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REPORT ON THE MINI-SOSIE SEISMIC

REFLECTION SURVEY IN EL 699.

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16/10/1981

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ABSTRACT.

During the latter half of 1980, Comalco carried out a series of geophysical investigations aimed at resolving the relationship between Cambrian geology and geophysics in the tenement areas. Mini-Sosie reflection seismic, gravity and ground magnetics were carried out along a 40 km traverse, extending in a generally north-westerly to south-easterly direction from Manya-1 (27° 52' 29", 133° 40' 21").

The results of the gravity and magnetic data confirmed the regional picture and indicated that the Wintinna Gravity High has an amplitude of some 32 milligals. The cause of the anomaly cannot be totally explained by the presence of a trough infilled with carbonates. The gravity data indicates that basement generally shallows to the south-east which is corroborated by the magnetic data.

The results of the reflection seismic survey proved on the whole to be disappointing. Data quality is generally poor and has been caused by unfavourable surface and sub-surface conditions. The seif dunes frustrated attempts to transmit enough energy into the ground while the widespread Tertiary silcrete horizon caused further attenuation of energy.

A number of reflector horizons have been delineated and a tentatively correlated with the stratigraphy found in drill holes. However, it is apparent that the horizons may not in fact represent the same stratigraphic units along the traverse. Without accurate velocity data, the identification of the reflected events is open to question.

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INTRODUCTION.

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The Officer Basin is an east-west arcuate trough extending from Western Australia to South Australia first discovered in 1954 by means of an aeromagnetic survey. The Basin attracted little attention until the early 1960's when its potential as petroleum province was first recognized. This growth in interest was reflected in the increased geophysical activity in the form of reconnaissance gravity, aeromagnetic surveys and semidetailed to detailed reflection seismic surveys. Over the past two decades both geophysical and geological data on the Basin has been steadily accumulating.

Comalco's present activity is restricted to the far eastern and south-eastern flanks of the Officer Basin and the western and north-western Arckaringa Basin. The area is characterized by unique gravity and magnetic morphology and has seen little detailed exploration work.

A series of geophysical investigations were carried out by Comalco as an aid to understanding the geological significance of the gravity and magnetic features. One such investigation is the subject of this report.

In late 1980 a Mini-Sosie seismic survey was carried out along a traverse which in its north-eastern end overlaps with the old SADME seismic ED line (Hall 1973).

This work was initiated after a qualitative reassessment of the existing regional geophysicao data and carried out. Along with the seismic survey both gravity and magnetic data was obtained.

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1. REGIONAL GEOLOGY.

The Officer Basin is an intracratonic Basin filled by Proterozoic and Palaeozoic sediments, extending from EVERARD in the east to BIRKSGATE in the west. Structurally the basin is bounded to the north by the Musgrave Block and the Gawler Platform to the south-east. It is overlapped by the Arckaringa Basin in the north-east and the Eucla Basin to the south.

There is evidence to suggest that the basin may be divided by a basement ridge separating the Eastern Officer Basin, which contains Palaeozoic sediments and the mainly Proterozoic Western Officer Basin. It has previously been held that the eastern limit of the Officer Basin coincided with an inlier of Proterozoic sediments known to outcrop at Ammaroodinna Hill (Kreig 1973). However, recent evidence indicates that this may not be the case. This same structure appears to mark the eastern limit of the Permian Arckaringa Basin (Hall 1973).

Most of the Eastern Officer Basin and the Western Arckaringa Basin is blanketed by Mesozoic to Cainozoic sediments. The latter form a veneer of red aoelian sand - the Great Victoria Desert. As a result of this cover, outcrop is particularly poor.

The oldest known rocks in the tenement area occur at Ammaroodinna Hill where quartz-mica schists and brecciated granitoid rocks probably of Early Proterozoic age are exposed (Kreig 1973).

Similar rocks were intersected in Manya-4 at a depth of 796 metres.

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Granitic basement at a depth of 472.4 metres was intersected in Karkaro-1, situated some 60 kilometres due south of Manya-4 (Demaison, 1969). The well was drilled to identify a high speed seismic horizon occurring to the north-west of the Mabel Creek Basement High (Milton 1969). Mt. Furner-1 located approximately 70 kilometres east south-east of Manya-4 was drilled for similar reasons and intersected granite gneiss at a depth of 549.2 metres (Demaison, 1969).

Byilkaoora-1, located about 40 kilometres north-east of Ammaroodinna Hill bottomed in Adelaidean sediments (Benbow & Pitt, 1980). These consist of a sequence of calcareous and dolomitic siltstones with interbedded feldspathic and calcareous sandstones and conglomeratic bands, collectively called the Rodda Beds. The Rodda Beds are unconformably overlain by the Middle to Late Cambrian Marla Sequence (Kreig 1976).

The Marla Sequence consists of the poorly sorted dolomitic Davies Bore Conglomerate, the Observatory Hill Beds, the Mt. Johns Conglomerate and finally the Trainor Hill Sandstones (Kreig 1976). The Observatory Hill Beds consist of a sequence of evaporitic dolostones and limestones with sandstones interbeds. A sequence of micaceous redbeds characterise the Mt. Johns Conglomerate, while the Trainor Hill Sandstone consists of sandstones/arkosic sandstones interbedded with siltstones and claystones. In Byilkaoora-1, 'Upper and Lower members' of the Trainor Hill Sandstone were recognized by Benbow and Pitt (1980).

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The Observatory Hill Beds contain evaporites and pseudomorphs of evaporite minerals (Gatehouse,1979, Benbow and Pitt,1980, White and Youngs 1981), Manya-1, 2 and 3 all bottomed in Observatory Hill Beds, similarly with Marla 1A, 1B and Mt. Willoughby-1. (Thornton 1975, Comalco Quarterly Report February 1981 and June 1981, Thornton 1971).

Manya-2 intersected a thin sequence of sediments immediately overlying the Observatory Hill Beds which have been tentatively interpreted as Ordovician. Further to the south-east the Marla sequence is generally overlain by Early Permian sediments.

Three sub-units have been recognized within the Early Permian. The oldest and basal unit is the Boorthana Formation which consists largely of conglomerates and sandstones. Overlying this is the Stuart Range Formation of marine shale, while the upper most unit is the terrestrial sandy and silty Mt. Toondina Formation (Townsend, 1976). This latter unit is the coal bearing unit throughout the Arckaringa Basin. Within the Arckaringa Basin these sediments rest unconformably on either Early Palaeozoic sediments or as indicated by Mt. Furner-1 and Karkaro-1, on crystalline basement.

Manya-1 and 3 intersected the lower-most Permian sequence, while in Manya-2 and 4 only the Stuart Range Formation appears to be absent. In the Arckaringa Basin a series of Jurassic to Cretaceous sediments unconformably overly the Permian. The basal unit is the Late Jurassic Algebuckina sandstone. Overlying this is the Early Cretaceous Cadnaowie Formation. This is then generally overlain by the marine Early Cretaceous Bulldog Shale. These sediments are part of the Great Artesian Basin (Eromanga).

Comalco drilled three wells during the course of investigations, Manya-2, 3 and 4. (Comalco Quarterly Report, February, June and July 1981).

The logs have been summarised as follows:-

Manya-2 (located at 7500 S).

Depth Range	Lithology
0 - 4.8	Aeolian sand
4.8 - 22.9	Sandstone
22.9 - 32.9	Gravelly sand with minor silcrete
32.9 - 117	Clayey sandstone
117 - 248	Sandstone, Minor claystone
248 - 267.5	Carbonaceous sandstone/laminated claystone
267.5 - 279.4	Laminated claystone/sandstone
279.4 - 458	Diamictite (sandy to pebbly mudstone)
458 - 497	Claystone/pyritic sandstone
497 - 510	Shale
510 - 522.5	Laminated claystone/sandstone
522.5 - 640	Siltstone (evaporitic, red beds)
640 - 643	Dolostone conglomerate
643 - 645	Dolostone.

Manya-3 (located 240 N) 1454

0 - 3.2	Aeolian sand
3.2 - 12	Sandstone & Siltstone
12 - 22	Silcrete and sandstone
22 - 90	Sandstone and claystone
90 - 112	Pyritic sandstone
112 - 174	Diamictite/pebbly sandstone
174 - 302	Sandy limestone, dolostone and quartz sandstone
302 - 375	Sandy limestone and dolostone with intraclast breccias
375 - 470	Limestone and dolostone cycles
470 - 812.9	Dolomite and minor limestone, with collapsed breccias after anhydrite.

Manya-4 (located at 21120S)

0 - 2	Aeolian sand
2 - 10	Silcrete
10 - 32	Claystone
32 - 106	Sandstone
106 - 162	Sandstone and claystone with coal fragments
162 - 432	Diamictite sandy claystone
432 - 498	Red bed dolomitic sandstone with minor anhydrite
498 - 796	Red bed sandstone
796 - 806.7	Granulite

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2. PREVIOUS GEOPHYSICS

Milton (1979) summarises all investigations carried out in the last two decades as part of exploration initiatives by both private companies and government agencies. The Eastern Officer Basin has been covered by reconnaissance aeromagnetic and gravity surveys. Considering the size of the basin, however, seismic coverage is very sparse with much of the existing data being of poor quality.

The semi-detailed seismic investigations were part of petroleum exploration efforts and were therefore restricted to the deeper parts of the Basin, generally in EVERARD. Less detailed work was carried out in the Arckaringa Basin in the late sixties by SADME (Milton, 1969, 1970).

2.1 GRAVITY

The first helicopter survey covering WINTINNA was carried out in 1968 by the SADME (Hall and Townsend, 1969). The work was designed to determine the boundary between the Arckaringa Basin and Eastern Officer Basin, using a 6.4 kilometre grid.

In 1970, Geophysical Associates carried a helicopter gravity survey on behalf of Murumba Oil N.L. covering the eastern sector of the Officer Basin (Nettleton, 1970).

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The survey was carried out in two parts; the first part was designed for regional cover on a 7.2 km grid whereas the second was a more detailed coverage with station spacings of 0.8 and 1.2 km on lines 3.6 km apart.

