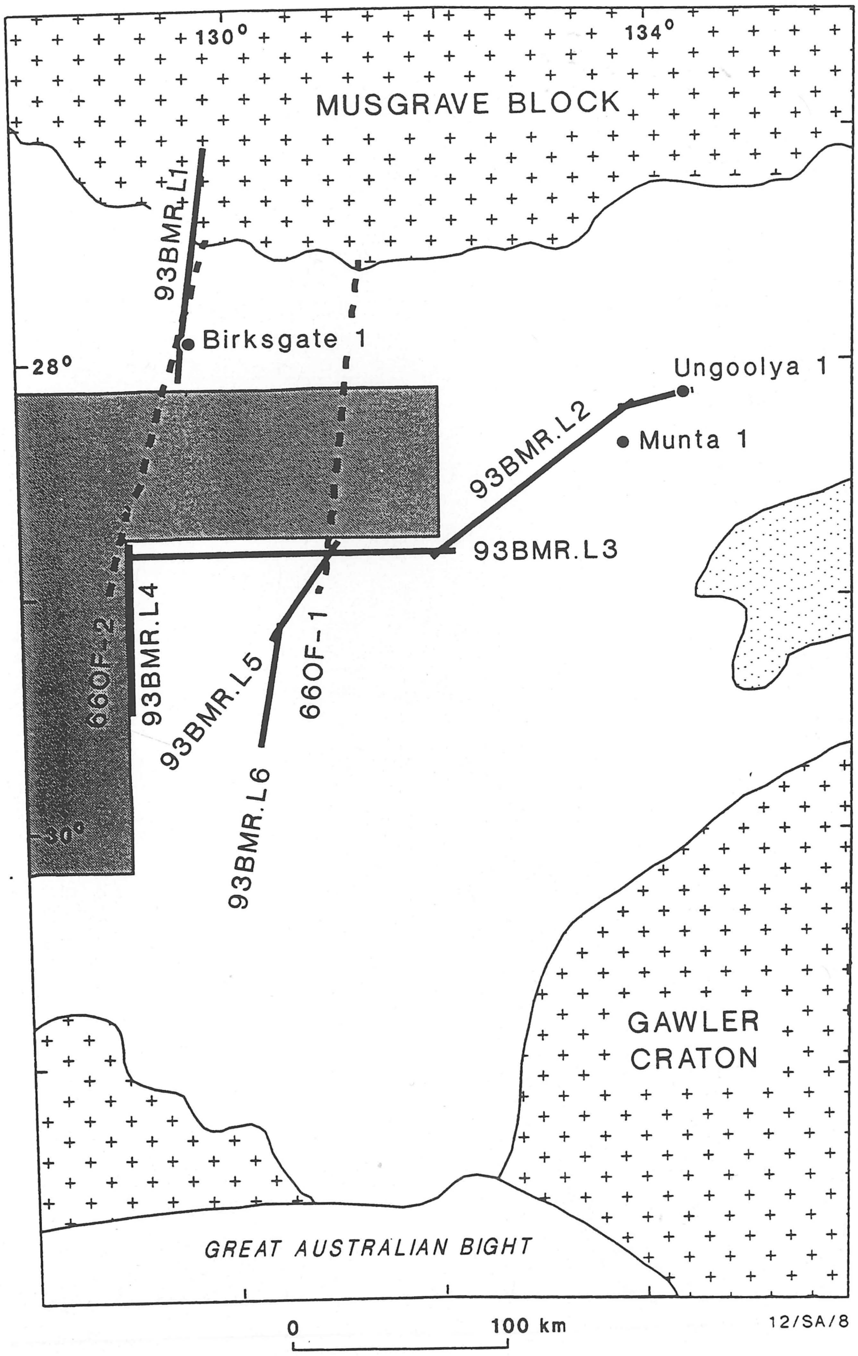

Figure 5. Map of the eastern Officer Basin showing the location of the proposed AGSO seismic lines. Broken lines indicate the location of earlier seismic lines that have been reprocessed to supplement to the new survey.

east. The seismic lines in this southern survey area need to connect to the two regional north-south Serpentine Lakes seismic lines which offer a connection across the conservation zone and into the northern area, albeit with the lower quality of 1966 vibroseis data (Fig. 7).

The southern survey proposal consists of four lines (Table 1, Fig. 5):

93AGS.L2 (150 km) is a connecting line running northeast from the southeastern corner of the conservation park to the existing seismic network and well control in the vicinity of Ungoolya #1 well.

93AGS.L3 (160 km) a strike line paralleling the conservation park border, providing seismic connection between 93AGS.L5-6 and 93AGS.L4 and the other stratigraphic data in the eastern Officer Basin. Ties to the seismic network in the eastern Officer Basin via 93AGS.L2.

93AGS.L4 (90 km) a north-south dip line paralleling the boundary of the conservation zone and providing an extension to Line 66OF-2 of the Serpentine Lakes survey.

