PR90-24

CRA EXPLORATION PTY LIMITED

SUBJECT: **DEPTH TO BASEMENT CALCULATIONS FROM POTENTIAL FIELD DATA, SOUTHERN GEORGINA BASIN, NORTHERN TERRITORY**

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DATE: **September, 1989**

CRAE REPORT NO.: **303836**

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Date: September, 1989

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Submitted by: 31.1.90

Accepted by: ....

Report No: 303836

<u>CONTENTS</u>

LIST OF PLANS

PLAN NO.	PET NO.	TITLE	SCALE
1.	PETNTcw3126	Georgina Basin - Regional Magnetic Interpretation	1:1 000 000
2.	PETNTcw3127	Georgina Basin - Regional Gravity Interpretation	1:1 000 000
3.	PETNTcw3122	Depth to Magnetic Basement - Elkedra	1:250 000
4.	PETNTcw3121	Depth to Magnetic Basement - Sandover River	1:250 000
5.	PETNTcw3124	Depth to Magnetic Basement - Urandangi	1:250 000
6.	PETNTcw3123	Depth to Magnetic Basement - Huckitta	1:250 000
7.	PETNTcw3125	Depth to Magnetic Basement - Tobermory	1:250 000
8.	PETNTcw3120	Depth to Magnetic Basement - Glenormiston	1:250 000

2. SUMMARY AND CONCLUSIONS

A geophysical study incorporating magnetic and gravity data sets was undertaken to produce depth to basement maps of the southern Georgina Basin. The study combined geological, well and seismic data with qualitative interpretations of magnetic and Bouguer gravity contours, and quantitative computer modelling of magnetic and gravity profiles.

The depth to granitic basement as inferred from magnetics is shown on Plans 3 - 8. The lack of a density contrast between the sediments and granitic basement meant that gravity modelling could not predict depth to basement. The observed gravity anomalies are probably due to the distribution of dolomite, but this distribution cannot be predicted.

3. INTRODUCTION

This study aimed to produce depth to basement maps of the southern Georgina Basin, based primarily on interpretation of magnetic and gravity data, in order to expand upon current knowledge of hydrocarbon prospectivity in the basin. The studied area is covered by the HUCKITTA, TOBERMORY, GLENORMISTON, ELKEDRA, SANDOVER RIVER and URANDANGI 1:250 000 map sheets (Figure 1).

The study commenced with a qualitative interpretation of magnetic data, followed by quantitative modelling of selected anomalies. These results were combined with basement information from wells, outcrops, and the 1988 Bundey River seismic program. This allowed the production of basement depth maps based on the magnetic interpretation.

This procedure was to be repeated for the gravity data, but gravity modelling of basement depths was not possible due to the lack of a density contrast between the basement and the sedimentary package. Some secondary work attempted to predict the distribution of dolomite within the sediments, but was also unsuccessful, as the gravity response over known areas of dolomitization was not consistent.

4. RECOMMENDATIONS

Areas labelled 1, 2 and 6 should be discounted as unprospective, since they are either shallow or too deep.

Computed depths and inferred faults should be combined with stratigraphic correlations, since they give insight into sedimentary history.

Ongoing work (Duncan Cowan, POG airborne magnetics) should be used to refine basement topography.

Data for future modelling should be edited as completely as possible in Canberra.

5 COMPLEMENTARY WORK

Hugh Rutter, of Geophysical Exploration Consultants, was involved early in the study producing qualitative interpretations of the magnetics and gravity data (Plans 1 and 2), which were used as a comparison with Pacific Oil & Gas' initial interpretations.

While in-house interpretations were being carried out, 10 test lines of BMR magnetic data from the HUCKITTA 1:250 000 sheet, with accompaning geological information, were sent to Duncan Cowan, of Cowan Geodata Services in the UK. These are to be analyzed using a computer based Werner deconvolution process. The results of this work are not yet available.