As a result of the 1968 and 1970 surveys, regional coverage of tenement areas in the WINTINNA, MURLOCCOPPIE, GILES and EVERARD 1:250,000 map sheets was complete, (Plate 1). Further work by the BMR and SADME has resulted in the complete regional coverage of the Officer Basin and the Arckaringa Basin. Examination of the regional gravity data in the tenement areas (Plate 1) clearly suggests that the field can be sub-divided into four discrete provinces (Fraser, 1976).

(i) Blackstone Regional Gravity Ridge.
This is characterized by an east-west arcuate zone of positive anomalies which generally coincide with the Musgrave Block. This province is sub-divided into three gravity units.

(ii) Officer Regional Gravity Low.
This arcuate depression is unique in that it contains some of the lowest gravity values in the continent. It covers the deepest part of the Officer Basin, but its axis is shifted northwards relative to the basinal axis as defined from seismic and magnetic data. It is sub-divided into two gravity units of which the eastern unit corresponds with the Eastern Officer Basin.

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(iii) Woorong Regional Gravity Complex.

This province is characterized by strong linear to sub-linear anomalies and embraces the western and north-western perimeter of the Gawler platform. The province may be further sub-divided into nine units, some of which reflect the gravity effect of marginal troughs of the Permian Arckaringa Basin.

(iv) Diamantina Regional Gravity Shelf. This province is characterized by a generally subdued gravity field and encompasses a large part of the Eromanga Basin. The Cooper Basin lies within the province. The province can be subdivided into several sub-units.

Comalco's tenement areas lie largely within the Woorong Regional Gravity Complex but do extend into the Officer Regional Gravity Low. (Plate 1).

Finlayson (1979) has shown from a study of the aeromagnetic and gravity data in TALLARINGA that the area is dominated by a series of north-east/south-west striking system of faults. The faults appear to have induced the formation of the present system of horsts and grabens which may have controlled deposition from Precambrian to Recent.

Finlayson (1979) further suggests that north-west/ south-east faulting may have restricted Permian deposition to the northern part of the Tallaringa Trough. The Trough appears to be divided into northern and southern segments by a basement ridge and is bounded to the south-east by the Karari Fault. Limb (1980) considers that the carbonate and Proterozoic sediments within the trough are unlikely to produce a significant gravity anomaly and instead suggests that the sediments above the carbonates may account for the positive residual anomaly over the trough. 1458

He also points out that the gravity effect of these sediments is essentially the same as that of Tertiary palaeochannels. The gravity patterns on TALLARINGA may be dominated by deeper crustal features although intrabasement density changes cannot be ruled out (Limb, 1980). Similar considerations may apply to gravity trends in GILES, MURLOOCOPPIE and WINTINNA.

The Arckaringa Basin seems to be partly delineated by the Woorong Regional Gravity Complex. The basin is made up of a number of marginal troughs surrounding a central area of shallow basement. The Coober Pedy basement ridge, the Mabel Creek basement ridge and the Mt Wood High represent the central basement highs. All three features are accompanied by a gravity expression. The Boorthanna Trough to the east, the Wallira and Phillipson Troughs to the south and the Tallaringa Trough to the south-west appear to have been foci of deposition in the Permian. The Wintinna Trough, however, has been reported in the literature as an older feature, with Palaeozoic sediments making up the sedimentary fill.

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Sedimentary basins are normally associated with gravity lows, the troughs of the Arckaringa Basin generally conform with this observation. However, the Tallaringa Trough and in particular the Wintinna Trough are both associated with residual gravity highs. An aeromagnetic survey first indicated the existence of a basement trough some 1900 metres deep in the north-west region of the Arckaringa Basin (Steeland 1962).

On WINTINNA and GILES the trough coincides with north-east/south-west trending gravity high whose amplitude is of the order of 32 milligals (Plate 1). This feature, designated the Wintinna Gravity High, forms a sub-unit of the Woorong Regional Gravity Complex, and is the dominant gravity feature in the tenement area.

Because the Wintinna Trough has an apparent positive gravity expression, Thornton & Milton (1971) proposed that the trough is infilled with dense carbonates. However, the following considerations show that this is not the whole answer. Both stratigraphic drilling and seismic data along the Manya survey line have shown that the Wintinna Gravity High is associated with a Permian horst structure (Comalco Quarterly Report February 1981 and June 1981). As a result of uplift 469 metres of Observatory Hill Beds (consisting largely of sandy dolostone and limestone) have been juxtaposed against low density Permian and Mesozoic sediments.

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Detailed density measurements on Manya-3 core (drilled on the horst) show that the Observatory Hill Beds have average wet bulk density of 2.62 t/m^3 with standard deviation of 0.13/m^3 (these measurements were made between depths 174 to 812 metres). No significant density increase with depth was apparent. The minimum density of the Permian and Mesozoic material is of the order of 1.9 t/m^3 suggesting a maximum density contrast of about 0.72 t/m^3. As a result, the horst should have a gravity effect of some 14.2 milligals, using the Bouguer plate formula. If we assume that the trough is indeed about 1900 metres deep, this leaves approximately 1300 metres of carbonates in the trough to account for the remaining 17.8 milligals.

There is evidence to suggest that crystalline basement forms the edges of the trough at depth. Density measurements in Manya-4 suggest a bulk density of 2.67 t/m^3 for basement. (This figure is largely in agreement with SADME measurement on similar rocks). Quite clearly if 2.62 t/m^3 is representative of the bulk density for the carbonates below 812 metres then the resultant density contrast will be negative (-0.05 t/m^{-3}), yielding a negative gravity effect of -2.9 milligals. However, if we assume that the bulk density of carbonates below 812 metres is 2.83 t/m^3 then the resultant density contrast will be positive, i.e. 0.16 t/m^3.

The former density corresponds with the maximum measured in Manya-3 and compares favourably with 2.85 t/m^3 obtained by a density log in a dolomitic sequence between depths 1219 metres and 1555 metres in Weedini-1 (Papalia, 1979).

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In this case the gravity effect of the remaining 1300 metres of carbonates would be about 8.7 milligals, resulting in an overall gravity anomaly of 22.9 milligals.

Quite clearly the gravity effect of 1700 metres of carbonates does not fully account for the observed anomaly. In fact even if one assumes a uniform density of 2.83 t/m^3 for the entire sequence of carbonates, a total thickness of 3 kilometres is required. This appears unreasonable, and is contradictory to the regional depth to magnetic basement data. An alternative is to assume that the remaining 9.1 milligals is caused by a lateral intrabasement density change, however, this would mean that the zone of anomalously high density is restricted to just below the horst which implies a genetic relationship with the episode of uplift.

2.2 MAGNETICS

The existence of the Officer Basin was first established in 1954 by a Bureau of Mineral Resources (Quilty & Goodex, 1958). The discovery was later confirmed by ground follow up work. It was not, however, until 1962 that a further aeromagnetic survey was undertaken in the region (Steeland 1962). The reconnaissance survey covered the Eastern Officer Basin to east longitude 134^{o} and was flown in bands of north-south flight lines at intervals of approximately 16.1 kilometres. Each band consisted of three lines (asl) in the north to 600 metres in the south.

In 1961 Delhi Auustralia Ltd.initiated an airborne survey covering a portion of the Great Artesian Basin in Queensland and South Australia for the purpose of providing data on configuration of basement and sedimentary thickness. (Delhi Aust. Petroleum Ltd., 1967). The survey was extended westwards to longitude 131°.30. Flight lines were in an east-west direction at a spacing of 8 kilometres. Survey altitude was approximately 45.7 metres.

Further reconnaissance surveys were carried out by the SADME to cover the areas excluded by previous work. In 1966 and 1967 the southern and northern parts of the Arckaringa Basin were surveyed with E - W flight lines at a spacing of 3.2 kilometres and survey altitude of 152 metres (Young & Gerdes, 1966).
All these data have now been integrated enabling a compilation of a regional depth to magnetic basement map of the area of interest. (Plate 2).

The basement topography can be divided into four broad zones, the eastern, central, south-eastern and northern zones, each is characterized by particular morphology and ranges in basement depths. The tenements generally lie within the central zone but extend into the eastern zone (Plate 2). The eastern zone is marked by an increase in basement depth to the west, reflecting the edge of the Eastern Officer Basin and generally trends in a north-east direction. The Ammaroodinna inler marks the eastern extent of this zone, in which basement depths range from 1 to 4 kilometres.

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The central zone encompasses that area between the Amm- 1463 aroodinna Hill and Manya-4 to the south-east. This zone is characterized by the presence of a number of generally linear horsts and grabens in which basement depths range from outcropping to 4 kilometres. However, the zone is dominated by a deep trough, some 24 kilometres north north-east of Lambina-1 called the Lambina Trough. It has a triangular shape, and narrows to the south-east, eventually forming the Wintinna Trough in the vicinity of the Manya-seismic line. (Plate 2).

The Lambina trough has steep margins to the north and east, but shallows more gently to the south. Another trough forming a westerly arm of the Lambina Trough occurs at Nicholson Hill.

Within the central zone a basement high block is present which is correlated with the Ammaroodinna inlier. Aeromagnetics suggests that it continues sub-surface further to the north-east. Parts of some troughs are coincident with gravity highs in this zone, particularly in the vicinity of Manya-1 and Mt. Willoughby-1. (Plate 3). The Lambina Trough, however, does not have a clear gravity anomaly associated with it. Its depocentre appears to be displaced about 28 kilometres to the north relative to the peak amplitude of the gravity anomaly. (Plate 3). The trough at Nicholson Hill is associated with a gravity low. There is no distinct boundary between the central and eastern zones in the south eastern part of the tenement area.

The south-eastern zone is characterized by shallow basement, less than 1000 metres and is considered to be part of the Gawler Craton. Results from Mt. Furner-1. Karkaro-1 and Manya-4 indicate that granite and granulite are the dominant basement rock types in this zone. Basement depths calculated from magnetics agree with drilling results to better than 20%.

The northern zone is also characterized by shallow basement and appears to be bounded to the south by major east-west faulting in the vicinity of 27^{o} south latitude. Basement is known to outcrop in this zone.

