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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 70

Ngalia Basin Seismic Survey,

Northern Territory 1968

by

D.H. Tucker

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS
DEPARTMENT OF NATIONAL DEVELOPMENT
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SUMMARY

The Bureau of Mineral Resources carried out a reconnaissance survey in the Ngalia Basin from May to December 1968. This survey was part of a joint geological and geophysical project to study the structural features and the extent and nature of sedimentation in the Ngalia Basin.

The seismic results confirmed that the basin was asymmetric with the axis located near the Proterozoic outcrops which delineate the northern margin. From the southern margin sediments dip gently northwards at attitudes of five to ten degrees towards the synclinal axis. North of this axis the structure is shown to be more complicated geologically with steeply dipping beds and numerous faults. In the western part of the basin the seismic results indicate large-scale overthrusting from the north.

The maximum thickness of sediments was found to be approximately 16,000 feet in the western portion of the basin. Tentative correlation of the seismic horizons with outcropping formations suggests that about two-thirds of the sedimentary sequence consists of Mount Eclipse Sandstone and Vaughan Springs Quartzite.

1. INTRODUCTION

From May to December 1968 BMR carried out a reconnaissance seismic survey over a large part of the Ngalia Basin. Four main north-south traverses were surveyed. These were located near Happerby Creek, Mount Allan, Mount Doreen and Waite Creek. The survey was a continuation of the seismic programme begun in 1967. In 1967 the seismic party carried out work along a north-south traverse across the central part of the basin in the Mount Doreen area (Jones, 1969). Part of the 1968 programme consisted of extending the main 1967 north-south traverse with the object of completely crossing the basin.

Access to the surveyed areas was by the beef road from Alice Springs to the Yuendumu Native Settlement and by track from there to the new Mount Doreen Homestead at Vaughan Springs. As the vegetation cover was generally dense in the area of interest, the seismic party had access and traverse tracks graded where possible, but in some areas grading was not feasible as dense eucalyptus and acacia scrub was frequently encountered.

Water was generally obtained from bores and the natural spring at Vaughan Springs. Some surface water was available in creek waterholes and floodouts as a result of the abnormally heavy rainfall in the early months of 1968.

This report is intended to present briefly the results obtained by the 1968 seismic survey. A full discussion of results for both 1967 and 1968, together with presentation of all variable-area cross-sections and refraction plots, will be embodied in a report by Jones (in preparation).

2. GEOLOGY AND PREVIOUS GEOPHYSICS

The geology of the central part of the Ngalia Basin has been discussed by Wells, Evans, and Nicholas (1968); parts of their geological maps that cover the location of the BMR seismic traverses of 1967 and 1968 are shown in Plate 1.

The Ngalia Basin is bordered by prominent outcrops of Proterozoic sandstone and quartzite, which unconformably overlie Precambrian metamorphic rocks and granite. Sediments of both Lower and Upper Palaeozoic age unconformably overlie the Proterozoic rocks. Overthrusing from the north gives a rise to more complicated structures at the northern margin than those present at the relatively undisturbed southern margin. However, as most units of the geological section are exposed at the north, most geological information has been gained from there.

The sediments of the Ngalia Basin have been divided into nine rock units with an aggregate thickness of about 20,000 feet (Wells, in preparation). Wells places the base of the sedimentary sequence at the base of the Vaughan Springs Quartzite and the units below this he refers to as the basement of the basin. Table 1 summarises the stratigraphy for the basin. It should be noted that the Treuer Member occurs in the lower half of the Vaughan Springs Quartzite.

Owing to the scarcity of outcrops within the basin, little can be inferred from geological mapping about the structural features and the extent and nature of sedimentation within the basin. Aeromagnetic investigations carried out for the Pacific Americal Oil Company (1963) indicated a maximum depth to basement of about 20,000 feet in the Ngalia Basin. Gravity surveys carried out for the Pacific American Oil Company (1965) and BMR (Flavelle, 1965; Whitworth, in prep.) indicated that the axis of a major Bouguer anomaly 'low' lay in approximate coincidence with the line of outcrops which are recognised as delineating the northern margin of the basin. Seismic investigations (Pacific American Oil Company, 1965) indicated that the basin was assymmetric in form with an axis of deepest sedimentation near the northern margin.