93AGS.L5-6 (100 km) a dip line along the existing Cook road which connects to Line 66OF-1 of the Serpentine Lakes survey, providing a regional cross-section of the Officer Basin.

Grand Total approximately 620 km

These data will be supplemented by reprocessing of the Serpentine Lakes seismic data (Fig. 7). The regional Serpentine Lakes Lines 66OF-1 and 2 provide an important seismic connection across the Namungarintja Conservation Park (Fig. 5).

Funding as presently envisaged will allow a total of approximately 600 kilometres of seismic recording. The final survey grid will be determined by the ongoing negotiations with the two Aboriginal communities and the assessment of scientific priorities.

PRIORITY AND RATIONALE OF PROPOSED SEISMIC LINES

In the northern area line 93AGS.L1 provides the northern half (with 93AGS.L4 in the south) of a cross section of the basin. The seismic connection from the southern area to 93AGS.L1 will have to rely on the older reprocessed Serpentine Lakes Line 2. The dip line 93AGS.L1 has been assigned a high priority because of the importance of the Birksgate #1 well in understanding the stratigraphy of the central portion of the basin, and the requirement for modern seismic data tied to this well for sequence stratigraphic analysis. This line and 93AGS.L4 lie to the west of the Nurrai Ridge.

93AGS.L5-6 has been assigned top priority for logistic reasons. It will follow close to the existing road between Cook and Vokes Hill Corner. This road will be the major supply route during the acquisition of the southern portion of the seismic grid. This line also connects onto the southern end of the 1966 Serpentine Lakes Line 66OF-1, and with it, provides a 220 km cross section of the basin from the northern margin to the Murnaroo Platform. 93AGS.L5-6 will be recorded from north to south, and terminated when data quality deteriorates due to the increasing thickness of the Nullarbor Limestone. These two lines complement 93AGS.L1 & L4 in that they lie to the east of the Nurrai Ridge.

The east-west trending strike-line control (93AGS.L2 and L3) is a vital component of the proposed seismic network, as it connects the seismic and stratigraphic control established by industry in the eastern Officer Basin to the central region of the basin, and ties together the dip lines with modern multifold seismic data. Either proposed option ties into Ungoolya #1 well. The 93AGS.L2 and 93AGS.L3 combination of lines has been assigned high priority largely because the bulk of the higher priority seismic acquisition lies to the south of the conservation park. This plan therefore relies on the reprocessed 1966 Serpentine Lakes Line 66OF-2 data to achieve a seismic tie to the Birksgate #1 well - the only deep stratigraphic control in the central Officer Basin.

In the southern area, lines 93AGS.L4 complements the cross section provided by 93AGS.L5-6, and will give a picture of the changing nature of the platform hinge. Based on the Amadeus Basin analogue, the seismic network provided by 93AGS.L4, 93AGS.L5-6 and 93AGS.L3 covers this hinge-line which is the area of the basin with the highest prospect of hydrocarbon accumulation. As with 93AGS.L5-6, 93AGS.L4 will be recorded from north to south, and terminated when data quality deteriorates due to the Nullarbor Limestone.

In summary, the lines provide a cross section west of the Nurrai Ridge (93AGS.L1 & L4 combined with the reprocessed Serpentine Lakes Line 2) an abbreviated section to the east of the Nurrai Ridge (Lines 93AGS.L5 & L6 combined with the reprocessed Serpentine Lakes Line 1) and a tie to the well established seismic grid to the east (Lines 93AGS.L2 & L3). The sub-basins either side of the Nurrai Ridge appear to be structurally separate entities (Fig. 2). The network of lines that provides, within the limits of funding, the best coverage of the deep sub-basins to the north and the hinge zone to the south.

RECONNAISSANCE OF PROPOSED LINES

Seismic Line 93AGS.L1

This is the northern most of the proposed seismic lines and would extend from a point near Watarru (Mt Lindsay) to a point south of Birksgate #1 well on the northern edge of the Namungarintja Conservation Park. With the assistance of Pitjantjatjara Council representatives a reconnaissance of the line was carried out on March 31 and April 1. From Watarru Community the reconnaissance headed south, across country, for approximately 26 km to a point at 27° 20.77'S, 129° 54.91'E where the traverse intersected the old Conoco access road to Birksgate #1 well. The party then followed the old access road which is roughly parallel to Serpentine Lakes Line 66OF-2.

Beginning from Watarru the country was open with only occasional large transverse sand dunes. The dunes were generally less than 10 metres high and readily crossed. From a point at 27°11.98' S, 129° 54.40' E, the dunes almost disappear and the country opened out completely. Much of the surface was covered with siliceous and carbonate lags and occasionally patchy outcrops of these materials and, while rough, was readily traversed. Conditions remained relatively constant until the traverse intersected the old Conoco access road to Birksgate #1 well in the vicinity of large basement exposures (gneiss) at Mt. Poondinna.