2.3 SEISMIC.

Seismic coverage has been restricted to petroleum exploration activity to the west in parts of the Eastern Officer Basin (Bowman and Harkey, 1962, Shorey, 1966, Moorcroft, 1969, Rait and Bowman, 1967) and some detailed work in the Boorthanna Trough to the east (United Geophysical Corp.,1970). During 1964, reconnaissance refraction probes were shot along the Stuart Highway from Coober Pedy to just north of Welbourn Hill H.S. (Milton, 1964) while in the period between 1968 and 1972 a series of investigations over a number of gravity and magnetic features were undertaken by the SADME (Milton, 1969,1970 and Hall, 1973). These investigations, incorporating refraction and some experimental reflection coverage, revealed the existence of a high speed refractor deepening to the north getween Coober Pedy and Wintinna H.S.

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The average velocity of the refractor is about 5680 m/s and is known to correspond with crystalline basement as shown by Karkaro-1 and Mt. Furner-1. The basement in this area ia generally overlain by a thin sequence of Permian sediments and reaches a maximum depth of some 1100 metres just south of Wintinna H.S. North Of Wintinna H.S. the high refractor is observed at a shallower depth with average velocity of 6140 m/s. This is inconsistent with aeromagnetic data which suggest that basement is about 1800 metres deep.

Subsequent drilling has shown this refractor to correspond with Palaeozoic carbonates (Milton,1970, Thornton 1971). Attempts to obtain reflections from crystalline basement below the carbonate reflector proved fruitless due to surface conditions (Milton 1970). From about 15 kilometres south of Welbourn Hill H.S. northwards a high speed refractor with an average velocity of 5550 m/s was recorded. The velocity was subject to a great deal of variability and was attributed to bad surface conditions. It has been tentatively correlated with crystalline basement (Milton 1970), although it is more likely to be associated with carbonates (Thornton 1975).

In 1972 the SADME carried out seismic investigations of the Wintinna Trough using three traverses, designated EE, ED and EH, (Hall,1973). The work consisted of refraction and some reflection and was designed to test the proposal by Milton and Thornton (1970) that the gravity high is due to dense carbonate infilling a basement trough.

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The discovery of a dense Palaeozoic dolomite in Mt. Willoughby-1 (Thornton 1971) in a structurally analagous setting was advanced as evidence in support of the hypothesis (Milton, 1970). Seismic line ED, started 10 kilometres south of Wallatina H.S. and continued in a SSE direction to produce a profile across the Wintinna Gravity High. Traverse EE started at the same point as ED but went WNW while EH was shot north of Wintinna Hill.

As the results along ED cover the northern part of the survey line they will be reviewed here. Plate 4 presents the interpretation by Hall (op.cit.) between ED45 and ED90, also shown is the position of the Comalco survey line and the results of stratigraphic drilling. Although the data was generally poor, interpretation by Hall suggested three layers in the vicinity of Manya-1. A low velocity layer of variable thickness was correlated with Late Tertiary to Quaternary sediments and a second layer with range in velocity from 1690 m/s to 2070 m/s overlies a high speed refractor with a velocity of 5330 m/s (plate 4).

In the vicinity of Manya-1 the high speed refractor was interpreted to occur at a depth of 165 metres which compares favourably with the top of the Cambrian at 146 metres in Manya-1 and 174 metres in Manya-3 240 metres north-west of Manya-1 (Comalco Quarterly Report June 1981). Both wells intersected Mesozoic and Early Permian sediments, elsewhere these units are generally distinguished by different refractor velocities.

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Hall (op.cit.) attributes difference to weathering. The results along the northern part of the traverse confirmed that the Ammaroodina Inlier is a fault bounded horst. A high refractor of average velocity 5200 m/s was also observed along line EE. The refractor is at comparatively shallow depth but deepens to the north, and has been correlated with carbonates (Thornton 1975).

2.4 GEOPHYSICAL PROPERTIES OF ROCKS.

The geophysical properties of the major geological units have been described by the SADME during the course of regional stratigraphic drilling programme. Thornton (1975) in describing the characteristics of the carbonate units of the Eastern Officer Basin and Arckaringa Basin indicated that variability in geophysical properties (i.e. density and P-wave velocity) may be related to the degree of dolomitization. Refractors correlated with Early Palaeozoic carbonates show that P-wave velocities vary in the range 4.1 km/s to 6.4 km/s. Measured bulk densities demonstrate similar variability with a range of 2.46 t/m^3 to 2.77 t/m^3 (Milton & Thornton 1971).

Density measurements were made on core samples from Manya-2, 3 and 4. The results indicate an average density of 2.62 t/m^3 S.D. of 0.13 t/m^3 for Observatory Hill beds. Densities of the Mesozoic and Early Permian units were quite variable due to the relatively unconsolidated nature of the sediments.

A bulk density of 2.1 t/m^3 with S.D. of 0.14 t/m^3 was measured for Mesozoic rocks and 2.45 t/m^3 with SD 0.15 t/m^3 for Permian rocks in Manya-2. These densities should be considered upper limits, because most samples were too friable for density determinations. The granulite intersected in Manya-4 had an average bulk density of 2.67 t/m^3 with SD of 0.06 t/m^3, which compares favourably with basement densities in the range of 2.62 t/m^3 to 2.70 t/m^3 in Mt Furner-1 and Karkaro-1 (Milton,1969). P-wave velocities for the latter, computed from a series of refraction probes averaged 5.68 km/s. (Milton 1969).

In conjunction with geophysical logging the SADME has conducted well velocity surveys on a number of important stratigraphic wells. As the results of these surveys are of particular relevance to this report, they are summarised here.

Wilkinson-1 is located some 250 kilometres south-west of Coober Pedy in the Tallaringa Trough. The well penetrated the following sequence, (Gatehouse,1979):-

Age	Lithological Unit	Thickness in metres
Quarternary	Surficial Sands	18
Tertiary	Sandstones and Gravels	98
Early Cambrian	Observatory Hill Beds, Unit 1, 11 and 111	594

Gatehouse (1979) sub-divided the Observatory Hill Beds into an upper clastic unit 96.5 metres thick, a middle carbonate unit 361 metres thick and a lower evaporite unit 136 + metres thick. Calculated interval velocities within the Observatory Hill Beds show considerable scatter, however, an average interval velocity of 4090 m/s can be assigned to the clastic unit and 3410 m/s to the carbonate unit. No data is available for the evaporitic unit due to the termination of the survey just above the unit. An average interval velocity of 3550 m/s can be assigned to the entire sequence of the Observatory Hill Beds.

Byilkaoora-1, located approximately 10 kilometres north-west of Marla, in the Mt Johns Range penetrated the following sequence (Benbow & Pitt):-

Age	Lithologic Unit	Thickness in metres
Quarternary	Surfical Sand & Talus	6.7
	Trainor Hill Sandstone (Upper member)	42.5
	Mt Johns Conglomerate	49.6
Early to	Trainor Hill Sandstone	
Middle	(Lower Member)	57.0
Cambrian	Observatory Hill Beds	457.2
	Davies Bore Conglomerate	106
Adelaidean	Rodda Beds	10.7 +

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Benbow & Pitt (1979) recognize five members in the Observatory Hill Beds, ranging from clastic to carbonate-clastic to carbonates. Member 3, between 259 and 322.5 metres consists of evaporitic sediments with calcite pseudomorphs after shortite and trona. The well velocity survey indicates an average interval velocity of 1940 m/s for the 'Upper Member' of the Trainor Hill Sandstone and 2600 m/s for the 'Lower Member'. A velocity inversion exists between the 'Lower Member' of the Trainor Hill Sandstone and the overlying Mt. Johns Conglomerate which has an average interval velocity of 5000 m/s. The variable lithology of the Observatory Hill Beds is reflected in the scatter of calculated interval velocities. An average of 5560 m/s has been calculated for the entire sequence. The 'Davies Bore Conglomerate' has average interval velocity of 5850 m/s.

Mt. Willoughby-1 was drilled to identify a high speed refractor at a depth of about 610 metres (Thornton & Milton 1970). The well, located about 10 kilometres ENE of Wintinna H.S. intersected the following sequence:-

Age	Lithologic Unit	Thickness in metres
	Bulldog shale	100.6
Early Cretaneous	Cadna-Owie Formation	43.9
Late-Jurassic	Algebuckina Sandstone	55.2
	Mt. Toondina Beds	93.0
Early Permian	Stuart Range Formation	96.9
	Boorthanna Formation	234.1
Cambrian	Observatory Hill Beds	16.1 +

The well velocity survey in Mt Willoughby-1 was between 52.1 and 635.2 metres (Thornton 1971). Interval velocities show a normal increase with depth as follows:-

Lithologic Unit	Depth to top in metres	Interval velocity m/s
Bulldog shale	0	1850
Cadna-Owie Formation	99.4	1560
Algebuckina Sandstone	143.3	2050
Mt. Toondina Beds	199.7	2360
Stuart Range Formation	292.6	2440
Boorthana Formation	389.5	3000
Observatory Hill Beds	622.4	5490

Milton, in comparing the interval velocities obtained from the well survey and p-wave velocities obtained from refraction probes over similar units further to the south, suggested that for the Lower Permian and Observatory Hill Beds the relationship Velocity (interval)/velocity (refraction) =0.9 holds reasonably well.

The following table summarises the interval velocities observed in the wells discussed above plus results from surveys carried out in Cootanoorina-1 (Kendall,1967 and Weedini-1 (Pexa,1970).

Age	Lithologic Units	Observed Range in Interval Velocity in m/s.
Quarternary	Unnamed sands	270 - 570
Early Cretaceous	Bulldog shale	~ 1850
Early Cretaceous	Cadna-Owie Formation	~ 1560
Late Jurassic	Algwbuckina Sandstone	~ 2050
Early Permian	Mt.Toondina Beds	2360 - 2590
	Stuart Range Formation	2470 - 2510
	Boorthanna Formation	2820 - 3380
Middle-Late Cambrian	Trainor Hill Sandstone	1940 - 2600
Middle-Late Cambrian	Mt.Johns Conglomerate	~5000
Middle-Late Cambrian	Observatory Hill Beds	3550 - 5490
Early-Middle Cambrian	Davies Bore Conglomerate	~5850

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3. FIELD TECHNIQUE & SURVEY DETAILS.