The BMR reconnaissance seismic survey in 1967 (Jones,1969) indicated that at least 15,000 feet of sediments existed near the northern edge of the basin, and supported the previous evidence of assymmetry. No correlation of reflecting horizons with outcrops was made.

TABLE 1

Stratigraphy of the Ngalia Basin

Age	Formation	Lithology	Maximum thickness (feet)
Carboniferous	Mount Eclipse Sandstone	Feldspathic sandstone, conglomerate.	7000±
Ordovician	Kerridy Sandstone	Red-brown silty sandstone.	2300
	Djagamara Formation	Grey and white sandstone, green siltstone, in part glauconitic.	1050+
Cambrian	Bloodwood Formation	Red sandstone and siltstone; fossiliferous.	650
	Walbiri Dolomite	Grey to pink dolomite; fossiliferous.	1420+
Proterozoic	Yuendumu Sandstone	Red-brown and pale-brown sandstone.	2310+
	Mount Doreen Formation	Boulder beds, green siltstone and dolomite.	370+
	Vaughan Springs Quartzite	Strongly silicified sandstone, massive quartzite, basal pebble conglomerate.	5700±
	Treuer Member	Deeply leached siltstone, evaporate encrustations.	1700

3. OBJECTIVES AND PROGRAMME

The survey was aimed at determining the extent and thickness of the sedimentary section in the Ngalia Basin with particular reference to the extent of Lower Palaeozoic sedimentation. More specific objectives formulated from the results of the 1967 BMR survey were as follows:

1. To identify a strong reflecting and refracting horizon observed on BMR Traverse B (1967) (Plate 1).

2. To correlate this event along BMR Traverse A (1967), which crossed at least one major fault zone where reflection continuity was interrupted.

3. To identify and map this strong reflection/ refraction marker elsewhere in the basin.

The programme carried out to achieve the proposed objectives is outlined below. Reference should be made to Plate 1 for the location of traverses.

1. A north-south reflection and refraction traverse (Traverse C) was surveyed near Napperby Creek. An east-west reflection and refraction traverse (Traverse D) was surveyed through SP 501 of Traverse C.

2. Reflection Traverse L was surveyed in a roughly south-west direction from near Mount Allan. The surface geology indicated that structures were not complicated and it was hoped that reflecting horizons and outcrops could be correlated. A reflection profile and a velocity profile (Musgrave, 1962) were produced on Traverse M, which ran east-west through SP 4491 of Traverse L.

3. Traverse A (1967) was extended northwards from SP 1621 and southwards from SP 1558 to the apparent margins of the basin using the reflection and refraction techniques.

4. A refraction probe (Traverse E) was made along a line at right angles to Traverse A (1967) through SP 1611, in an attempt to pick up the 19,800-ft/s refractor observed on Traverse B (1967). A reflection profile, an offset reflection profile and a velocity profile (Musgrave, 1962) was produced on Traverse E in an attempt to tie reflectors to refracting horizons.

5. A reflection traverse (Traverse H) was surveyed in a south-easterly direction from the eastern end of Traverse E in an attempt to tie reflectors to outcrop.

6. A short refraction probe (Traverse G) was shot on a dolomite ridge which ran east-west through SP 1621 of Traverse A (1967). It was thought that the dolomite might correlate with the 19,800-ft/s refractor.

7. An offset reflection profile was made on Traverse F, in an east-west direction through SP 1558 of Traversea A (1967) in an attempt to correlate reflections and refraction events.

8. A north-south reflection traverse (Traverse J) was surveyed across the basin on the western side of Waite Creek. An east-west reflection profile and velocity profile (Musgrave, 1962) was made on Traverse K through SP 3508 of Traverse J.