A similar analysis was carried out on a single test line by Geophysical Exploration Consultants early in the study, the results of which were considered too unreliable for further work with GEC to be considered.

A detailed airborne magnetic survey over interesting features within the basin which was flown for Pacific Oil & Gas is awaiting processing.

6 MAGNETICS

6.1 Qualitative Interpretation

The maps produced in this study correspond to the 1:250 000 map sheets which cover the studied area.

The interpretation commenced with a collation of all available well data, including depths, magnetic susceptibilities and densities, both from logs and core analysis (Table 1). The known basement depths and outcropping basement areas were transferred to overlays.

The magnetic interpretation was based on TMI profiles and contours produced by ECS. These represented BMR data merged with all known open file and CRAE data relevant to the area. Major gradients were marked, dividing the sheets into magnetic provinces. These were further divided, on the basis of anomaly wavelengths, into areas representing constant basement depth and character, with a relative depth assigned to each. Since there are no volcanic sources within the sediments all magnetic features were ascribed to basement.

6.2 Modelling

One hundred and five lines of BMR magnetic data were chosen for modelling, on the basis of simplicity and their orientation to strike. This meant some good well ties were ignored, and this should be taken into account in future work. The lines were extracted from the tapes by Richard Lane of CRAE Research in Canberra.

Initial modelling followed a regional approach, with large sections of the profiles being modelled on the Toolkit software. Well ties and known susceptibilities were incorporated. This approach was unsuccessful since the geology is too complex, so individual anomalies were modelled using the Geosoft Magmod 3 software. This created problems, because the data needed to be constantly edited and cut down to fit into this software. Edlin, Quickedit, Sidekick, Lotus, Toolkit, and the VAX EDT editor were all tried with varied success, but no single editor was completely satisfactory and much time was lost. Future modelling will be more efficient if as much editing as possible is carried out in Canberra, where computing facilities are more powerful.

Once all available constraints to the models had been applied (which was often only an upper limit to susceptibility), the program computed a depth to basement over a distance corresponding to the extent of the top of the model (Figure 2). These depths were then combined with the qualitative interpretation. Control depths were then assigned to the areas of constant basement depth and character. These were compared with the well control, seismic data or outcropping basement which lay within the magnetic provinces but not on the modelled lines. The areas where the computed depth and inferred depths differed were reassessed eg. a computed depth of 3200m corresponded to a granitic outcrop, implying the granite was non-magnetic and throwing doubt upon other computed depths in surrounding areas. However, the two depths usually agreed.

The completed depth to basement maps from magnetic data are shown in Plans 3 - 8. Numbers correspond to the following depths:

1 - Outcrop
2 - 0-500m
3 - 500-1000m
4 - 1000m-2000m
5 - 2000m-
6 - Non-magnetic

7. GRAVITY

7.1 Qualitative Interpretation

The first pass gravity interpretation was carried out in the same way as the magnetic interpretation. A correlation between magnetic and gravity features was carried out by Hugh Rutter and Pacific Oil & Gas. This varied little from a similar comparison made by Dennis Taylor and Doug Morris. The later study found the Jinka Feature and Toomba Feature do not extend as far northwards as previously supposed.

7.2 Modelling

Since gravity responses are affected by intrasedimentary densities as well as basement densities, modelling of the gravity required greater geological input than the magnetics. This was provided by Gordon Wakelin-King, of Pacific Oil & Gas Alice Springs.

Nine lines of data from the 1987 Southern Georgina Basin Regional Gravity Survey conducted for Pacific Oil and Gas were extracted from the data by Richard Lane, as were 3 lines from the 1988 Bundey River Seismic Survey grid.

Initial modelling indicated that the observed gravity profiles are not caused by variations in basement depth, as the density contrast between the granitic basement and the overlying sediments (predominantly limestone of the Arrinthrunga Formation) is quite small wherever measured (Table 2). This suggested that the gravity anomalies must be due to density contrasts within the sedimentary package and they may reflect the distribution of dolomite.