3.1 MINI-SOSIE TECHNIQUE

The Mini-Sosie seismic technique is based on the transmission of low energy pseudo-random pulses using modified vibration rammers of the type used in civil engineering for earth compaction. The pseudo-random sequence of pulses is achieved by 'randomly' varying the impact rate in the range 1 to 10 impacts per second. Pulses are recorded by means of a source sensor attached to the base plate of each rammer which is linked by cable to the main processing unit.

The weak geophone signals from each individual ramming pulse are progressively time shifted and added until satisfactory signal amplitudes are obtained. This process ensures that an optimum signal/noise is achieved. The maximum number of ramming pulses allowable depends on sample rate and record length. The 8 k memory size of the 1632Ms is a major constraint to the maximum amount of data that can be stored during any given ramming sequence.

In the survey a maximum of 2000 rams per segment was used with a 2ms sampling rate and 1 sec record length without saturation.

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3.2 SURVEY DATA

The survey was designed to cover a number of second derivative gravity anomalies, including the Wintinna Gravity High and a gravity low flanking it to the south south-east.

The survey line extends across EL's 698, 699 and 701 in a general SSE direction as shown by plate 2. There is a 7 kilometres overlap between the line and the SADME seismic traverse ED (Hall, 1973). Manya-1 situated between ED 55 and 56, was chosen as the origin, consequently all stations are designated by their north or south distance from Manya-1; the line extends to 3 km NNW of Manya-1 and 37.4 kms to the SSE, a total length of 40.4 kilometres. It was pegged at twenty metre intervals and optically surveyed using the known elevation of Manya-1 (241.0 m) as tie. Relative elevations between stations are considered accurate to 1 cm.

Seismic coverage along the line was as follows:-

1. 6-fold Mini-Sosie coverage between 3000N to 37400S
   - (a) 1500 Rams along interval 0 to 6940S
   - (b) 2000 Rams along intervals 6940S to 37400S and 0 to 3000N.
   - (c) 4-shot dynamite pattern over 40 metres along intervals 100S to 3600S and 6799S to 9100S.

2. 12-fold Mini-Sosie between intervals 4000S to 4800S and 6700S to 9100S.
   1500 and 2000 Ramming sequences were used along both intervals.

Velocity Data Pty.Ltd., carried out the work under the direction of B.E. Long. Instrumentation consisted of the 1632Ms seismic system, 2 x BS60Y (approximately 60 kilograms) Wacker Rammers and GS33 40Hz geophones. The operating system used the two rammers, ramming simultaneously over a 40 metres segment, to ensure that the target ram number was reached over the segment. The survey commenced on 18th August 1980 and was completed on the 20th September 1980.

3.3 GROUND CONDITIONS

A system of Quaternary seif dunes transects the seismic line from the north to the south, becoming more subdued towards the south. As a result, ground conditions were generally sandy.

The detailed ground surveys showed that dunne amplitudes range from 2 to 6 metres with an average of 3.5 metres, whereas widths range from 150 to 400 metres with an average of 200 metres. Wavelengths (peak to peak) range from 150 to 1100 metres, with an average of 450 metres.

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Because of the generally unfavourable surface conditions a number of noise tests were carried out over representative areas to determine the optimum geophone pattern, ramming sequence and frequencey filters.

The tests indicated the existence of a significant ground roll component with an average velocity of 1000 m/s having a dominant frequencey of about 50 Hz. As a result of these tests a number of measures were adopted to optimize cancellation of the coherent noise. Both frequency and spatial filtering techniques were applied. The latter was achieved by:-

1. Spacing 12 geophones over 20 metres, centred at each station.
2. Ramming segment of 40 metres.
3. Using a 60 metre offset.

These measures were complemented by low cut frequency filtering at the recording site. In general, minor differences in noise characteristics of the test sites were not large enough to warrant marked changes in recording technique. The technique of Sign-Bit summing was briefly applied and no major improvements were discernible from the monitor records, therefore, this technique was not adopted.

Manya-1 indicated the existence of a 2 metre thick silcrete layer at a depth of 20 metres. Subsequent drilling has shown that both depth and thickness of the silcrete is variable. During the augering of shot holes, hard pebbly calcretized layers were intersected in some interdune areas.

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It was anticipated that the existence of a near surface variable high velocity layer would cause some static problems, therefore shallow refraction spreads were carried out using a BISON 1575 seismograph in the hammer mode. Refraction spreads were restricted to 100 metre lengths and were carried out every 500 metres in areas expected to cause static problems.

The near-surface profile indicated by the shallow refraction spreads generally consisted of three layers characterized by different velocity ranges. The surface layer with a range of 300 m/s to 630 m/s appears to be continuous with a maximum thickness of 12 metres and average thickness of 2.8 metres. This layer corresponds to the Quaternary sand cover. The average velocity of this layer was observed to be about 380 m/s on dune 'tops' whereas the same layer averaged 500 m/s in the interdunal zone.

The third layer characterized by moderately high velocity, ranging from 1800 m/s to 2400 m/s varies greatly with depth. The intermediate layer, which is not always present varies greatly in thickness over short distances. The velocity of this layer ranges from 900 m/s to 1600 m/s. At the southern end of the line it is absent and the low velocity layer rests directly on the high velocity layer. All three layers are generally present on dune tops, whereas the intermediate layer may be absent in interdune areas.

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3.4 PROCESSING

The processing of the Mini-Sosie field tapes was carried out by S.S.L. Pty. Ltd., Adelaide.

The processing sequence adopted by SSL was as follows:-

1. In general after editing the data, a bandpass filter (35 - 40 - 180 - 200 Hz) and a sliding window trim were applied.

2. First breaks were removed by the use F.K. designed operator and generally proved to be successful.

3. This was followed by a further application of a band-pass filter with marginally different characteristics to the first set applied, 35 - 45 - 180 - 200 Hz.

4. At this stage a CDP sort was carried out and then the field determined statics were applied. The latter were interpolated into areas where no refraction data were available.

5. This was followed by the application of NMO corrections after which noisy data were muted.

6. Two passes of C.D.P. aligned residual statics were applied at this stage after which the data was stacked.

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7. After stacking a mild coherency filter was applied using an 11 trace pilot. This was immediately followed by deconvolution using 75 ms operator.

8. Finally, a further bandpass filter with 25 - 30 120 - 130 Hz characteristics and 150 ms sliding window trim.

Velocity determinations were made at approximately 1 kilometre intervals. Average, interval and RMS velocities were calculated at given intervals.

A portion of the data will be processed by Digicon at a future date to allow processing comparisons to be made.

4. PRESENTATION OF RESULTS.

4.1 DISCUSSION OF MINI-SOSIE DATA.

The seismic data is presented in a series of sections; Part 1 and 4 cover the section between stations 3000N and 9700S, Part 2 covers the section between 9700S and 22000S, and Part 3 covers the remaining section between 22000S and 37400S.

Velocity surveys were not carried out in nearby wells, consequently no reliable velocity data is available for the area. Therefore, the following presentation is constrained to a qualitative discussion of the seismic sections.

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The aim of the interpretation is to resolve the sections into constituent major horizons, determine whether they represent stratal surfaces or unconformities and attempt to estimate depths and thickness of units. An attempt is made to correlate interpreted horizons with lithostratigraphy using the following data:-

1. Computed velocity functions at regular intervals along the line.
2. A review of all observed interval velocities for the equivalent lithologic units presented in section 2.4.
3. Detailed density measurements of core from all wells.
4. Regional geophysical data complemented by the gravity and magnetics carried out along seismic line.

Factors 1, 2 and 3 above, are combined to provide some basis for recognition of changes in acoustic impedance, and thus facilitate correlation.

The generally poor data quality at best severely limits application of the concepts of seismic stratigraphy to recognition of depositional sequences and therefore to the interpretation of depositional environments in the section.

Also, quality of reflectors varies considerably over the survey area.

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Because of this problem, it is not possible to trace the prominent horizons across the whole traverse with assurance.

However, an attempt to correlate events along the sections has been made based on the known more or less uniform distribution of the Early Permian and Younger sediments through the south eastern tenement areas.

Four horizons, A, B, C and D were defined. Horizon A varied somewhat in character and quality in the south eastern half of the survey line. At Manya-1, 2 and 4, Horizon A correlates reasonably closely to the top of the Early Permian Boorthana Formation. Horizon B is a reflector which maintains fair to good quality and character over most of the survey line, and ties well in Manya-3 at the top of the Cambrian Observatory Hill Beds. However, a similar tie in Manya-4 tentatively identified the reflector as the top of a sequence of red beds the stratigraphic level of which is as yet uncertain.

Horizon C maintains fair quality and character mainly in the south eastern end of Part 1 and the north western end of Part 2. A tentative tie to Manya-4 suggests that it correlates with the top of crystalline basement.

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Horizon D is very poor and lacks both character and continuity. Because of this, it was not traceable over most of the survey line. A tentative tie in Manya-2 correlates the reflector with a change in lithology from coarse grained sandstones to predominantly fine grained sandstones of the (?) Mt Toondina Formation.

All times quoted in the following discussion will be two way times unless otherwise stated.

4.1.1 MINI-SOSIE PART 1 AND 4, PLATES 6 AND 9.

These two sections are between stations 2800N and 9700S and on the basis of coherency and reflection character can be clearly separated into two zones, that between 2800N and 5000S, and that between 5000S and 9700S.

In the same zone between stations 2800N and 5000S, reflectors are generally weak and discontinuous. Below 0.3 seconds the reflectors appear hummocky in character and lack coherency. No continuous events are discernible below 0.3 seconds in this zone. Above 0.3 seconds the reflectors appear a little more distinct, nevertheless, are still discontinuous. To the south east between stations 5000S and 9700S the section is characterized by generally horizontal reflectors which are discernible to at least 0.7 seconds. Events appear patchy and because they exhibit good continuity over short distances can be traced along section with some certainty.