The programme carried out differed in some details from that originally planned, but variations were made with the proposed objectives in mind. Traverse E was more intensively surveyed than was initially planned, and Traverse H was surveyed to provide a tie of reflecting horizons to outcropping formations. Deep refraction probes were dropped from the programme in the Waite Creek and Mount Allan areas since refraction work elsewhere in the basin indicated that results were often difficult to interpret and yielded marginal information.

4. DISCUSSION OF RESULTS

Plate 1 shows a composite summary of the seismic reflection results obtained in the Ngalia Basin by the BMR seismic party in 1968. The natural-scale migrated and reduced seismic cross-sections on the transparent overlays are placed so that the datum lines coincide approximately with the traverse lines as indicated on the geological base map. The Traverse A profile includes results from the 1967 work (SP 1621 to SP 1559) to allow better appraisal of results obtained in 1968 (SP 1558 to SP 1538 and SP 1622 to SP 1627).

The seismic results on Traverses A, C, D, E, and H, and the possible correlations of reflecting and refracting horizons with the stratigraphy of the Ngalia Basin have been discussed in some detail by Smith (1968).

Napperby Creek

Reflection shooting on Traverses C and D in the Napperby Creek area indicated that there is about 8000 feet of sedimentary section in the central region of the basin near Napperby Creek and that sediments dip northwards at about 10°. Results of refraction shooting are summarised in Table 2.

TABLE 2

Refraction data from Traverse D

Intercept time (seconds)	Refractor velocity (ft/s)	Average velocity (ft/s)	Depth (ft)
0.080	13,200	9,000	800
0.280	16,900	11,200	2000
0.385	18,300	18,000	3500

Mount Allan

Reflection profiling on Traverse L was carried out in a south-westerly direction from outcropping Vaughan Springs Quartzite near Mount Allan, through an area of south-dipping Mount Eclipse Sandstone, and then southwards to tie in with Pacific Americal Oil Company seismic lines. Two suites of reflections are present on the records and these can be followed with certainty for about six miles near the middle of Traverse L (Plate 1). A short reflection profile on Traverse M indicated that the direction of strike was 115° magnetic for the shallower suite of two reflections and 135° magnetic for the deeper suite of four reflections, which suggests that an unconformity exists between the two suites. Table 3, which summarises the results of a velocity profile produced on Traverse M, indicates depth to, and interval velocities between, the various reflections.

TABLE 3

Velocity data from Traverse M

Reflection time (seconds)	Interval velocity (ft/s)	Average velocity (ft/s)	Depth (ft)
0.830		12,700	5200
	12,900		
0.960		12,700	6100
	18,800		
1.260		14,100	8900
	18,000		
1.680		15,100	12,700
	15,600		
1.910		15,200	14,500
	18,600		
2.100		15,500	16,200

Reflection profiling on Traverse L showed the presence of a syncline with an axis through SP 4490 for the shallower suite of reflections which extend to a maximum depth of 6500 feet, and through SP 4492 for the deeper suite of reflections which extend down to about 16,000 feet. Dips into the syncline are at a maximum of 40° to 50° at SP 4501, but they reduce to about 10° at SP 4506.

North of SP 4506 reflection quality is extremely poor, but it is apparent that all events continue to dip to the south at about 10°. By projection of reflections at the north end of Traverse L it is evident that the shallow suite of two reflections are from layering in the Mount Eclipse Sandstone, the third event can be associated with Kerridy Sandstone and the three deep events can be associated with Vaughan Springs Quartzite.

Dips into the syncline from the south are between 5° and 10°. Reflection quality deteriorates badly south of SP 4485, but the records do indicate that the north dip is maintained. This agrees with the results of Line 2 of Pacific American Oil Company (1965), which runs south from SP 4473 of BMR Traverse L. The Pacific American Oil Company work showed that all reflections dipped northwards.