Occurrences of dolomite may reflect facies changes (if the dolomite is primary), and so the profiles over wells where the Arrinthrunga Formation is predominantly dolomite were examined. Unfortunately, this response was not consistent, and so further modelling was abandoned.

KEYWORDS

HYDROCARBONS, GEOPHYS GRAVITY, GEOPHYS MAGNETICS, GEOPHYS MODELLING, GEOPHYS SEISMIC, GEORGINA BASIN, HUCKITTA, TOBERMORY, GLENORMISTON, ELKEDRA, SANDOVER RIVER, URANDANGI, BASEMENT, WELL DATA, COMPUTER APPLICS.

LOCALITY

ELKEDRA	SF 53-7
SANDOVER RIVER	SF 53-8
HUCKITTA	SF 53-11
TOBERMORY	SF 53-12
URANDANGI	SF 54-5
GLENORMISTON	SF 54-9

RELEVANT READINGS

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NAME	RELEVANT STRATIGRAPHY	FORMATION TOPS (m)	WET DENSITY (g/cc)
AMMAROO 2	DEVONIAN CLASTICS	0	2.4
BEANTREE 1	ALTERED ADAMELLITE AMPHIBOLITE	 549 628 (TD)	
BRADLEY 1	FRESH GRANITE	890	2.63
COCKROACH	NINMAROO FORMATION ARRINTHRUNGA FORMATION MARQUA BEDS TD	0 148 829 1219	2.7 2.71 2.68
ELKEDRA 3	ARTHUR CREEK FORMATION ERRARA FORMATION L PROTEROZOIC SEDIMENTS TD	0 114 191 291	
ELKEDRA 6	TOMAHAWK BEDS ARRINTHRUNGA FORMATION CHABALOWE FORMATION HATCHES CREEK GRANITE	0 149 537 840 (TD)	2.4 2.72 2.7 2.65
ELKEDRA 7	CHABALOWE FORMATION CHABALOWE FORMATION ARTHUR CREEK FORMATION ERRARA FORMATION GRANITE	0 130 238 300 328	2.65 2.75 2.7 2.7 2.65
EXOIL HUCKITTA 1	GRANITE	1117	2.61
HACKING 1	ARRINTHRUNGA FORMATION EUROWIE SANDSTONE MEMBER ARRINTHRUNGA FORMATION ARTHUR CREEK FORMATION RED HEART DOLOMITE GRANITE	0 200 320 1230	2.66 2.56 2.66 2.66 2.66 2.63
LUCY CREEK 1	CAMBRIAN CLASTICS MARQUA BEDS GRANITE	0 300 700 1097	2.70 2.65 2.65 2.72

TABLE 1: Wells relevant to study area, depths to relevant units and densities

NAME	RELEVANT STRATIGRAPHY	FORMATION TOPS (m)	WET DENSITY (g/cc)
MIRRICA 1	GRANITE	3263	
MOUNT WHELAN 1	GRANITE	606	
NETTING FENCE 1	GRANITE	2009	
NIGS HUCKITTA 1	JINKA GRANITE		
PHILLIP 2	GRANITE	1493	2.62
SANDOVER 13	ARRINTHRUNGA FORMATION	0	2.61
	ARRINTHRUNGA/ARTHUR CREEK FORMATION	300	2.45
	ARTHUR CREEK FORMATION	450	2.7
		700	2.56
	ARUNTA GNESS	930	2.78
	GRANITE	1015	2.65

TABLE 1: Continued

FORMATION	ROCKTYPE	DENSITY (G/CC)
Cover	Unconsolidated	2.0
Tomahawk Beds	Sandstone	2.4
Nimaroo Formation	Sandstone, Carbonate	2.5
Arthur Creek Formation	Limestone Shale	2.71
Arrinthrunga Formation	Limestone Dolomite	2.71 2.9
Basement	Granite	2.65

TABLE 2: Densities used in modelling