From Mt. Poondinna the Birksgate road crosses relatively open country for a further 16 km south from the intersection. From this point large dunes occur every 0.5 to 1.0 km. The road skirts the major dunes following a torturous path for more than 20 km. At this point the country becomes broadly rolling and dunes are infrequent. In all, from the intersection south, more than 30 major dunes were crossed. Some are steep and will present problems for larger vehicles but most were readily traversed. Southward the dunes gradually disappear.

The old access road to Birksgate was formed in 1966 and is still relatively free of regrowth although locally overhanging shrubs are a problem. The road could probably be upgraded with a minimum of effort.

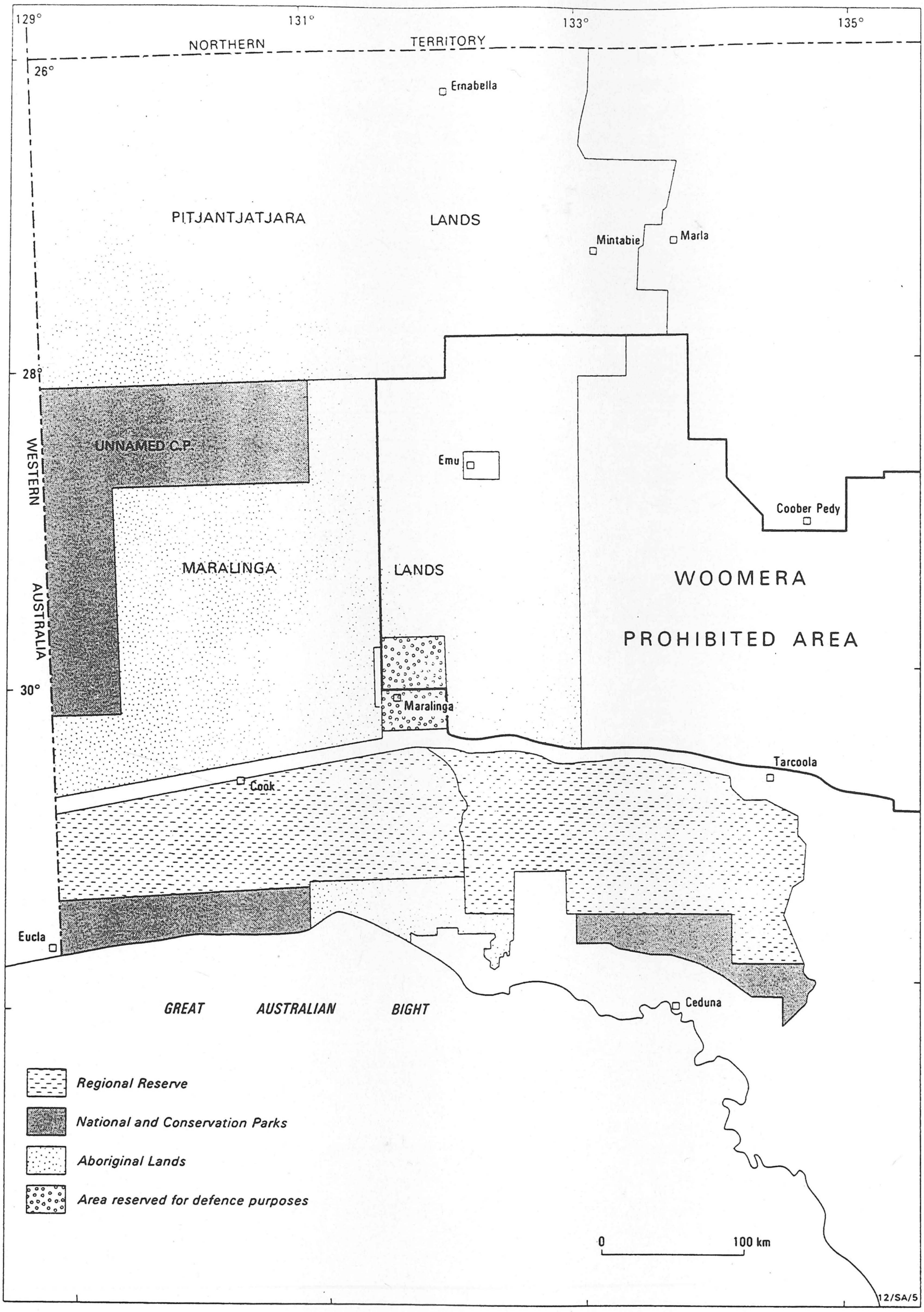

Figure 6. Map of Aboriginal lands and conservation zones in the central Officer Basin. The seismic survey will be carried out on Maralinga and Pitjantjatjara Lands.

Line 93AGS.L1 was traversed in association with representatives of the Pitjantjatjara Council in April 1992 to assess sacred sites. During this traverse three sacred sites were identified and visited. All three, along with others north of the line, relate to a single Dreamtime ancestor and are of great significance to the Pitjantjatjara Community. The Pitjantjatjara Council has requested that the edge of the seismic line corridor clear any sites by at least 1000 m.