Mount Doreen

Three main reflections are recorded on Traverse E. The reflecting horizons are conformable and approximately horizontal, but there is a small upturn towards the eastern end. Average velocity, interval velocity, and depth data for these reflections, which are summarised in Table 4, have been derived from the velocity profile shot about SP 2350 on Traverse E.

Refraction shooting was carried out on Traverse E and the velocities of three refractors were recorded, the shallowest of which by both velocity and intercept time can best be described as a sub-weathering refractor. Velocities of, and depth to, refracting horizons are summarised in Table 4.

By analysis of an offset reflection/refraction profile on Traverse E the 18,600-ft/s refractor can be associated with the middle reflection event, and the 16,800-ft/s refractor can be associated with the shallow reflector. The depth estimates for the reflection and refraction events, which are presented in Table 4, are in conflict. No explanation for this fact can be offered yet.

Reflection profiling was extended from Traverse E, south-east along Traverse H towards an area of outcropping Lower Palaeozoic and Upper Proterozoic formations. The quality of the shallowest reflection deteriorates beyond SP 3007, but by projection to the surface at the dip indicated where the event is still visible, it can be associated with the Mount Eclipse Sandstone, which extends as far as SP 3015 in the vicinity of Traverse H. Between SP 3009 and SP 3010 the continuity of the two deeper horizons is disturbed by faulting. From SP 3013 to SP 3015 the dip component to the west on the deeper two reflections is about 15°. Beyond SP 3015 record quality deteriorates and no events can be followed with certainty.

Reflection shooting on Traverse A north of SP 1622 produced no recognisable shallow events.

On Traverse A from SP 1558 to SP 1543 all reflectors dip to the north at 5° to 10°. South of SP 1543 record quality deteriorates badly.

By projecting reflection events to the surface on Traverses H and A it is evident that the three strong common events observed on Traverses A, E, and H are associated with the Mount Eclipse Sandstone, the Mount Doreen Formation, and the Vaughan Springs Quartzite.

A refraction velocity of 20,000 ft/s can be associated with outcropping dolomite on Traverse G. The dolomite is probably within the Mount Doreen Formation.

TABLE 4

Reflection and refraction data from Traverse E

Depth (ft)	Average velocity (ft/s)	Interval velocity (ft/s)	Intercept time (seconds)	Average velocity to refractors (ft/s)	Refractor velocity (ft/s)	Depth (ft)
					14,000-15,000	Subweathering
		14,500				
2500	14,500		0.140	12,500	16,800	1500
		17,600				
5000	16,000		0.270	15,000	18,600	3500
		19,000				
8000	17,000					

Waite Creek

Reflection profiling on Traverses J and K showed the presence of four main reflection events, which can be followed from SP 3492 in the south to SP 3520 in the north where there are outcrops of Vaughan Springs Quartzite and older material. The maximum depth of section is about 16,000 feet at SP 3518, and the general trend, south of this shot-point, is a gentle dip of 10° to the north with no obvious reversals.

When shooting was proceeding it was expected that reflections would not be obtained north of SP 3520 as there, surface geology indicates that basal sediments dipped strongly to the south-east. However, it was found that even though reflection quality deteriorated north of SP 3518 some horizontal continuity was present in the section down to at least 13,000 feet. It appears that the Precambrian material evident in surface outcrops has been thrust southwards over Palaeozoic sediments for at least two miles. The northward extent of Palaeozoic sedimentation is therefore much in doubt in the Traverse J area.

Table 5 is a summary of data derived from a velocity profile shot on Traverse K.