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The stratigraphy intersected in Manya-1 and 3 has been summarised in section 2.4. Manya-3 was spudded 240 metres north west of Manya-1 and reached a total depth of 812.4 metres. In the vicinity of the well, a weak event coming in at 0.176 seconds has been designated Horizon B. The event becomes stronger and more coherent to the north west but decreasing in continuity to the south east.

The computed velocity functions in the vicinity of Manya-1 and 3 are as follows:-

Location	Horizon	Time(secs)	Average Velocity m/s	Depth (m)
500N		.155	1900	
	B	.192	2090*	200
		.195	2110	
240S	B	.176	1930*	170
260S	B	.130	1800	
		.192	1890*	181
		.205	1895	

Velocities marked with asterisk have been interpolated.

Assuming a linear change in velocity between 500N and 260S, an average velocity of 1930 m/s has been determined down to Horizon B at 240S. This leads to a depth estimate of 170 metres for Horizon B.

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Quite clearly this horizon can be correlated with the top of the Cambrian Observatory Hill Beds which were intersected at 174 metres in Manya-3. The discrepancy of some 2% between calculated and true depth is probably due to an overestimate in velocity.

The Observatory Hill Beds are predominantly carbonates with minor quartz sandstones. The strong impedance constrast between the overlying Early Permian diamictite and the Cambrian carbonates will largely mask all but the strongest signals from below this interface.

Drilling results indicate that the Observatory Hill Beds were eroded prior to deposition of Early Permian sediments. The minimum erosion is estimated to be about 130 metres, and as a consequence an irregular Cambrian topography may have existed. This, combined with a relict weathering profile, may be the reason for the non-coherency of reflection events to the south east of Manya-3. It would also explain why Horizon B becomes stronger and more continuous dipping to the north west.

The north westerly dip of Horizon B is consistent with the results of Hall (1973), figure 5. In the most north westerly part of the line, Horizon B is at 0.340 seconds.

The interpolated velocity function yields an average velocity at 2820 m/s down to Horizon B at 2800N indicating a depth of about 480 metres to the reflector at this point.

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This is far deeper than the 280 metres calculated by Hall (1973) on the assumption that the high speed refractor correlates with Horizon B.

The large discrepancy may indicate that the velocity function in this part of the section yields higher than normal average velocities. An average velocity of 1650 m/s is required to give a depth comparable to that of Hall. It is felt that this velocity is unrealistic for a combined sequence of Mesozoic and Early Permian sediments and a figure of the order of 2000 m/s is more acceptable, yielding a depth of some 340 metres.

South west of Manya-1 and 3, Horizon B is seen to deepen slightly as result of possible faulting, forming a minor depression between stations 100S and 2200S. Further evidence to suggest that Horizon B may be correlated with the top of the Cambrian carbonates is seen in the gravity profile. Between about 100S and 2200S a broad residual low of about 1 milligal is present (Plate 5). If we assume that this anomaly is due to local thickening of post Cambrian sediments, then using densities obtained from cores, a local thickening of 140 metres is suggested. This compares favourably with the 120 metres calculated from the seismic section.

Between stations 3000S and 5700S, Horizon B dips gently to the south east, finally levelling off at about 5800S. This south-easterly dip was observed by Hall (1973).

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However, Hall's data suggested that the high speed refractor begins to deepen at about 2000S whereas the seismic section shows the interpreted Horizon B shallowing slightly towards 3000S after which it begins to deepen.

This discrepancy may arise if we assume that the high speed refractor does not correlate with Horizon B in this part of the line. A similar discrepancy is evident in the north-western flank of the structure where Hall's data suggests that the high speed refractor begins to deepen suddenly at approximately 1300N whereas Horizon B clearly dips consistently to the north west from station 400N. This latter observation is more consistent with the dips and fracturing observed in the carbonate sequence intersected in Manya-1 and 3.

Not withstanding these discrepancies it is clear that both Horizon B and the high speed refractor forms a broad anticlinal fold, the apex of which has been subjected to severe erosion in post Cambrian times. The flexure in Horizon B between stations 3000S and 5700S is in part reflected in the gravity profile by an increase in gradient (Plates 5). The gravity signature is presentative of a fault model.

A further major horizon has been interpreted to coincide with the relatively weak low frequency event coming in at about 0.1 seconds in the Vicinity of Manya-3. This reflector designated Horizon id discontinuous to the south east, of Manya-3, but becomes increasingly more coherent to the north west.

Using the computed velocity function, to Horizon A occurs at about 95 metres in the vicinity of Manya-3. The horizon does not clearly correlate with any lithostratigraphic unit although it may either be the top of the Early Permian diamictite unit of the Boorthana Formation, or the top of the pyritic sandstone unit of the overlying Mt. Toondinna Formation. The former was intersected at 112 metres while the latter at 90 metres in Manya-3. The regional velocity data reviewed above suggest that, in general, there is a larger velocity difference between the Mesozoic and Mt Toondina Formation than there is between the Mt. Toondina Formation and the Boorthana Formation. Consequently, the latter correlation is favoured. This correlation must, however, be regarded with some caution since a similar but much thinner pyritic sandstone at 122 metres in Manya-1 was interpreted by Thorton (1975) to be part of the Boorthana Formation.

To the south east Horizon A follows Horizon B except that it begins to deepen further to the south east. Both horizons are generally flat lying from 5700S to the end of the section.

Between 5700S and the end of the section strong reflector facies appear to be present down to at least .66 seconds. Where a third major horizon, Horizon C ahallows to the south east. A fourth major hrizon, Horizon D, coincides with a rather discontinuous low frequency event coming in at about 0.13 seconds in the vicinity of Manya-2. This horizon is also flat lying between 30000S and 5700S.

Manya-2, located at 7500S, was drilled to intersect these flat lying sediments. The hole lithology sandstone, siltstone and claystone down to 511 metres. These sediments were generally soft, frustrating attempts at obtaining wet densities. A moderately hard evaporitic siltstone marks the upper unit of the Observatory Hill Beds which in turn overlies dolostones.

The evaporitic siltstone unit is 130 metres thick and has been logged as one continuous unit, but on the basis of density measurements, it can be clearly sub-divided into two units. The upper unit between 511 and 565 metres has a density of 2.39 t/m^3 (S.D. 0.07 t/m^3), whereas the lower unit between 565 and 640 metres is characterised by a density of 2.53 t/m^3 (S.D. 0.04 t/m^3). The density of the underlying dolostones was measured as 2.62 t/m^3.

It is reasonable to assume that an acoustic impedance contrast will exist between the younger sediments and the upper siltstone unit and between the lower siltstone unit and the underlying dolostones, with a more significant contrast between the former.

However, the computed velocity function at station 6900S is as follows:-

Horizon	Time (Sec).	Average Velocity (m/s)	Depth (m)
	0.100	1850	
Horizon D	0.130	1870*	122
Horizon A	0.304	2080*	318
	0.315	2090	
Horizon B	0.400	2230*	446
	0.425	2270	
	0.550	2750	756
Horizon C	0.660	-	

The velocities marked with asterisk have been interpolated from the computed function assuming linearity.

Comparing these velocities with the sequence in Manya-2 the following observations are made.

1. Horizon A may represent the top of the Early Permian diamictite unit.
2. Horizon B may represent the base of the diamictite unit, i.e. the interface between the diamictite and the pyritic sandstone claystone unit at a depth at 458 metres.
3. Horizon D may represent the change between a generally coarse grained clayey sandstone to a predominantly fine grained sandstone unit with minor claystones at a depth of about 116 metres.
4. The depth to Horizon C is greater than 900 metres.

In the vicinity of Manya-1 and 3 it was suggested that Horizon A probably represents the top of the Early Permian sediments, in this case, the Mt. Toondinna Formation. In the vicinity of Manya-2 it is likely to be correlated with the top of the Boorthanna Formation. If this is correct then clearly Horizon A is in fact a Permian intraformational event and does not in general coincide with the Palaeozoic - Mesozoic unconformity.

4.1.2 MINI-SOSIE PART 2, PLATE 7.

This section covers the area from station 9700S to station 2200S.

The character of reflection in the northern half is a continuation of the character observed in the previous section. Reflectors tend to be patchy relatively strong in places, and exhibits a distinct shallowing to the south east. This shallowing is consistent with the gravity field over the area, over which a broad high of some 15 milligals is present.

Both Horizon A and B can be confidently traced into this section and are generally flat lying up to station 12000S after which they shallow to the south east, although disrupted by a number of minor faults.

This shallowing parallels that observed for Horizon C in the south eastern end of the previous section.

The general shallowing of all horizons is consistent with shallowing of magnetic basement inferred from a series of short wavelength anomalies between stations 11000S and 23000S, which suggests a maximum depth of the order of 1000 metres. From 15600S all reflectors become less distinct. There is no obvious reason for this change since no apparent deterioration of surface conditions is evident.

Manya-4 located at station 21100S was designed to test the apparent shallowing of the Observatory Hill Beds. The lithology intersected consists of a sequence of generally soft claystones and sandstones to a depth of 432 metres. These overlie a relatively hard red bed dolomitic sandstone unit some 66 metres thick, which in turn overlies 298 metres of moderately hard to soft red bed sandstone. Granulite was intersected at 796 metres.

The velocity function at station 21000S is as follows:-

Horizon	Time (sec.)	Average Velocity (m/s)	Depth (M)
	.100	1800	
A	.175	1910*	167
	.180	1920	
B	.290	2200*	319
	.390	2450	
C	.432	2580*	557
	.620	3150	

Velocities marked with asterisks have been interpolated assuming a linear increase in velocity with depth.

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Correlation between lithology and seismic sections in this area is hampered by the difficulty in tracing events south east of 15600S, and of course by the lack of accurate velocity data. However, it is apparent that Horizon A is best correlated with the top of the Early Permian diamictite unit of the Boorthanna Formation which was intersected at 162 metres. The correlation with Horizons B and C is a little less clear.

It is not known at what stratigraphic level lie the red beds intersected in Manya-4. Density measurements on core indicates that the red beds between 432 and 498 metres have a much higher density, 2.55t/m^3 (S.D. 0.02 t/m^3) than the red beds between 498 to 796 metres, 2.36 t/m^3 (S.D. 0.06 t/m^3). This difference is clearly due to the increase in carbonate content in the upper unit. The granulite density has been measured at 2.62 t/m^3 (S.D. 0.06 t/m^3).