Seismic Line 93AGS.L2-3

A reconnaissance of the full length of these proposed lines was not possible. However, the reconnaissance party was able to access near the western-most end of line 93AGS.L2 at Munta #1 well by way of earlier seismic lines and the access road to the well. The country at the western end of the line is on a topographic high and will present some access problems. Sand dunes are high and closely spaced and the sand is loose making travel slow. The planned line orientation parallels the strike of the dunes minimising the number of dune crossings. This line will tie to Ungoolya #1 well by way of the existing Comalco seismic line 85-198.

Further to the southwest the proposed line crosses the Beadell Highway. The dunes in this area at approximately the mid-point in the line are broad low features and relatively firm. Vegetation is light and scrubby. Conditions should be much easier than at the northeastern end of the line.

Southwest from the Beadell Highway intersection line 93AGS.L3 was inaccessible to the reconnaissance party. However, a reconnaissance westward along, the Beadell Highway suggests that conditions are much the same along the length of the line to the southwest except that the dunes may be slightly lower and more widely spaced.

Seismic Line 93AGS.L4

This is the most inaccessible of the proposed seismic lines. It could only be reached at one point close to the middle on a BHP track west from Yorks Camp (Fig. 8). The line was visited during the reconnaissance of May 1991 and the area found to be moderately well vegetated with mulga.

Even though inaccessible, the topographic map and aerial photography suggest the conditions will be similar to 93AGS.L5-6.

Seismic Lines 93AGS.L5-6

These lines are planned to follow the main track south from the Namungarintja Conservation Park to Cook on the Trans-Australian Railway Line. The northern part of the line (93AGS.L5) is dominated by low widely spaced dunes with a moderate scrub cover. The road is passable to small four-wheel drive vehicles but will need considerable upgrading before data acquisition could be begin. Locally, the road has some washouts and some patches of loose dune sand cross the road.

Further south (93AGS.L6) the dunes are still low but lower dunes replaced by broad dune complexes up to a kilometre or more in width. The dune surface is rough but the sand firm. Interdune areas are broad and consist of firm red soil or low rough rocky outcrops of bedrock. Vegetation cover is moderate and consists of low scrubby shrubs.

The road to the Ooldea Range south from Yorks Camp crosses a broad low relief surface free of dunes. The road is straight and the surface smooth such that it is possible to travel at 60-70 km/hr.

The Ooldea Range dunes are locally intense and high with soft tops. The dunes are covered with an open mulga scrub of moderate density while interdune areas are firm and covered with mallee scrub. The existing road winds through this area and considerable bulldozing will be necessary to realign the road.

Beyond the dune field to the south is an open rolling rocky plain, covered with a light mulga scrub and bluebush. The topography remains much the same but the scrub thin and finally disappears about 70 km north of Cook where the Nullarbor Plains begins.

In summary the main work on these lines will be in the north and in the central part of the line where it crosses dune fields.

ACCESS TO SEISMIC LINES

Northern Area.

Access to the northern area is possible by air to Yulara and then by road to Curtin Springs. Alternatively, road access is via the Stuart and Lassiter Highways to Curtin Springs on sealed road.

The road south from Curtin Springs and east-west from Mulga park to Amata, Umpukulu, Nyapri and Kunyapi is unsealed but in good condition. In general the road is two lanes and speeds of 80 km/hr could be maintained safely by the survey vehicles. The road narrows a little and has some gullies or creek crossings west of Umpukulu but is still in good condition.

South from Umpukulu the road is single lane but has a firm surface and is well maintained. Further south it deteriorates slightly becoming a little sandy. In general, however, speeds of 60-70 km can be maintained safely. This is probably the best road to use as a supply route. The reconnaissance party travelled across a new track graded from the Kintore Road to Mt. Lindsay (Watarru). The road, while generally passable to smaller vehicles, was narrow and the surface loose and probably unsuitable for larger vehicles. Larger vehicles would probably gain easier access by following the main Kintore Road to its junction with the Mt. Davies Road ("The Numbers") and turning northwest to Watarru (Mt Lindsay) and the start of the proposed seismic line.

An alternative access to the proposed seismic line is from The Numbers. The old Conoco access road for the Birksgate #1 well meets with the other roads at this intersection. Access on this road is fast and relatively comfortable. It is a single lane road with few ruts or corrugations and a generally firm surface. It is possible to travel at 60 km/hr for most of its length. It joins with the old Serpentine Lakes seismic line 660F-2 at the Old Conoco Campsite beside Mt. Poondinna (27° 20.84'S, 129° 54.82'E) approximately 40 km from The Numbers.