TABLE 5

Velocity data from Traverse K

Reflection time (seconds)	Interval velocity (ft/s)	Average velocity (ft/s)	Depth (ft)
	12,900		
0.790		12,900	5100
	17,100		
1.120		14,200	7900
	19,700		
1.520		15,600	11,900
	16,500		
1.720		15,700	13,600

5. REFERENCES

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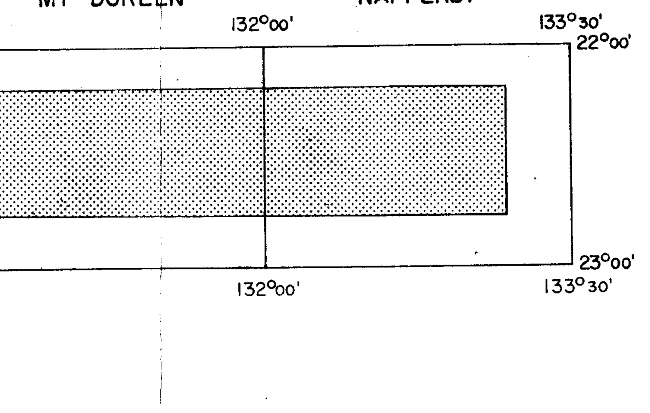
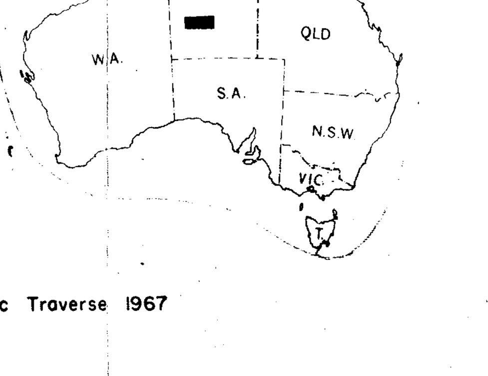
* Unpublished report on a Commonwealth-subsidised operation.

Reference

CAINOZOIC	QUATERNARY		Qa	*Alluvium*
			Qc	*Colluvium*
			Qs	*Aeolian sand*
			Qr	*Red soil, alluvium*
			Qt	*Evaporites*
			Ql	*Travertine*
	UNDIFFERENTIATED		Cz	*Silcrete and ferruginized (lateritized) rock*
PALAEOZOIC	CARBONIFEROUS	Mount Eclipse Sandstone	Pzt	*Coarse-grained, arkosic sandstone; subgreywacke, minor cobble conglomerate and red micaceous siltstone*
	ORDOVICIAN ?	Kerridy Sandstone	Pzy	*Red-brown, silty arkosic and calcareous sandstone; subgreywacke and interbedded siltstone*
		Djagamara Formation	Pzd	*White, well-sorted sandstone, glauconitic; abundant clay pellets. Interbedded green shale in places*
	CAMBRIAN	Bloodwood Formation	€b	*Red-brown micaceous siltstone and sandstone. Abundant trace fossils and rare macrofossils*
		Walbiri Dolomite	€w	*Dolomite, siltstone and minor stromatolitic, oolitic and glauconitic dolomite and sandstone. Abundant fragmentary marine macrofossils*
PRECAMBRIAN	PROTEROZOIC	Yuendumu Sandstone	Ꞓuy	*Red-brown sandstone, minor coarse arkose at the base*
		Mount Doreen Formation	Ꞓuq	*Green siltstone with erratics, lenses of dolomitic sandstone and pebbly sandstone; siltstone, pink laminated dolomite, red shale, Thick dolomite sequence in places*
		Vaughan Springs Quartzite	Ꞓuv	*Thick bedded qartzite, basal pebbly sandstone and pebble conglomerate*
		Treuer Member	Ꞓut	*Thick bedded sandstone, siltstone. Possibly interbedded evaporites.*
		Patmungala Beds	p€p	*Silty sandstone, quartzite, siltstone, spotted claystone, minor stretched chert pebble conglomerate and shale*
			p€	*Undifferentiated igneous and metamorphic rocks*
			p€g	*Granite*
			p€d	*Dolerite*
			p€s	*Schist*
			p€m	*Undifferentiated metamorphic rocks*
			p€q	*Quartzite*
			p€n	*Gneiss*





2068 BMR Seismic Traverse 1967

4998 BMR Seismic Traverse 1968

NGALIA BASIN

GEOLOGY AND BMR MIGRATED DIP REFLECTION SECTIONS

Scale

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