Based on this data and the observed interval velocities presented in section 2.4 it is reasonable to assume that an acoustic impedance contrast exists between the red beds and granulite and also between diamictite and red beds. However, an unambiguous correlation between the horizons and the above two interfaces is not immediately apparent. This can be seen if the expected arrival times of events are calculated from the various interfaces, using known depths and the maximum and minimum values of interval velocities for the various units.

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The results of these calculations are presented below:-

Interface	True Depth	Calculated Time		Observed Time
		Min.Vel.	Max.Vel.	
Jurassic Sand-stone/Diamictite	162	.161	.157	.175
Diamictite/Red beds (Upper)	432	.352	.317 (?)	.290
Red beds (upper)/ Red beds (lower)	498	.380	.345	?
Red beds (lower)/ granulite	796	.533	.498 (?)	.432

The interval velocity of the upper and lower unit of the red beds, i.e. 4800 m/s and 3850 m/s respectively were determined from the empirical velocity density plot of Gardner et.al. (1968).

A calculation of the reflection coefficients for the various interfaces suggests that the reflector from the diamictite/red beds interface should be a strong one and comparable to that of the red beds/granulite interface. Consequently, tentative correlations may be made between Horizon B and the diamictite/red beds interface and between Horizon C and the red beds/granulite interface.

Horizon D is based on an event which is very patchy in character and cannot readily be traced into this section. The quality of the event seems to deteriorate towards the south east. In the vicinity of Manya-4, Horizon D is not apparent, although a similar lithologic change occurs at a depth of 106 metres in Manya-4, to that observed in Manya-2, with which the horizon has been correlated.

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4.2.3 MINI-SOSIE PART 3, PLATE 8.

This section covers the area between stations 22000S and 37400S. The quality of reflectors in the north-western half of this section is very poor due to the lack of continuity, and consequently correlation of reflected events in the south eastern half of the sections with the interpreted horizons in the north west is subject to conjecture.

In the zone between 22000S and 24800S, continuity of reflectors deteriorates considerably, with events having a disrupted hummocky appearance. South east of 24500S the reflectors display fair to good continuity. However, between 25100S and 29400 the section is complicated by what appears to be complex step faulting which has downfaulted the sediments to the south east.

The apparent subsidence of the sediments to the south east is consistent with the hypothesis that the gravity field between 10,000S and 28,000S is the result of a broad basement uplift. This interpretation is corroborated by the magnetic data and drilling results.

It is evident that the horizons previously defined cannot readily be traced across the interval 21100S to 24800S. Horizon B in particular cannot be followed south east with certainty. Therefore in this section few reliable conclusions are possible and thus the treatment is largely qualitative.

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The deepening of Horizon A to the south-east implies a general thickening of Mesozoic and Tertiary sediments. This conclusion is valid only if the previous identification of Horizon A with the top of the Boorthanna Formation holds in this area. It is also possible that the Mt. Toondinna Formation thickens to the south-east, significantly up-grading the potential for coal.

A significant gravity low of some 1.2 milligals, between 28450S and 29100S, may be associated with a local Permian Trough, although it may also be due to a a thickening Tertiary sequence. The evidence from the seismic section is not conclusive, although a minor downwarping of Horizon B does seem to occur in the area.

Between 30700S and 33800S a 'cut and fill' structure truncates the generally flat lying reflected events. The feature is characterised by divergent fill seismic facies. The age of the structure cannot reliably be determined because of uncertainty in the identification of the horizons. There is no significant gravity anomaly directly associated with the feature, although a 0.3 milligal depression occurs between 29600S and 32000S.

South-east of 29400S except for the 'cut and fill' featue all reflectors are generally flat lying.

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There is no clear evidence from the seismic data that basement shallows as indicated by the gravity profile and the Mt Furner-1 and from coal exploration drill holes (Australian Selection (Pty.) Ltd., 1975). The latter work indicated that further to the south-east the Early Permian sediments lie directly on crystalline basement.

4.2 EXPERIMENTAL RESULTS.

Part of the seismic program consisted of a number of experimental surveys aimed at establishing an optimum survey design with respect to quality, coverage rate and the cost effectiveness. This information would enable design parameters to be chosen more effectively in future programs in the area.

The following experimental work was carried out:-

1. 1200% Mini-Sosie coverage between 4800S and 6700S to 9100S. These intervals were recorded using both a 1000 and 2000 ramming sequence.

2. 600% dynamite coverage between intervals 100S to 3600S and 6800S to 9100S.

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The 1200% coverage was obtained using the same spatial configuration adopted in the 600% coverage. The two BS60Y rammers were stationed 20 metres apart at the beginning of a ramming sequence, one at the start and the other in the middle of the 40 metre segment. Ramming was temporarily halted when a total of 1000 rams was recorded, to be stored on tape. At this stage both rammers progressed forward by 10 metres, resulting in the middle point of the ramming segment being 5 metres off centre.
The data was processed with this in mind.

The final 1000 rams were recorded as the two rammers walked the last 10 metres. The two ramming sequences were added resulting in a total of 2000 rams which subsequently were recorded on tape.

The result was two records for each 40 metre ramming segment with the centre of the 1000 ram segment being 75 metres offset from the nearest geophone.

The 600% dynamite coverage was achieved by laying the explosives in four holes 10 metres apart over the 40 metre segment. The explosives were put in shallow hand augered holes which were not more than one metre deep due to the inability of the augers to drill deeper.

On the advice of B. Long, a 2 oz charge per hole was used. The charges were lowered in the holes and then covered with sand after application of water to assist in the compaction of the sand.

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Each charge was fired, the data stored and summed to the previous one, resulting in a final record consisting of the sum of four charges which was subsequently stored on tape. The firing procedure was in accordance with the Department of Mines and Energy regulations.

On completion of the processing by SSL it was discovered that the surface conditions, as expected, downgraded the quality of the seismic sections. The problem was related to the application of statics. As part of the processing sequence two passes of C.D.P. aligned residual statics were made to the data in addition to the restricted field statics supplied by Comalco. To assess the effectiveness of the field statics the 1200% 2000 ram coverage of the interval 400N to 4800N was reprocessed without fieldstatics. The results are discussed below.

The seismic sections produced as a result of the experimental work are as follows:-

PART 1A	1200% @ 1000 rams Mini-Sosie	400N-4800S
PART 1B	1200% @ 2000 rams Mini-Sosie	400N-4800S
PART 1C	600% Dynamite coverage	100S-3600S
PART 1D	1200% @ 2000 rams Mini-Sosie	400N-4800S

Processed without field statics.

PART 2A	1200% @ 1000 rams Mini-Sosie	6700S-9100S
PART 2B	1200% @ 2000 rams Mini-Sosie	6700S-9100S
PART 2C	600% Dynamite coverage	6800S-9100S

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4.2.1 COMPARISON BETWEEN 600% AND 1200% MINI-SOSIE COVERAGE.

Seismic section 1A covers the area between 400N to 4800S. It was previously shown that the Observatory Hill Beds are generally within 200 metres of the surface, and are correlated with Horizon C.

The equivalent 600% coverage of the same area appears in Part 1. This was recorded using a 1500 ramming sequence; both sections were subject to the same processing sequence.

Comparison between 1 and 1A indicates that there is very little apparent change in frequency content. Reflected events in general are somewhat stronger and continuity improving in 1A. In Part 1 there is no indication of reflections from below 0.3 seconds. However, in section 1A a number of weak reflection events are discernible below 0.3 seconds. Except for this the 1200% coverage appeared to no great advantage.

Similar comparisons can be made between Part 2A and Part 1 between stations 6700S to 9100S. This section was chosen as a test site because in the 600% coverage, reflectors are clearly evident down to 0.6 seconds. As with the previous example, there is no major improvement in the 1200% coverage except for a small increase in continuity for some reflectors. In fact, there appears to be some deterioration of Horizon C towards the north west.

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From the comparisons it is concluded that a two fold increase in coverage from 600% to 1200% was not accompanied by an equal increase in definition and continuity of reflectors.

4.2.2 COMPARISON BETWEEN 1000 AND 2000 RAM SECTIONS.

To compare the difference between a survey recorded at 1000 rams to one recorded at 2000 rams, two test areas were considered, between 400N and 4800S and between 6700S and 9100S.

Parts 1A and 1B are the result of tests in the interval 400N to 4800S. Reflectors clearly are better defined in the 2000 rams section (1B), and the signal to noise ratio definitely improved. Still more improvement is evident between stations 3100S and 4800S because the shallow events are focussed and continuity is slightly improved. Similar conclusions apply to the results between 6700S and 9100S (Parts 2A and B).

Evidently an increase in ram number is accompanied by a small improvement in signal to noise ratio. A quantitative analysis of this improvement can be made only if a detailed study of the frequency content of each section is carried out.

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4.2.3 DISCUSSION ON THE DYNAMITE TESTS.

The results of the dynamite tests are presented in Parts 1C and 2C. Clearly, the results are disappointing.

Part 1C was recorded getween 400N and 4800S, where the Observatory Hill Beds are shallow. Previous Mini-Sosie coverage at 1200% failed to define any significant reflectors below the Cambrian Unconformity, and it is not surprising that this test also failed. However, it is also clear that the shallow events have not been satisfactorily defined.

Part 2C was recorded between 6800S and 9100S, an area where the Observatory Hill Beds are known to be at 522 metres below the surface. The section can be described as very poor with both shallow and deeper events ill defined.

The failure of the dynamite test can be attributed to three main factors.

(i) The inadequate amount of explosives used for the test. Although monitor records obtained during tests appear to be slightly richer in higher frequences it was difficult to see reflected events. This was also encountered in the Mini-Sosie work, consequently it was difficult to gauge the effectiveness of the explosives in the field. Care was taken not to use too much explosive power so as to not swamp the arrivals of reflections.

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(ii) The second factor is that the explosives were not in general placed below the weathering layer, consequently the energy transmission into the ground was not optimum. The thickness of the weathering layer varied from about 0.5 m to 12 metres, but the hand auger holes could not be drilled deeper than one metre.