Travel Between Northern and Southern Areas

Two alternatives are available for travel between the Northern and Southern area:

1. Travel on sealed road via the Lassiter, Stuart and Eyre Highways

2. Travel across country via the old Beadell road from Iltur to Anne's Corner near Emu Junction.

The first alternative is straight forward and on sealed road but the time involved is large. The second alternative is suitable only for light four-wheel drive vehicles unless the road is upgraded considerably. During the reconnaissance the road to Iltur from The Numbers was found to be firm and passable at reasonable speeds (60-80 km/hr). Southeast from

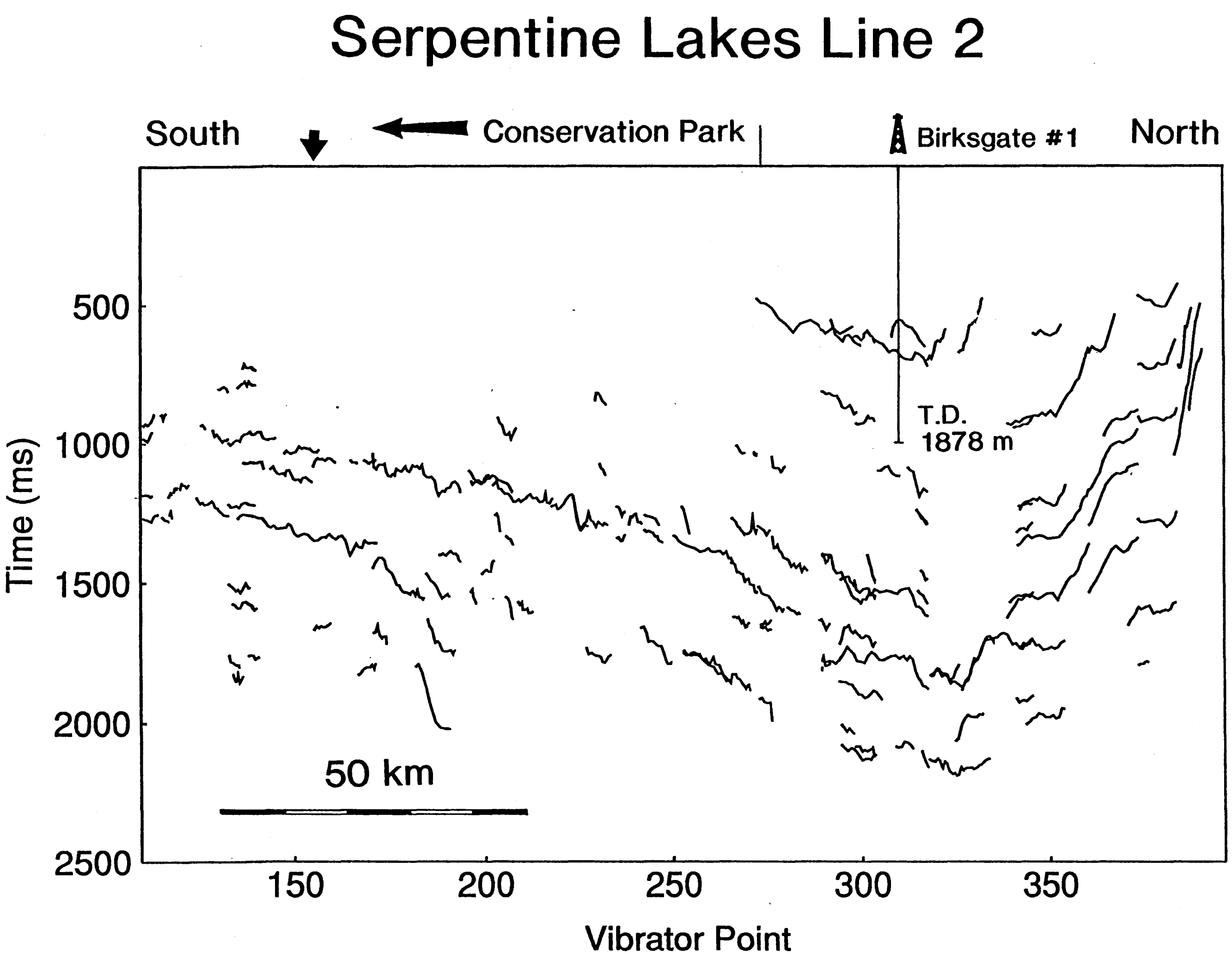

Figure 7. Coherent reflection segments interpreted from original Serpentine Lakes Line 2 (66OF-2). Birksgate #1 well reaches total depth within the latest Neoproterozoic Rodda Beds. Major reflectors beneath the well are probably earlier Neoproterozoic evaporitic units (Alynia Beds?). The deepest reflector perhaps indicates the contact with the basement.

Iltur the road is seldom used and somewhat overgrown. Travel along this section of the road is slow due to numerous dunes which become higher and broader further south. This route should only be used in an emergency.

East or west from Ann's Corner or south from Vokes Hill Corner road conditions are generally good providing reasonable access to the proposed seismic lines.