(iii) The third and final factor relates to the application of the field statics. These were calculated from restricted refraction spreads. The effects of the restricted field statics is thought to be small and manifests itself in a general decrease in continuity of reflectors, particularly shallower events.

4.2.4 DISCUSSION ON STATICS.

The different time shifts observed in different traces can be attributed to lateral subsurface inhomegenieties such as variations in the thickness of the weathering layer. These time shifts are referred to as statics and clearly need not have the same value along the entire length of a trace since deeper sources such as salt, shale and facies changes give rise to time delays.

Naturally, the scale of the lateral inhomegeneity relative to the length of the spread determines the lateral resolution of events. In this survey the sand dunes and associated weathering profile plus the Tertiary silcrete layer caused static problems.

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To ascertain the variability of the first two factors a program of restricted refraction spreads was carried out. Soundings consisted of 100 metre spreads and were carried out every 500 metres in those areas which were thought to cause difficulties.

Both dunes and interdune areas were studied. Three layers were generally observed, and first and second layers were characterised by a greater variability in velocity than the third. The first layer was correlated with the Quarternary sand cover, and the second layer was correlated with more compact sands underneath. The first layer has an average thickness of 2.8 m and a velocity range of 300 m/s to 630 m/s. This represents a maximum delay of 0.019 seconds two way time.

Towards the south-east end of the traverse, fewer sand dunes occur. In this area the first layer was generally thinner than average and rested directly on the third layer. Silcrete rubble was common.

In the conclusion of this work it was apparent that lateral variations in velocity and/or thickness of the weathering layers were not very great, particularly over a distance of 500 metres. Consequently, it was decided to interpolate between refraction soundings and thus estimate the static corrections for the intermediate regions. These restricted field statics were applied to all sections.

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To investigate the influence of these field static corrections on a data sample, section 1C was reprocessed. Two passes of C.D.P. aligned residual statics were carried out and no field statics applied. The result is presented in section 1D.

The differences between the two sections are minimal. The range in field static corrections along the interval is from -8 ms to - 17 ms which represents a maximum relative change of - 9 ms from one trace to the next.

To further study this question, continuous refraction coverage was subsequently carried out over the same interval using 220 metres spread length and explosives as sources. The result of this work will be used when the data is submitted to another processing house to enable processing comparions to be made.

4.3 SUMMARY OF RESULTS AND CONCLUSIONS.

The quality of the seismic results is generally poor to very poor; There is very poor lateral continuity of reflected events and character and quality are highly variable.

It is felt that this result has been caused by two main factors. The first is the inability at the wackers consistenly to get adequate energy into the ground because of the sand dune cover and the presence of a variable silcrete layer.

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The second factor is the application of restricted field statics. The effect of these corrections on the data was not very noticable and therefore they may have a minimal influence on the section.

There were no marked improvements accompanying the two-fold increase in coverage from 600% to 1200%. Similarly, the differences between 1000 ram and 2000 rams sequence were small and only a small increase of signal to noise ratio resulted. However, because the production rate for a 1200% coverage at 1000 rams sequence is only marginally greater than the production rate for 600% coverage at 2000 rams (1.5 km/day cwf 1.1 km/day) the use of the 1200% coverage is always recommended because of the inherent increase in data definition. In this case the ground conditions were such that the expected increase in data definition was small. No reliable conclusions can be made regarding the dynamite tests due to the inadequate amount of explosive charges used.

Because of the generally poor data quality, the treatment of the seismic sections has been restricted to a qualitative assessment. Reliable interpretation of seismostratigraphy has not been possible, although a number of major horizons have been interpreted and tentatively correlated with known lithology.

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Horizon C maintains poor to fair quality over most of the traverse. The event first appears towards the south-eastern end of Part 1 and is seen to form a broad structural high between 10000S and 28000S. In the vicinity of Manya-2 it occurs in at about 0.66 seconds which, conservatively, is about 900 metres below surface. A tentative tie to Manya-4 identified the event with the top of crystalline basement. This is consistent with the gravity profile which shows a broad 15 milligal high over the same area. Similarly, ground magnetics indicate shallow basement between 12000S and 24000S.

Horizon B is a reflected event which maintains poor to fair quality along some of the survey line. At the north-eastern end of the traverse quality and continuity of Horizon B is very good, but deteriorates to the south-east. The structure of Horizon B conforms with the qualitative interpretation of the gravity data. Between 3000N and 5700S the horizon forms a broad structural high coincident with the Wintinna Gravity High.

To the south-east it follows the trend similar to Horizon C. In Part 3 the horizon could not reliably be correlated laterally. A tie to Manya-2 and 3 identified the horizon as the top of the Cambrian Observatory Hill Beds. It thus represents the Cambrian Unconformity surface. However, a tie to Manya-4 is tentatively identified the horizons with the top of a sequence of redbeds which may or may not be Cambrian.

Horizon A varies considerably in character over the whole traverse. The horizon appears to form monoclinal drapes over the Wintinna structural high suggesting that post depositional uplift occurred. A tie to Manya-3 suggests that it can be correlated with the top of the diamictite unit of the Early Permian sequence. This correlation held good in Manya-2 and 4.

Horizon D was reliably defined over a relatively small distance in Part 1 and 2. A tentative tie to Manya-2 identified the reflector with a change in lithology from coarse grained sandstones to predominantly fine grained sandstones.

The implications for the structural history of the Wintinna feature are schematically illustrated in the Plate 17. During the Cambrian Observatory Hill Beds were deposited probably in a marginal basin whose depocentre was to the north-east of Manya-4. This event was followed by a significant period of uplift accompanied with an erosional hiatus. The minimum erosion from the top of the structure was estimated to be about 130 metres. The erosion was, however, not sufficient to cause planation of the horst and by Early Permian times the horse still must have been a topographic high. A thin veneer of Boorthanna Formation was deposited on top of the horst. This was subsequently followed by the Mt. Toondinna sandstone and the other units of the Permian.

By the end of the Permian, deposition had stopped and was followed by minor uplift along the same fractures. Uplift may have occurred slowly right through the Permian. Subsequent erosion removed all but a small amount of the (?) Mt. Toondinna formation from the top of the horst. Finally, the Mesozoic and Tertiary sediments were deposited, completely covering the structure.

It was shown that the hypothesis of a carbonate-filled trough cannot account alone for the observed amplitude of the Wintinna Gravity High. It is proposed that the combined effects of an uplifted carbonate filled trough and intra-basement density change is the likely cause of the gravity feature.

5. RECOMMENDATIONS.

The poor data quality can be attributed to two main problems. The first and perhaps the most important is that of getting sufficient energy into the ground while the second is the result of adverse surface and subsurface conditions which created difficulties in static control.

It is felt that because of these two problems the Mini-Sosie technique as used in this survey is not appropriate for future work in the tenement areas. A dynamite survey with shot holes drilled below the weathering layer (and where possible below the silcrete layer) would yield a greatly improved result.

The problem with the dynamite test in this survey was that insufficient charges were used. Consequently, should any future seismic work be contemplated, dynamite coverage must be considered. The improved result would outweigh the extra costs incurred.

It is further recommended that a portion of the existing data be considered for reprocessing by another processing house such as Digicon. The continuous refraction profiling conducted over a portion of the traverse should be used to further study the effect of residual statics on the final section.

REFERENCES.

Australian Selection (Pty) Ltd 1975.Final Rpt.EL 184 SADME EN2556

Benbow & Pitt, 1980 Byilkaoora No.1 Well Competion Report. Rept.Bk No. 79/115 (unpub).

Bowman & Harkey, 1962.Seismic Survey Rept.Mabel Creek area by Namco Boort BMR. File 62/1588 (unpub.)

Comalco Quarterly Report. Feb. 1981

Comalco Quarterly Report. June-July 1981

Delhi Aust. Petroleum Ltd.1967 Interpretation of Airborne Magnetic Surveys in S.A.

Demaison 1969. Stratigraphic Drilling in the Arckaringa Basin Quarterly Geol.Notes;Geol. Survey S.A. No. 31.

Finlayson 1979. A Geophysical Interpretation with Depth to Magnetic Basement-TALLARINGA, GILES, MURLOCCOPPIE, 1:250,000 sheets.Rept.Bk No.79/80 (unpub).

Fraser 1976. Gravity Provinces and their Nomenclature BMR Journal Vol. N24

Gardner et.al. 1968 Formation Velocity and Density. The Diagnostic Basics of Stratigraphic Traps Geophysics Vol. 39 No. 6.

Gatehouse 1979. Wilkinson No. 1 Well Completion Report. Rept. Bk No. 70/88

Hall 1973. Seismic Investigations of the Wintinna Trough 1972 Rept.Bk No. 73/81 (unpub.)

Hall and Townsend 1969. Helicopter Gravity Survey of Areas Marginal to the Western Great Artesian Basin Rept.Bk. 68/55 (unpub).

Kendal 1967. Report on Well Velocity Survey S.A.G. COOTANOORINA No. 1 Rept. Bk 65/41 (unpub).

Kreig 1973. The Ammaroodinna Inlier Quart. Geol. Notes. Geol. Survey S.A.

Limb 1970. A Geophysical Interpretation of the TALLARINGA Trough and Karari Fault Zone Rept.Bk.No.80/123 (unpub).

Milton 1964. Report on Seismic Refraction probes and profiles Welbourne Hill to Coober Pedy Rept.Bk.No.59/104 (unpub.)

Milton 1969. Report on Seismic Operations - Western and Central Arckaringa Basin. Rept.Bk.No.7012 (unpub).

Milton 1970. Geophysical Exploration of the Arckaringa Basin Rept.Bk. No.71/59

Milton and Thornton 1970. Discovery of a Dense Lower to Middle Palaeozoic Dolomite in the North-West Arckaringa Basin. Quart.Geol.Notes. Survey S.A. No. 36.

Moorcroft 1969. Seismic Reflection Refraction and Gravity Survey Eastern Officer Basin 1966.

Nettleton 1970. Eastern Officer Basin Gravity Survey,PEL 10 & 11 SADME Env.1196 (unpub.)