Southern Area

The most obvious access to the southern survey area is by way of the Eyre Highway to Nullarbor and Cook then north from Cook along the existing road. The northern end of this road forms the basis for line 93AGS.P1.

North from Cook the road poses few problems for smaller vehicles. However, the dune complex around the point where latitude 30°S intersects the road will present problems for larger vehicles as the dunes are both broad and their summits loose. If thus seems likely that the best alternative for supply vehicles will be via Watson, the main Maralinga road which is sealed and the north west via Oak Valley to Yorks Camp. This road is relatively free of loose sand and does not cross major dune fields.

A third alternative for access to the seismic survey area is from the Stuart Highway to Cadney Park and then via the access road to Munta #1 well. A full reconnaissance of this 220 km road has not been made. A reconnaissance of the last seven kilometres to the well site showed it to be in good condition with only occasional washouts. Similarly, a later reconnaissance by SADME (G. Kreig) from the Stuart Highway along the first 150 km of the road indicates that it is in good condition and that speeds of 70-80 km are possible in a light four-wheel-drive vehicle. This road may provide access for heavy vehicles allowing work to begin on the north eastern extension of the same area.

Water

Water will be the major logistic problem for seismic operations. No free standing water was seen in our travels in the basin (with the exception of the Tallaringra well farther to the east). Consequently, an exploratory water drilling program will be carried out by SADME along existing tracks near the proposed seismic lines. Emergency drinking water supplies can be found at four shed-tanks on Maralinga lands in the southern survey area. Two shed tanks are located on the Cook Road near Yorks Camp (29° 14.76'S, 130° 12.85'E), a third is located at the Oak Valley community site and a fourth is located on the road between Oak Valley and Maralinga.

In the northern survey area, on Pitjantjatjara lands, drinking water is available at the communities and outstations. South from Iltur the only drinking water is to be found at a small bore with a hand pump (27° 19.95'S 130° 02.07'E) just north of The Numbers on the road to Ann's Corner (Fig. 8).

Supply

Supplies for the proposed Officer Basin seismic operations can only come in via four routes (Fig. 8):

1. Supply trips from Nullarbor (roadhouse, motel and pub), Eyre (roadhouse, motel) or Ceduna will be possible while operating near the Eyre Highway.

2. Supplies can be delivered by rail to any of the sidings. Cook has a hospital, small store, good air strip, with fuel and water for sale. The "tea and sugar" supply train operates every Thursday.

3. South and east of the Namungarintja Conservation Park, it may be more efficient to obtain supplies from Coober Pedy along the Ann Beadell Highway. This track is in reasonable condition but distances and travel times are considerable.

4. In northern survey area, on Pitjantjatjara lands, supplies may have to be trucked from Alice Springs or arrangements made with local community stores (e.g. at Watarru).

The complete lack of firewood will be a problem on the Nullarbor Plain.

CONCLUSIONS

Land access has been a major factor in the planning of the Officer Basin seismic program for 1993. Geological and geophysical constraints limit the northern and southern bounds of the study area. The Musgrave Block bounds the basin to the north, and to the south the onlapping carbonates of the Eucla Basin limit our ability to effectively image the underlying Officer Basin rocks. The area between these two bounds is interrupted by the Namungarintja Conservation Park which, at present, remains inaccessible to this National Geoscience Mapping Accord Project. Land to the north of the park is owned by the Pitjantjatjara Anangu and land to the south and east is owned by the Maralinga Tjarutja. Negotiations with these two communities are progressing with broad agreement having been reached.

As a consequence of the above constraints we have outlined two potential survey grids involving nine proposed seismic lines. Financial constraints ultimately limit the amount of seismic acquisition. The priority of these lines has been determined on scientific and logistic considerations, but the final decision of which lines will be recorded must await more detailed negotiation with the Aboriginal communities.

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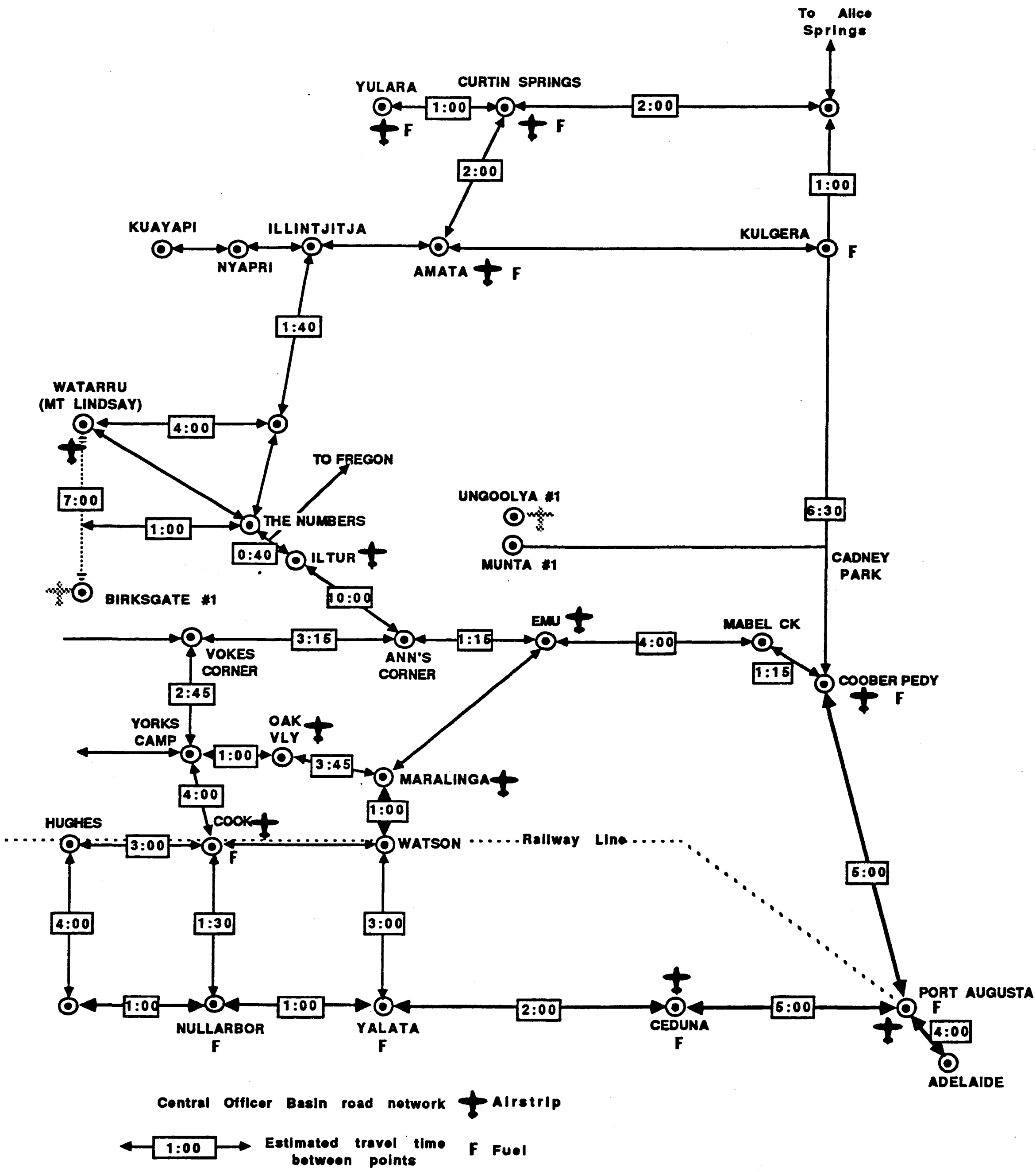

Figure 8. Diagrammatic representation of the road network across the central Officer Basin showing travel times for small (Toyota) four-wheel-drive vehicles (Hours:Minutes) between main centres.

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APPENDIX 1: RECONNAISSANCE OF THE CENTRAL OFFICER BASIN, MARCH - APRIL 1992

The reconnaissance of Maralinga Lands in the southern part of the proposed seismic study area of the central Officer Basin was carried out between May 6 and 18, 1991. The reconnaissance party consisted of eight people from both participating institutions:

BMR Representatives

John Lindsay	(Geologist)
Jim Leven	(Geophysicist)
Dave Gregg	
Tim Johnson	

SADME Representatives

Graham Krieg	(Geologist)
Mike Brennan	(Drilling Supervisor)
Peter Smith	(Hydrogeologist)

Pitjantjatjara Representatives

Munti Smith	Acting D.M.E/A.P Liaison Officer
Lemma Tjakara	(Liaison Officer)
Bernard Tjalkuri	(Liaison Officer)
Andy Kunmarara	
Michael Mitimgiri	
Taylor Wanima	
Frank Young	(AP Works Supervisor Watarru)
Ushma Scales	(AP Anthropologist)

The objective of the reconnaissance was to assess the area from the viewpoint of logistics and accessibility (Fig. 8) prior to the proposed seismic survey and to meet with members of the Pitjantjatjara Aboriginal community to discuss access to lands.

Initially the BMR and SADME parties assembled at Curtin Springs on March 29 before driving to Amata to meet with the Pitjantjatjara representatives. The subsequent reconnaissance of the study area was divided into two stages. First, between March 29 and April 3 the party surveyed the northern part of the study area on Pitjantjatjara Lands. Second, the party continued the reconnaissance of the lines proposed for the southern part of the study area in Maralinga Lands.

29 March

BMR and SADME staff met at Curtin Springs Road House.

30 March

The party drove to Amata where they were met by representatives of the Pitjantjatjara Council. The combined group then drove west to Umpukulu, Nyapri and Kanypi to assess roads and facilities before heading south towards Watarru (Mt. Lindsay) (27° 01.48'S, 129° 54.00'E).