Papalia 1979. Final Report on Weedina No.1 Well. Pexa Oil N.L. S.A.Env.1374 (unpub).

Pexa Oil N.L. 1970. Final Report on Weedina No.1 Well, S.A. Env. 1374 (unpub.)

Quilty & Goodex 1958. A Reconnaissance Airborne Magnetic Survey of the Ucla Basin, 1954. BMR Record 1958/87 (unpub).

.../2

Rait and Bowman 1967. Eastern Officer Basin Seismic and Gravity Survey. OEL 28 S.A.Env.829 (unpub.)

Steeland 1962. Final Report on Eastern Officer Basin S.A. and W.A. S.A. R578

Shorey 1966. Final Report on the Serpentine Lakes Reconnaissance Seismic Survey 1965-66 by S.S.L. or CONOCO. BMR File 65/11004 (unpub.)

Thornton 1971. Mount Willoughby No. 1 Well Completion Report Rept. Bk. No. 71/37 (unpub.)

Thornton 1975. Manya-1, Marla-1 Well Completion Report. Rept.Bk No. 75/106 (unpub.)

Townsend 1976 Stratigraphic Drilling Arckaringa Basin, 1969-1971. Geol. Survey S.A. Report on Investigation 45.

United Geophysical Corp. 1970 (a) Lake Conway Seismic and Gravity Survey for Pexa Oil N.L. S.A. Env. 1236 (unpub.)

United Geophysical Corp. 1970 (b) Peake Creek Seismic and Gravity Survey for Pexa Oil N.L. S.A. Env. 1495 (unpub.)

White & Youngs 1980. Cambrian Alkali Playa-Lacusstine Sequence in the North-eastern Officer Basin, S.A. Report N24 of the Officer Basin Study Group. Report Bk. No. 79/197.

Young and Gerdes 1966. Central South Australia Airborne Magnetics and Radiometric Survey S.A. BMR Record 1966/224 (unpub.)

PLATE 3.

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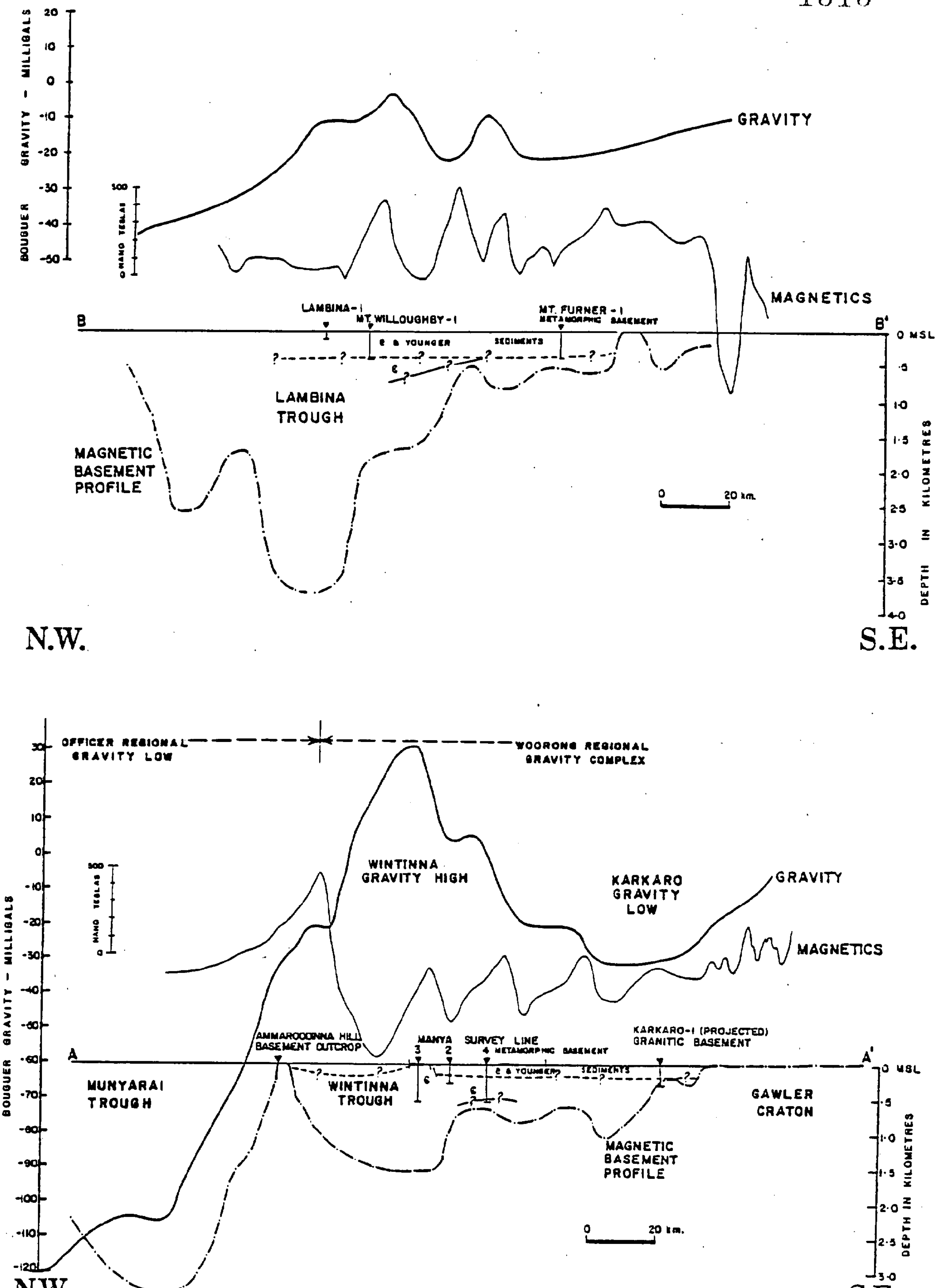

PROFILE OF GRAVITY & MAGNETIC BASEMENT

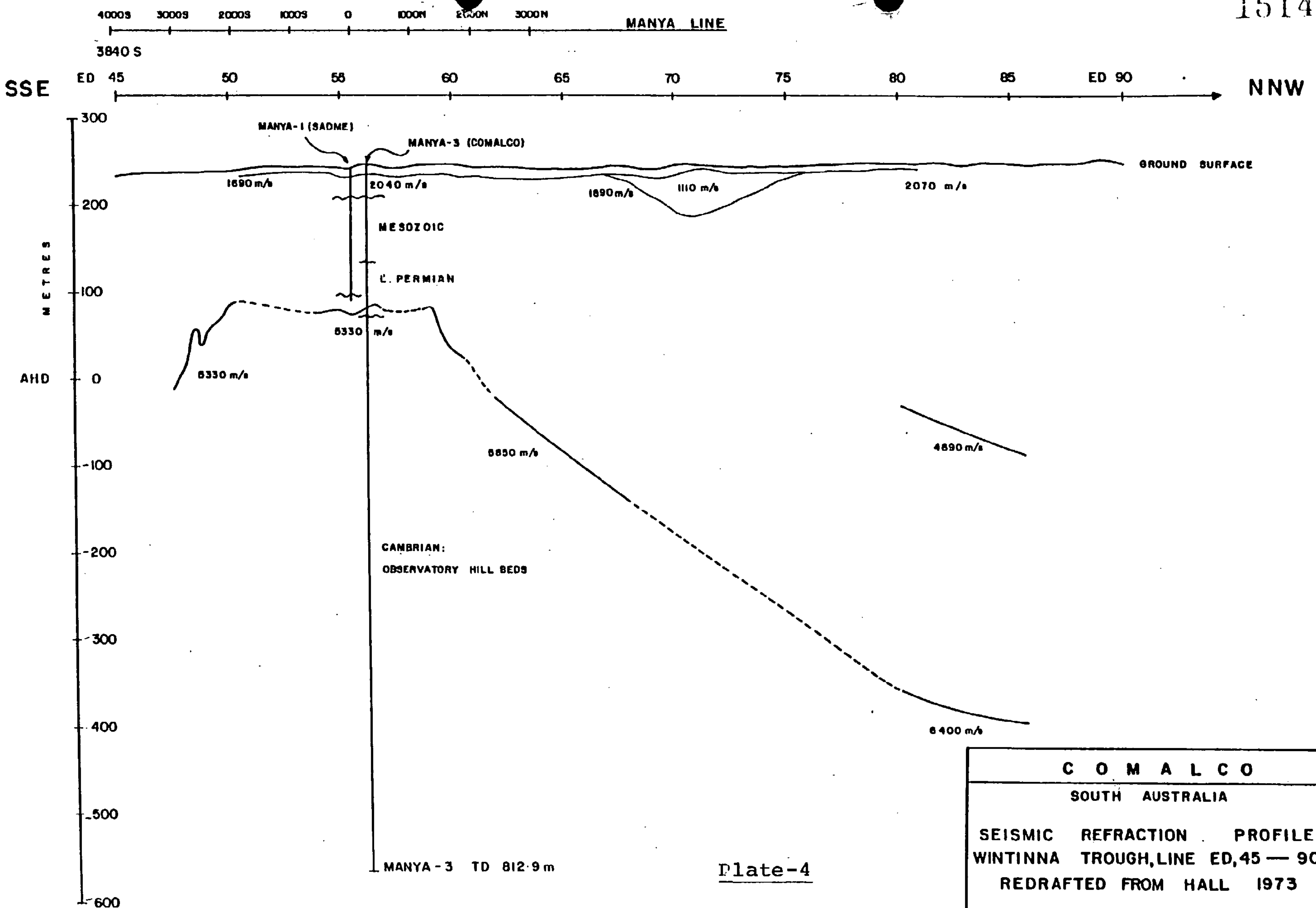

Plate-4

C O M A L C O		
SOUTH AUSTRALIA		
SEISMIC REFRACTION PROFILE WINTINNA TROUGH, LINE ED, 45 — 90 REDRAFTED FROM HALL 1973		
Compiled: J.C.	Revised:	Drawn: M.P.
Date: July, 1981	Scale: V. 1cm = 50m H. 1:731·5 (2400ft)	DrgNº SA-81-227