31 March - 1 April

Drove across country along the proposed seismic line to the old Birksgate #1 well site (27° 56.30'S, 129° 47.26'E). Assessed the full length of line 93AGS.L1 to the Birksgate #1 well.

2 April - 3 April

Drove down the Mt. Davies Road via Iltur to Ann's Corner (28° 32.36'S, 131° 44.29'E) on the old Beadell highway.

3 - 4 April

Drove along the Beadell highway to Emu Junction (28° 38.32'S, 132° 11.62'E). Drove from Emu Junction along old seismic lines to Munta #1 well (28° 21.45'S, 131° 53.90'E) to assess the western end of proposed seismic line 93AGS.L2. Parted company with the AP representatives on passing into Maralinga Lands. We then returned to the Beadell Highway and Ann's Corner.

4 - 5 April

Drove from Ann's Corner to Vokes Hill corner (28° 33.99'S, 130° 41.14'E) before turning south along the Cook Road via Yorks Camp (29° 19.97'S, 130° 11.84'E). Assessed seismic line 93AGS.L5-6 which will be sited along the road. Continued to Cook and then Nullarbor Road House on the Eyre Highway before driving on to Ceduna.

6 April

Reconnaissance party disbanded at Ceduna.

In Ceduna the party met Ross Allen of the National Parks and Wildlife Service to discuss access to park lands and conservation zones. BMR representatives also visited the Maralinga Tjarutja offices for continuing discussions with Archie Barton.

Accommodation and Other Contacts

<u>Accommodation in Adelaide near SADME:</u>

Adelaide Hilton Motor Inn	(08) 271 0444
Powell's Court	(08) 271-7033

<u>Accommodation at Curtin Springs:</u>

Curtin Springs Station	(089) 59 2906 Fax (089) 56 2934

<u>Accommodation in Ceduna:</u>

Ceduna Community Hotel	(086) 25 2008
East West Motel	(086) 25 2102 Fax (086) 25 2829

<u>Port Augusta Flying Doctor Service VNZ</u>	(086) 422 044 Fax (086) 410 461
<u>Shell Truck Stop Ceduna</u>	(086) 252 501

<u>Cook Community</u>

Railway Station Supervisor, Cook	Merv Gould (086) 422611
Store Manager, Cook	Andrew Spackman

Trains to/from Adelaide

Depart Cook 7:00 pm	arrive Adelaide 2:00 pm
Depart Adelaide 10:30 am	arrive Cook 4:45 pm

Maralinga Tjarutja

Archie Barton	administrator (086) 252946
Andrew Collett	lawyer (Johnston Withers) (08) 231 1110
Dickie Le Bois	supply driver
Allan Dodd	manager CEDA
Mervin Dey	elder
Scott Cane	Anthropologist (044) 762 601 (08) 232 3522

Pitjantjatjara Council

Contacts Alice Springs PH (089) 505411 (089) 505422

Ushma Scales	Anthropologist
Greg Borchers	Lawyer

Contacts on Anangu Pitjantjatjara Lands

Munti Smith — Acting D.M.E/A.P Liaison Officer

Fregon, via Alice Springs, NT 0871
PH (089) 562944

Jim Newkirk A.P. Senior Project Officer
Umuwa PH (089) 567577.

Facilities on Anangu Pitjantjatjara Lands

Airstrips
(see Fig. 8)

Amata
Location: 26°11'S, 131° 07'E
Elevation: 2279', Runway: 02/20 length 1410m
No lights, gravel surface

Nyapari
Location: 26° 12'S,130°14'E
Elevation: 2100', Runway: 10/28, length 1370m
No lights, hard sand surface

Watarru
Location: 27° 01'S, 129° 54'E
Elevation: 2000', Runway: 02/20, length 1300m
No lights

Emu Junction
Location: 28° 38'S, E 132° 12'E
Good wide dirt strip suitable for large aircraft

Iltur
Location: 27° 33' S, 130° 29'E

Good grass strip

Stores

Amata: Large Community Store. Open Monday to Friday and Saturday morning.

Kanypi: Small Community Store.

Watarru: Small Community Store.

Telephones

Amata: Several Public Phones.

Nyapari: One Public Phone (089) 567521

Kanypi: One Public Payphone (089) 567532

Watarru: One Public Payphone

Fuel Supplies

Amata: Diesel, and petrol available.

Kanypi: Diesel $1.00 per litre.

Road Conditions

Contact A.P Roads Supervisor Ian McKie at Umuwa. (089) 567577
Roads are generally fair to good. No summer rains and very few wash outs.

Aircraft Hire

Hire of aircraft from Ngaanyatjarra Air in Alice Springs. Single Engine Cessna $220 per hour, $150 overnight fee. Check availability with Ngaanyatjarra Air on 524367 or 505445.

NPWS

Ross Allen — Manager, western SA (086) 25 3144
Fax (086) 25 3123

Nuclear Test Sites

Karen Powell, DPIE on (06) 272-4202